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STATISTICAL METHODOLOGY REVIEWS

1941–1950

STATISTICAL METHODOLOGY REVIEWS

1941–1950

EDITED BY

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JOHN WILEY & SONS, INC., NEW YORK
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PREFACE

THIS volume is the third in a series of publications prepared to assist research workers and statisticians to locate and to evaluate the statistical methodology books in all fields in which statistical methods are used. A detailed account of the initiation, growth, and objectives of this service to users of statistical methods was presented in the preface of *The Second Yearbook of Research and Statistical Methodology Books and Reviews.*

Plans for the continued publication of a new volume every two years had to be abandoned because of World War II. Even after the cessation of hostilities, the preparation of this volume was seriously delayed because of my failure to get sufficient financial support for clerical and editorial assistance. As a consequence, I had to abandon my original plans to expand the scope of this series to include bibliographies, abstracts, and reviews of the vast periodical literature. Owing to the long interval of time that has elapsed since the publication of *The Second Yearbook,* this volume has been entitled *Statistical Methodology Reviews, 1941–1950.*

This volume differs in several respects from earlier volumes in the series. (*a*) Previous volumes included books on research methods, scientific methods, social relations of science, collective biographies of scientists, and general histories of science, as well as on statistical methodology. This volume lists only books on statistical methods and such closely related subjects as probability and mathematics of statistics. (*b*) Previous volumes included the critical portions of all known book reviews, regardless of the quantity and quality of the reviews. Some selection has been made in this volume. The reviews that seemed least valuable have been omitted. In the case of widely reviewed books, some important reviews have been omitted in order not to give excessive space to any one book. (*c*) This volume covers a longer period of time—a ten-year period. (*d*) The name index has been changed to permit rapid identification of authors and reviewers. (*e*) "The Classified Index to Books" has been extended to include a listing of authors and publication dates for each subject.

The objectives of this series remain essentially the same as those reported in *The Second Yearbook of Research and Statistical Methodology Books and Reviews.* Except for a slight change made necessary by the omission of nonstatistical books, these objectives are:

1. To make students and teachers of statistics more keenly aware of the inadequacy of much of what is presented in textbooks and classes despite the fact that such statistical techniques are incorrect, inefficient, and obsolete.
2. To help students, teachers, and librarians to select textbooks with greater discrimination.
3. To point out to students and teachers the weak and strong points of particular books.
4. To assist more advanced students in keeping abreast of modern developments in monograph and textbook writing and criticism.

5. To encourage research workers to consider and examine statistical methodology books intended for workers in other fields.

6. To emphasize that there are marked differences of opinion even among the more advanced students of statistical theory in their appraisal of a particular book.

7. To indicate the vast extension of the fields in which statistical techniques are being found useful and necessary.

8. To discourage the writing and publication of stereotyped textbooks written by persons ignorant of modern developments in statistical theory.

9. To make readily available important and provocative statements which, though appearing in book reviews, have considerable value entirely apart from a consideration of the book under review.

10. To improve the quality of reviews by stimulating editors to take greater pains to choose competent reviewers who have the industry and the courage to contribute frankly critical reviews after a careful study of the book being reviewed.

11. To improve the quality of book reviews by stimulating reviewers "to take their responsibilities more seriously" by refusing to review books that they cannot, or will not, appraise competently and honestly.

This volume lists a total of three hundred and forty-two statistical methodology books written in English and published or reviewed in the ten-year period 1941–1950 in the following countries: Australia, Canada, Denmark, England, Holland, India, Puerto Rico, Scotland, South Africa, Sweden, Switzerland, and the United States. Less than three percent of these books were also included in *Research and Statistical Methodology Books and Reviews, 1933–1938.* The present volume includes a total of eight hundred and forty-two review excerpts from one hundred and twelve journals. Except for books and reviews published in the last two months of 1950, the coverage is believed to be fairly comprehensive for the ten-year period 1941–1950.

Rutgers University has played an important part in the preparation of *Statistical Methodology Reviews, 1941–1950.* I am greatly indebted to the Rutgers University Research Council for the financial assistance it has given to this project. Without such support, this volume could not have been completed. I am also grateful to the Rutgers University Library staff for facilitating my use of the library resources and to the School of Education for sponsoring my work.

I have been most fortunate in having had the assistance of an exceptionally able group of part-time workers in the preparation of this volume. It is with special pleasure that I express my thanks and appreciation to Sheila C. Brantley, Luella Buros, Robert O. Gleason, Norman Levison, Doris G. McCan, Gertrude Rauch, and Ruth Thurlow for the efficiency, loyalty, and patience with which they have assisted me in preparing the manuscript and seeing the book through the press. Special mention should be made of the services of three of the above-named assistants: Mrs. Thurlow who served as chief proofreader; Mrs. Rauch who served as copyreader in addition to typing most of the manuscript; and my wife, Luella Buros, who was largely responsible for the design of the book in addition to typing a part of the manuscript.

Readers are urged to bring to my attention errors of omission and commission. I should be grateful for criticisms and suggestions which will help me to make future issues in this series more useful. Since I hope to expand the scope of this series to include the periodical literature, it would facilitate my work considerably if authors would send me reprints of their articles on statistical methods.

OSCAR KRISEN BUROS

New Brunswick, N. J.
April 17, 1951

HOW TO USE THIS VOLUME

The following suggestions should be carefully read by all persons wishing to get the maximum value out of *Statistical Methodology Reviews, 1941–1950.*

1. *Contents.* The table of contents should be consulted to get an over-all picture of the volume's contents.

2. *Page and Entry Numbers.* Two sets of numbers appear in this volume—page numbers and entry numbers. The page number appears next to the inside margin on each page and is set off from the rest of the running head by a bracket. The numbers on the contents page refer to pages; *the numbers in the indexes and in the cross references refer to entry or book numbers.* The entry numbers for the first- and last-listed book on each pair of facing pages appear next to the outside margins. Readers will generally use entry numbers rather than page numbers.

3. *Classified Index of Books.* A roughly classified subject index (pp. 454–6) will assist the reader to locate books on a particular subject. In addition to using this index, readers are urged to skim over titles and excerpts in search of works that otherwise might be missed.

4. *Book Entries.* The books listed in the section "Books and Reviews" are arranged in alphabetical order by authors. Rather complete bibliographic information—including both American and British publishers and prices—has been presented for each book. Stars indicate new books not previously listed in this series. The asterisk following a book entry indicates that the editor has examined the book to determine relevancy and to insure an accurate bibliographic listing.

5. *Review Excerpts.* Excerpts from book reviews originally published elsewhere are arranged under each book in alphabetical order by journals. Reviews that included no critical comment are not listed. Many of the least important reviews have been omitted. Some important reviews have been omitted in the case of widely reviewed books. A few reviews which appeared in *Chemistry and Industry* and *Science Progress* are listed but not excerpted because of copyright restrictions. References to the original reviews have been made in a few instances where the reviews were unusually long. Asterisks and ellipses within excerpts indicate the omission of nonevaluative material which appeared in the original review; asterisks indicate a break in continuity of reading, and ellipses indicate continuity of reading.

6. *Cross References.* Cross references to later editions of a book follow the book entries. Cross references to reviews of the same or earlier editions of books either in this volume or in earlier volumes follow the excerpted reviews. Cross references are to be interpreted thus: "see 286" means to see entry 286 in this volume; "see 36:B82" means to see entry B82 in *Educational, Psychological, and Personality Tests of 1936*;* "see 38:B603" means to see entry B603

* Buros, Oscar K. *Educational, Psychological, and Personality Tests of 1936:* Including a Bibliography and Book Review Digest of Measurement Books and Monographs of 1933–36. Rutgers University Bulletin, Vol. 14, No. 2A; Studies in Education, No. 11. New Brunswick, N.J.: School of Education, Rutgers University, August 1937. Pp. 141. Paper. $0.60.

in *Research and Statistical Methodology Books and Reviews, 1933–1938*† (or *The Nineteen Thirty Eight Mental Measurements Yearbook*‡); "see 2:47" means to see entry 47 of *The Second Yearbook of Research and Statistical Methodology Books and Reviews.*§

7. *Catchwords.* The running heads present catchwords to assist readers in the location of particular material. In the section "Books and Reviews," the last names of book authors are used as catchwords. In the indexes, one or more words showing the alphabetical sequence of the index are used as catchwords. In all cases, the catchwords refer to the first- and last-listed items in the alphabetical sequence on each pair of facing pages.

8. *Periodical Directory and Index* (pp. 435–40). The major purpose of this directory and index is to serve as a key to the abbreviations used for excerpted journals. Additional information presented includes the frequency of publication, date of the first issue in a recent volume, price, and the names and addresses of the editor and review editor.

9. *Publishers Directory and Index* (pp. 441–3). The major purpose of the directory and index is to provide addresses of book publishers.

10. *Index of Titles* (pp. 444–8). If only the title of a book is known, the quickest way to locate it is to use the Index of Titles, an alphabetical listing of all books in this volume.

11. *Index of Names* (pp. 449–53). This index lists the names of all authors, reviewers, and other persons referred to in book entries. The abbreviations and numbers following the names may be interpreted thus: *"bk,* 167" indicates authorship of book 167; *"exc,* 112" indicates authorship of an excerpted review of book 112; *"misc,* 289" indicates that the name is mentioned in the entry for the book for some other reason.

† Buros, Oscar Krisen, Editor. *Research and Statistical Methodology Books and Reviews, 1933–1938.* Highland Park, N.J.: Gryphon Press, 1938. Pp. vii, 100. $1.50.

‡ Buros, Oscar Krisen, Editor. *The Nineteen Thirty Eight Mental Measurements Yearbook.* New Brunswick, N.J.: Rutgers University Press, 1938. Pp. xv, 415. Out of print.

§ Buros, Oscar Krisen, Editor *The Second Yearbook of Research and Statistical Methodology Books and Reviews.* Highland Park, N.J.: Gryphon Press, 1941. Pp. xxi, 383. $5.00.

REVIEW WRITING AND EDITING

The publication of this volume presents reviewers and editors with an excellent opportunity to re-examine and to re-evaluate their own policies and practices with regard to the reviewing of statistical methodology books. This series presents a fairly comprehensive collation of the statistical methodology book reviews published in English-speaking countries over the past eighteen years. It is my hope that critics will take advantage of this wealth of material and will make a thorough review of the reviews and present recommendations for improving reviewing of statistical methodology books. It is my belief, based upon my experience as editor of this series and as book review editor of the *Journal of the American Statistical Association* during the years 1945–1949, that some progress has been made in improving the quality of book reviewing in statistics in recent years. Nevertheless, I believe that there is a pressing need for better review writing and editing.

Very few reviewing journals give book reviewers suggestions as to how reviews should be written. The length of the review is usually the only specification. It may be that no other suggestions should be given. In order that reviewers and editors may be in a better position to judge for themselves, I am presenting the following excerpts from a mimeographed sheet, "Information for Reviewers," which I prepared for the guidance of reviewers during the five-year period that I was review editor of the *Journal of the American Statistical Association:*

1. Reviewers are requested to review a book with the following two objectives in mind: (*a*) To provide readers with a scholarly appraisal of the book for their reading guidance. (*b*) To stimulate progress toward higher professional standards among statisticians by praising good statistical writing and scholarship and by censuring poor statistical writing and scholarship.

2. Reviewers are requested to describe and evaluate rather than summarize a book. Both good and bad features of a book should be specifically pointed out in a judicious manner. An indication of the importance and value of a book relative to competing books is desired. Minor typographical and computational errors should not be stressed; however, errors that are likely to cause readers trouble should be pointed out. Emphasis should be given to the methodological aspects of the book even though the methodological contributions are only secondary to the main purpose and value of the book.

3. Reviews should be of whatever length is necessary to present a scholarly criticism of the book. In general, it is expected that most reviews will run between 500 and 900 words in length.

4. Reviewers who will write frankly critical reviews in a scholarly and objective manner are desired. A reviewer who does not consider himself in a position to review a book objectively because of personal friendship for, or dislike of, the author, or for other reasons, is expected to decline an invitation to review the book.

5. In order to secure reviews representing various viewpoints, two or more reviews will be published for many of the books.

6. Anonymous reviews will be published occasionally whenever anonymity appears necessary in order to secure a review of the quality desired.

TABLE OF CONTENTS

PREFACE v

HOW TO USE THIS VOLUME vii

REVIEW WRITING AND EDITING ix

BOOKS AND REVIEWS 1

PERIODICAL DIRECTORY AND INDEX 435

PUBLISHERS DIRECTORY AND INDEX 441

INDEX OF TITLES 444

INDEX OF NAMES 449

CLASSIFIED INDEX TO BOOKS 454

BOOKS AND REVIEWS

[1]

★Acceptance Sampling: A Series of Papers and Discussion on the Subject of Acceptance Sampling Delivered at the 105th Annual Meeting of the American Statistical Association at Cleveland, Ohio, on January 27, 1946. Washington, D.C.. American Statistical Association, 1950 Pp. iv, 155. Paper. $1.50. *

J Am Stat Assn 45:145–7 Mr '50. H. A. Freeman. * two parts, acceptance sampling by attributes (78 pages) and by variables (71 pages) * First, attributes. This opens with a brief, well-written probe by Paul Peach into the earlier history of the field * Attention is paid to the similarity of the development of sampling inspection theory and statistical theory, in particular, to the interesting correspondence of Dodge's producer and consumer risks with Neyman and Pearson's errors of the first and second kind. Edwin Olds follows with a workmanlike account of the 1941–1945 period. * The closing bibliography is excellent. The article is a nice blend, heavy neither in mathematical or inspection detail. Olds makes no critical comparison of these plans; he has a good word for each. * the informal discussion ....is most engaging. It is gay, pleasantly chaotic, and discloses a fund of wisdom as well as a mild feud or two. John Curtiss of the Navy, Bellinson and Schwartz meet somewhat obliquely on a favorite topic, Army and Navy inspection, and the text is soon brightened by such familiar phrases as "the traditional policy of the Navy...." There are a few spirited paragraphs on zero acceptance numbers and an instructive if randomized discussion of critical versus non-critical defects. In the free-for-all I would declare Curtiss the winner, a victory which suggests that the war-time superiority of Army over Navy inspection may be temporary. * The second half, sampling inspection by variables, is very interesting. This area has seen fewer applications, and the result is a freshness which attribute inspection lacks. Moreover, the mathematics here is more interesting and unsolved problems are many. The two principal papers, by Curtiss and Allen Wallis, are excellent. While both speakers have had experience with applications in this relatively new field, they stay close to statistical theory. Curtiss develops his discussion from the basis of null and alternative hypotheses, using the apparatus of size and power. Dealing only with single sampling and largely with normal variables he discusses tests of hypotheses on the mean, with variance known and unknown, and tests of hypotheses on the variance. These tests are well-known but they are particularly well described here. Also discussed here and less well-known in inspection circles are Stein's test, Bernstein's (rather than Tchebycheff's) inequality and the problem of using several parameters to measure quality. The subtle question of whether one is accepting a lot or a process, a question which is seldom asked let alone answered in the literature, is considered. Finally there are compact tables of various pairs of null and alternative hypotheses, best statistics and the corresponding critical regions, all for single sampling. This is certainly an effective paper and one that cannot be found elsewhere. Wallis's shorter paper is equally fine; it is the one principal paper of the meeting that contains original results. The problem here is to test hypotheses on the proportion de-

fective by use of a statistic of continuous variates. This leads for single sampling to non-central t, whose application to this problem was originally developed, I believe, by Jennett, Johnson, and Welch; Wallis gives a number of useful approximate formulae (some original with him) for this case, including that of the power function of the test. He then turns to an area in which he has done pioneering work—sequential tests, using statistics of continuous variates, of hypotheses on the proportion defective. This leads, at least in principle, to the best of best tests, for both the merits of the sequential method and those of continuous variates are present. The prepared discussion matches the two papers, with all discussors, particularly Kenneth Arnold, Joseph Daly, and Alexander Mood, making solid contributions. Thereafter, the open discussion makes a slow slide to an agreeable mixture of information and conversation. Finally, John Tukey's excellent closure, classifying and summarizing the contributions of the discussors, with pertinent remarks of his own. The passage of time has not dealt kindly with this book, for interest in sampling inspection is not quite what it was in 1946. Moreover, some of the material has already been published; Wallis's 6-page paper is contained in a 91-page paper published elsewhere. But it is an interesting book now or anytime. Along with the Statistical Research Group's *Sampling Inspection* (by attributes) and the forthcoming book by Albert Bowker and his Stanford associates on sampling inspection by variables, it will provide enough information on the theory and mechanics of sampling inspection to satisfy almost all of us. A vote of credit should go to Chairman John Tukey and to his two associates, Frederick Mosteller and Charles Winsor. The assembly of a book of this sort must have been an arduous task; they have done their work well. They deserve thanks, too, for editorial restraint. Such passages as

"Curtiss: I mean the last thing he was doing, about subdividing the stuff. I thought that covered it.
Mosteller: I thought Colonel Simon had some stuff on that in his book
Chairman: Well, is the discussion running down to an end or does somebody want to say something?"

may contribute little except to printing costs, but they give the book, as they must have given the discussion, a gentle air of informality and irresponsibility, probably necessary conditions for important contributions. Necessary or not, the result is a good book, full of important fact and authoritative opinion; in fact, it's full of stuff.

[2]

★Federal Dimensional Quality Control Primer: A Simplified Method for Applying Quality Control to Dimensions, Revised Edition. Providence, R.I.: Federal Products Corp., 1946 Pp. 38. Paper. Gratis. *

J Am Stat Assn 41:247 Je '46. Casper Goffman. * the present treatment would at first sight have greater appeal for the shop supervisor or inspector than most existing presentations. On the other hand, it offers no convincing explanation of the practical meaning of statistical control or of the relationship between control chart limits and specification limits. Indeed, the reader is likely to acquire a false understanding of the latter since the control chart limits on averages of 5 are likened to the 3 limits of a frequency distribution for individuals. No mention is made of a frequency distribution for averages of 5. The reader is likely to believe—as many users of control charts do until shown otherwise—that a process will make good parts if it is in control and has control chart limits within the specification limits. The practical consequences of this misunderstanding can be drastic. * Another technique, not a control chart technique,....consists of drawing action limits at calculated distances from the tolerance limits. The reviewer feels that this method merits greater attention than has been given to it in the book, especially since it has wide application to machining operations with tool wear. *

J Am Stat Assn 41:248–9 Je '46. Lloyd A. Knowler. Although....probably written to aid in the sale of precision measuring instruments, it is worthy of rather careful attention by one interested in....quality control. * In general the ideas of variation are rather well developed. However, figures 8 and 9 might be a little confusing since the frequency curve representing the entire lot in figure 8 is not the sum of the separate parts; and the 3σ limits and the average in figure 9 do not refer to the data set out on the chart. Again some disagreement might result from what was meant to be an elementary analysis of a car on a highway in figure 10. A reader might question the wisdom of recording the data to four figures as on the work sheet in figure 11 when the deviation from the mean or

a nominal would represent much less work, decrease the error hazards, and make calculations simpler. Also, the advisability of rewriting the largest value and the smallest value in computing the range is questioned. The numerical calculations on this work sheet might be rechecked: $\bar{R}$ = .0004 is apparently obtained by dividing .0069 by 15. This discrepancy alters the numerical work and some of the analysis on the following pages. As with many statistical papers, some new notation and variation from somewhat standard procedures have been developed. For example, $\bar{\bar{X}}'$ and $\bar{R}'$ denote standard values instead of $\bar{X}'$ and R' as set by the American War Standards; crosses have been used for averages and circles for ranges instead of using the same notation for each chart; broken lines have been used as guide for averages, and vertical ones for ranges—this was defended but probably not too convincingly. The difficult subject of control limits as related to tolerance or specification limits might very well be rewritten. No test formula is given (one might be implied, but it would be necessary to know theory or method to get it) to determine whether or not individual items meet specifications when the process is in control. The examples and analyses....are much better chosen than in the first printing. The booklet is of convenient size, has an attractive appearance, and is easily read. The illustrations, diagrams, and pictures are interesting. * It is recommended that the *Primer* be read by those interested in quality control by statistical methods. It represents a considerable amount of work. Federal Products Corporation is to be commended for making more readily available, material on this important phase of quality control by statistical methods.

[3]

★**1000 Pictorial Symbols.** New York: Pictograph Corp., 1942. Pp. vii, 57. Paper, spiral binding. * For latest edition, see 4.

[4]

★**Pictorial Symbols, Second Edition.** New York: Pictograph Corp., 1943. Pp. 69. Paper, spiral binding. Out of print.

[5]

★**The Place of Statistical Methods in Biological and Chemical Experimentation.** Annals of the New York Academy of Sciences, Vol. 52, Art. 6, Pages 789–942. New York: the Academy, March 10, 1950. Pp. 789–942. Paper. $2.25. *

[6]

★**Proceedings of the Auburn Conference on Statistics Applied to Research in the Social Sciences, Plant Sciences, and Animal Sciences, September 7–9, 1948.** Auburn, Ala : Statistical Laboratory. Alabama Polytechnic Institute, 1948. Pp. xii, 91. Paper, lithotyped. Gratis (10¢ mailing charge). *

Agron J 41:395 Ag '49. A. A. Hanson. * In the section on plant science J. A. Rigney discusses "Techniques in Field Plot Experimentation," in which he considers such important aspects as shape and size of plots, replication, number of locations and seasons, and subsampling. A rather general lecture by G. W. Snedecor on "Some Principles of Experimental Design" emphasizes the need for experiments that are capable of yielding unambiguous answers to the questions asked. Lectures by H. L. Lucas and R. E. Comstock will be of particular value to those workers concerned with animal experimentation. Although the articles and abstracts are quite brief they have been carefully prepared so as to be as informative as possible in the space provided.

[7]

★**Statistical Workers.** Occupational Briefs on America's Major Job Fields, No. 185. Chicago, Ill.: Science Research Associates, Inc, 1947. Pp. 4. Paper. Single issues not sold. *

[8]

★**Symposium of Papers on Statistical Quality Control.** Birmingham, England: Quality Control Panel, Birmingham Production Committee, Ministry of Production, [March 1945]. Paper. Pp. 76. Out of print. *

J Am Stat Assn 41:121–3 Mr '46. Irving W. Burr. * The opening paper is a good general introduction to the problems of where and how to use the methods in a plant. Mr. Sealy's paper explains clearly the basis of measurement control charts and the relationship of control limits and specifications, bringing in modified control limits. Mr. Desmond gives the typical application of fraction defective and then discusses the advantages of using a compressed or narrow tolerance and studying by chart the number of cases outside these limits. In this way there are enough "rejects" to enable the use of small samples. Both papers are well illustrated with diagrams and shop problems. Neither paper would be quite complete for the beginner, but both contain useful material. The three application papers are excellent for presenting the kinds of problems which are met in practice, their solution and the general economic value of control chart methods. An industrial man will find many useful tips and adaptations, such as, a sampling compromise (last two pieces from the machine and three at random from the tote box) and the group control chart for auto-

matics (McNaughton), the extent of applications (Baker), and the economic decision of when and when not to use the methods (Webb). Mr. Swan's paper discusses the problem of designing single and double sampling inspection plans for attributes. The aim would seem to be to help one design his own sampling plan. The general outline for single sampling is (*a*) to choose the maximum number of pieces which can be called a lot, (*b*) to decide what is the maximum percentage of a lot which one can afford to inspect, (*c*) to determine the process average and decide upon the producer's risk at this level, and (*d*) to decide what consumer's risk to assume for some to-be-determined lot tolerance fraction. There will then be several choices of pairs of sample size and lot tolerance quality. The practical choice can be made to minimize the former or to use the lowest value of the latter. This is an interesting approach and may well be that desired by some operators. The paper is not, however, very clearly written and in particular it is difficult to find out what mathematical methods were used in the derivations. For example, the Poisson, binomial or hypergeometric distributions are not always indicated, the basis of Table IV is not presented, nor are there adequate references. On page 50 after Table III, there seems no particular reason why a sample for 105 and lot tolerance of 5 per cent would not better meet the author's desires. Mr. Swan's double sampling plan involves two equal samples making up the equivalent of a single sample. This may or may not be an economical set-up. The section "Operating a Double Sampling System" contains two serious defects. The Operating Characteristic of a process is "the way in which the quality swings up and down about an average percentage of defectives." The point is that even when the quality level is stable at say 1 per cent defective, the fraction defective of lots actually sent will vary around this level in a random and well understood manner. Knowing the probability of acceptance of a lot of any given fraction and the probability of occurrence of such a level, then one can by using the latter as weights find an average outgoing quality for the manufacturing stream which is under control at 1 per cent. Average amount of sampling inspection is similarly available. Mr. Swan errs, however, in using as weights, not the probability of such lot quality levels, but the probability of such sample levels. Hence his averaged results are meaningless. The second point is that it is actually unnecessary to use the weighting of probability of occurrence of each lot level, because if the process level is at 1 per cent this gives a constant probability of occurrence of a "pass" sample and of a "reject" sample *a priori*. The sampled part of the lot is not correlated *at all* with the remainder of the lot (if the process is stable at 1 per cent). It is as though we were to take a sample of 150 consecutive pieces from the process, make our decision to pass or reject and then to choose 850 more to complete the lot. The quality in the remainder will average 1 per cent in the long run regardless of what has happened in the first 150. Looked at this way it is a most simple matter to calculate the average outgoing quality. The method using lot quality weights looks convincing, sensible and correct, because it is. But so is the above simpler method. The two give the same results because both are correct. Mr. Swan's paper has many interesting points for one familiar with say the Dodge and Romig tables * It is scarcely safe nor clear reading, however, for one relatively unfamiliar with sampling inspection by attributes. Mr. Rodgers primarily discusses two topics: tests of normality and analysis of variance. Neither topic is discussed fully enough to be very helpful to the practical man. Ranges are used for the analysis of variance, which is useful. It is not possible to check upon the accuracy of the suggested methods since the interpretations, tests and applications to be made are not indicated. The book as a whole has much of interest to well repay careful reading.

J Am Stat Assn 41:123–5 Mr '46. Paul Peach. * The lectures must have been effective and successful, but in printed form they will.... be interesting chiefly as history, not as reference or teaching material. For illustration, consider the last sentence of Lecture 1, by Mr. Sealy, on control charts for measurements: "The lecture was then illustrated by several examples of charts taken from actual factory practice." The presentation and discussion of these charts must have been one of the highlights of the meeting; but nothing more appears in the printed version. * A second objectionable feature has to do with the figures. * In Sealy's lecture the figures are dispersed through the text, but for the rest all figures are collected in a sort of appendix to the lecture; this makes for awkward reading. The awkwardness is in-

creased for American readers by the use of w instead of R for range; the references, too, are chiefly to British sources. The lectures....by McNaughton, Webb, and Baker are practical talks which must have been very effective when delivered and retain much of their effectiveness in print. * Lecture 5, by A. W. Swan, was of particular interest to this reviewer. It is a discussion of acceptance sampling for lot-by-lot inspection. Swan gives credit to Capt. A. H. R. Grimsey....in connection with the single and double sampling plans here presented. These plans are based on the ratio "Maximum Allowable/Process Average," as are the Dodge-Romig tables of 1929 and a table recently devised by the writer and a colleague; the Swan-Grimsey single sample tables are not especially compact, and overlook the simplification that can be obtained by using chi-square. Swan and Grimsey also propose the use of two equal samples for double sampling, thus again anticipating this reviewer. The Swan-Grimsey double sampling plans are arrived at by trial and error, with considerable computation. No adequate tables are given. However effective the spoken lecture may have been, the written presentation is difficult to follow. * The lectures....served a purpose, and an important one; but the pamphlet itself.. will have little utility in the postwar period.

[9]

★**Tables of the Binomial Probability Distribution.** Foreword by Churchill Eisenhart National Bureau of Standards, Applied Mathematics Series, No. 6. Washington, D C Government Printing Office, 1950. Pp x, 387 $2.50 *

J Am Stat Assn 45:474 S '50 Margaret A. Labadie. * These tables are more extensive than any now published the individual terms run $p = .01(.01).50$, $n = 2(1)49$ and $r = 0(1)n - 1$ and the partial sums run $p = .01(.01).50$, $n = 2(1)49$ and $r = 1(1)n$ *

[10]

★Abbott, J C, and Binac, T J **Principles of Counting and Probability.** Annapolis, Md: U.S. Naval Institute, 1947 Pp. iii, 40. Paper. $1.00 *

J Am Stat Assn 44:133–4 Mr '49 Herbert Solomon. * Intended primarily for students in naval science, particularly naval gunnery. However, the illustrations and exercises are directly analogous to those encountered in aircraft gunnery and bombing procedures. * An attempt at every fourth exercise revealed no irregularities in the published answers. Chapter I has some faint rumblings of set theory but mainly presents, in a very brief manner, material on permutations and combinations which can be found in any of the standard textbooks. Chapter II presents some of the fundamental theorems of probability in a simple nonrigorous manner which is, no doubt, exactly the intention of the authors. * The only probability distribution discussed is the binomial distribution and very little of its characteristics are studied. The multinomial distribution is left to the exercises. A noticeable omission is the normal distribution which plays a very important part in fire control studies in military and naval science. * except for its illustrations and exercises the material contained can also be found in many easily accessible books on algebra and mathematical probability.

[11]

Aitken, A C **Statistical Mathematics.** Edinburgh, Scotland Oliver & Boyd Ltd., 1939 Pp vii, 153. 5s. (New York Interscience Publishers, Inc., 1940. $2.25) * [The second, third, fourth, and fifth "editions" of this book appear to be reprintings, with minor corrections, and consequently are not listed separately.]

J Appl Physics 12:357 Ap '41. Walter A. Shewhart. This clear, concise survey of the mathematical basis of statistics presumes a knowledge of algebra up to the binomial theorem and the simpler infinite series, and of elementary calculus. It treats, with a marvel of compression and from a modern viewpoint, the concept of probability, the most common probability distributions, the elements of correlation, partial correlation, and regression, the sampling distributions of the simpler statistics, and comments on the problem of estimation. Elegance and brevity are attained by the introduction of the generating function in some of its most important forms. The book should be of great value to the physicist, chemist, or engineer interested in attaining with minimum effort a sound introduction to mathematical statistics.

J Appl Physics 14:223 My '43. E. C. Molina. * destined to rank as a classic. In the opening chapter the author distills, into the remarkably short space of ten pages, the literature on the history and philosophy of statistical and probability theory. Thereafter he runs through the entire gamut of probability principles and statistical techniques * The book has no preface so that the audience for which it is written is itself a question of probability; one not easy to answer. * a splendid résumé to one who has

digested the contents of at least half a dozen standard works on statistics, or probability; it will coordinate his previous reading and greatly improve his general perspective of the subject. The engineer, or physicist, will find the going hard. But it will pay him to master the text from *a* to *z* even if such mastery calls for considerable collateral reading. The statements in this paragraph are colored by comments from colleagues to whom the reviewer presented copies of the book under consideration.

For additional reviews, see 2:1.

[12]

★ALBRITTON, ERRETT C. **Experiment Design and Judgment of Evidence.** Washington, D.C.: the Author (George Washington University), 1946. Pp. iv, 52. For latest edition, see 14.

[13]

★ALBRITTON, ERRETT C. **Experiment Design and Judgment of Evidence, [Second Edition].** Washington, D.C.: the Author (George Washington University), 1948. Pp. vi, 114. For latest edition, see 14.

J Am Med Assn 138:1067 D 4'48. The stress ....is implied by the title; it is a book on experiment design and not a statistics book. * Albritton has succeeded to an amazing extent in presenting these somewhat abstract statistical concepts in a form which is usable by physicians in medical research. The favorable reception given the earlier brief edition will undoubtedly be far exceeded by the reception given the new edition.

Q R Biol 24:179 Je '49. A. Chapanis. This is a highly interesting manual with a worthwhile aim. It attempts to teach medical students the logic underlying the use of the experimental method in clinical medicine. Thus, although it must deal with statistical methods, it is not a textbook of statistics. It considers such topics as correlation and causation, the procedures for designing an experiment to investigate the effect of one variable on another, the necessity for having "control" observations, and the techniques by which experimental results can be evaluated statistically. One chapter contains a series of carefully worked out, model experiments so that the researcher can select a valid procedure for his own purposes. Another chapter applies the principles to the evaluation of experimental data reported in the *Journal of the American Medical Association* and other medical journals. Despite its worthwhile aim, this manual has some serious deficiencies. The author is careful to point out that correlation, in a statistical sense, does not imply causation, but he then goes on in the rest of the manual to talk about agent A "causing" a change in X. The extremely important point about how an investigator can validly infer causation from an experiment is treated much too glibly to satisfy a meticulous reader. In some places, too, the author is wrong—dangerously wrong, considering the aim of the manual. In discussing differences in the variability of data, for example, he presents a chart showing two hypothetical sets of blood pressure readings. About this graph he says, "In the succeeding graph it is possible again to reject the null hypotheses *on sight* (the emphasis is the reviewer's)....without estimating $\frac{1}{2}P$ for the difference in variability, we judge that the varability in the second group is significantly greater than that in the first...." Actual computation shows that the difference is barely significant. Now this guesswork is dangerous because the author is attempting to teach the student to avoid precisely this kind of uncritical judgment. In another place Albritton talks about the calculation of chi-square for cell frequencies of 8 and 2. This is just the kind of situation for which chi-square has questionable validity. He discusses the calculation of a coefficient of variation without pointing out an important limitation that is a matter partly of logic and partly of statistics, namely, that the coefficient of variation is valid only when the scale in which the event is measured has the properties of a ratio scale. The author has undertaken an extremely important mission. Since the manual is apparently undergoing yearly revision, perhaps the next edition will contain the precision that is so necessary to this topic.

[14]

★ALBRITTON, ERRETT C. **Experiment Design and Judgment of Evidence, [Third Edition].** Washington, D.C.: the Author (George Washington University), 1949. Pp. vii, 122. $2.75. *

J Am Stat Assn 45:294–5 Je '50. Margaret *Merrell.* * The book is not a textbook in the usual sense, but is a combination of a discussion on the logic of the scientific experiment and a condensed syllabus on statistical method. * The most effective part....is the lively discussion of the logic of clinical experimentation with medical illustrations to point up the issues involved * The medical student who has studied this book will be in a better position to read the

Journal of the American Medical Association with discrimination. To be a satisfactory statistics textbook, considerable re-writing and amplification are required. There are many errors, the exposition is frequently confused and there is less than a minimum of underlying concepts and assumptions outlined, even for a short course. The initial statement with regard to the contribution of statistical methods to experimental work places tests of significance in small samples as the principal contribution. These are, in the opinion of the reviewer, of minor importance compared with estimates derived from the data Although in his illustrations the so-called "result-statistics" or estimates are stressed, too little attention is given to the question of appropriate analysis of the data, and too much to tests of significance after estimates have been made. Similarly too little is made of biological variation and too much of sampling variation. There is confusion in the term "extremeness" of a difference between the size of the difference and the significance of the difference. Since the book is not to be formally published in its present form, there is no point in listing errors here. However there is one fallacy that should be mentioned since it goes beyond the matter of significance tests. This appears in the final problem of the last chapter, which is devoted to an interesting collection of problems from the medical literature. The problem in question deals with a long-time post-treatment follow-up of patients. Survivorship tables are given for the years after treatment, but they represent actually a combination of survivorship and duration of observation. Significance tests are applied to these "survivorship" tables for different treatments, although the values are not comparable. The recent emphasis on chronic disease problems has made this a frequently encountered problem and it is a rare medical paper that analyzes the material correctly. Although in the example presented the error is trivial, the method used frequently leads to results that are not of the same order of magnitude as the correct results. This deserves some real exposition in a book of this kind. Undoubtedly the errors in the book will be corrected with subsequent revision. It is to be hoped that in addition there will be considerable amplification in the exposition of statistical methodology. It is a stimulating and unusual book, and with revision and extension, could be a very useful contribution to the small supply of books on the quantitative approach to medical problems.

For reviews of the second edition, see 13.

[15]

★ALLEN, R. G. D. **Statistics for Economists.** London: Hutchinson's University Library, Hutchinson & Co. (Publishers) Ltd, 1949. Pp. 216. 7*s.* 6*d.* * (New York: Longmans, Green & Co., Inc., 1950. $1.60.)

Incorp Statistician 1:27 Jl '50. C. O(swald) G(eorge). * this volume, which is likely to be one of the most popular of the series, will appeal not merely to economists but to a wider field of general readers and to all students interested in the subject * There is a very useful section on rounding which might be read with profit by many experienced statisticians. The author concludes that "We must not be afraid to show a column of rounded figures which do not add exactly to the entry at the bottom. They must be rounded and not 'doctored.'" He might also have mentioned the time that is sometimes wasted in this practice of "doctoring." Not the least valuable part of the book will be found in Appendix I which consists of fourteen illustrative tables covering subjects ranging from national income to index numbers of retail food prices, from agricultural rents and crop yields to the average monthly price of eggs. With each table is an explanation of its object and some of the conclusions to be derived from it. No student can fail to benefit from a close examination of this section. There are a few of the minor errors inevitable in a first edition but they are surprisingly few, and numerical errors, the bane of all statistical authors, appear to be almost nonexistent. * More space might perhaps have been devoted to sampling and a little less to some of the other topics covered. And it might have been better to have said either less or a great deal more about the chi-squared test or testing "the sample mean with the *t*-distribution." There are less important points which may give rise to discussion: on the question of pictorial diagrams (page 49), for instance, there seems nothing at all to be said in favour of single symbols (casks of beer) which vary in size according to the quantity. There is apparently everything to be said in favour of two rows of small symbols rather than two casks of different sizes since it is difficult—here and elsewhere—to judge the beer content merely by looking at the side of the cask. But there can be no difference of opinion about the value of the book

as a whole: it is, in these days of inflated prices, an unusually cheap textbook which should prove valuable if not indispensable to every student of statistics.

J Royal Stat Soc 112 338–9 pt 1 '49 D. G C(hampernowne). * Allen lucidly explains those few and elementary statistical methods, an understanding of which is almost indispensable for students of economics, even when they do not specialize in economic statistics. * The majority of economists are intimidated by algebraic symbols, and Professor Allen has almost abolished algebra from his book by using, in its place, numerical examples and charts wherever possible. In explaining the meaning of a technical term he aims always at suggestive and homely phrases that will stick in the memory, rather than at pedantic accuracy. For this reason the book is not altogether suitable for the critical student with some training in mathematical rigour who is prepared to go deeper into the subject. For example, a critical student would be puzzled by various points in the last chapter of the book on "Sampling and Significance," where the process of digesting the material for the nonmathematical reader is most formidable. "The further complication now arises that, with the substitution of s for σ in the standard error of the mean, the sampling distribution of the mean is no longer normal. It follows a distribution, known as the t-distribution...." (p. 174). This may vaguely suggest to the average student why he has to use tables of the t-distribution in testing the significance of a mean when the standard deviation of the population is unknown: but the sentence quoted is false, the truth being more complicated, namely, that although the sampling distribution of the mean $\bar{x}$ is normal, yet that of the ratio $\frac{\bar{x} - \xi}{s}\sqrt{n}$ follows the t-distribution. The good student will be confused by the text, although the average student may well be less confused by an inadequate text than by the more complicated truth. On p. 173 we are asked, "Can it be asserted that the average rent paid by all Kensington working-class families occupying 4 rooms is higher than that paid by families with 3 rooms?" and the answer is found by using a two-tailed significance test. The very good student may be puzzled why a one-tailed test is not used. The various methods given (Chapter VIII) for detecting seasonal variations all involve fitting a trend to the data as a preliminary. This is a tedious process, and the chapter would have benefited by the inclusion of one of the rough methods which avoids the fitting of a trend. The division of the table on seasonal corrections between pages 147 and 148 is little short of disaster. As an arbitrary general rule for finding the quartiles and median, Professor Allen suggests (p. 81), "For n items of a variable, all specified and arranged in ascending order of magnitude, Q_1 is the $\left(\frac{n+1}{4}\right)$th, M the $\left(\frac{n+1}{2}\right)$th, and Q_3 the $\left(\frac{3(n+1)}{4}\right)$th in the order." Although the point is of no practical importance, I am puzzled why he did not specify the $\left(\frac{n}{4}+\frac{1}{2}\right)$th, $\left(\frac{n}{2}+\frac{1}{2}\right)$ th and the $\left(\frac{3n}{4}+\frac{1}{2}\right)$th, which would have agreed exactly with the rule given later (p. 83), in the case of a uniform distribution: this latter specification satisfies the criterion that the interquartile range covers exactly $\frac{n}{2}$ data. Apart from the comment on the printing on pp. 147–8, none of the points made above imply any serious criticism of the book's excellence for the purpose for which it is intended. It fills the need for an easy up-to-date book on statistical methods, specially adapted for the student of economics, who is not prepared to specialize in economic statistics.

[16]

★American Society for Quality Control. **Abstracts of Papers: Third Annual Convention in Conjunction With the Third New England Quality Control Conference, Copley Plaza Hotel, Boston, Massachusetts, May 5 and 6, 1949.** Rochester 8, N Y: the Society (c/o Alfred L. Davis, Treasurer, 65 Plymouth Ave, South), 1949. Pp 97. Paper. $1 50 *

[17]

★American Society for Quality Control. **Conference Papers: First Annual Convention, American Society for Quality Control and Second Midwest Quality Control Conference, Hotel Sherman, Chicago, Illinois, Thursday–Friday, June 5 and 6, 1947.** Rochester 8, N Y: the Society (c/o Alfred L. Davis, Treasurer, 65 Plymouth Ave. South), 1947. Pp. vi, 284 Paper. $3 50. *

J Am Stat Assn 43:353–4 Je '48. H. A. Freeman. * [Includes] a very good review of modern methods for variables inspection, including noncentral t, by Professor Olds * from a statistical point of view it is the most inter-

esting paper of all * should interest any one who is actually or potentially interested in industrial quality control. Administrators, plant personnel, teachers, and students will all find something in it for them. Its contents will not generally interest professional statisticians, except as they suggest problems which might be attacked by different methods. *

J Am Stat Assn 43:354–5 Je '48. Eugene L. Grant. * should be a useful addition to the library of any industrial statistician or any teacher of industrial statistics or statistical quality control * The number of industries represented would seem to give an impressive answer to any industrial manager who gives the familiar response, "My business is different," to the suggestion that he look into the applicability of statistical quality control techniques in his own plant. Nevertheless, it should not be concluded from this spread of applications that the time has yet been reached when statistical quality control methods are in widespread use in American industry. In many cases the uses described may be only in a single plant in a large industry. Some of the authors make it clear that they feel that the surface has only been scratched in their organizations. In other papers where this is not specifically stated it is evident that, at least in June 1947 when these papers were presented, the applications were in the beginning stage. Several of the papers deal with matters somewhat removed from strictly quality control problems. Two papers apply control charts to personnel statistics. Another applies statistical methods to the interpretation of time study data. A most interesting paper of this type is "Scientific Control of Stockroom Inventories" by R. H. Wilson, General Service Manager of Bell Telephone Laboratories; this applies probability mathematics to the determination of ordering points and presents a fresh and stimulating discussion which should be of interest to industrial engineers and cost accountants as well as to statisticians. The final paper in the volume, "Sampling and Sorting Ammunition for the Attack on Normandy" by Col. Leslie E. Simon, should, in the opinion of this reviewer, become a classic in the quality control field. This is not only because of the spectacular nature of the subject matter but also because of the effective way in which Col. Simon includes good sound advice for quality control men on the nonstatistical matters associated with their jobs. *

[18]

★AMERICAN SOCIETY FOR TESTING MATERIALS. **Symposium on Statistical Quality Control.** Philadelphia, Pa: the Society, 1946. Pp. 20. Paper, $0.50. †

[19]

★AMERICAN SOCIETY FOR TESTING OF MATERIALS, COMMITTEE E-1 ON METHODS OF TESTING. **A.S.T.M. Manual on Presentation of Data: Including Supplement A, Presenting ± Limits of Uncertainty of an Observed Average; Supplement B, "Control Chart" Method of Analysis and Presentation of Data; and Tables of Squares and Square Roots.** Philadelphia, Pa: the Society, 1945. Pp. ix, 73. Paper, $0.85. †

J Am Stat Assn 40:377–8 S '45. Eugene L. Grant. * The manual has been kept up to date by minor changes in each printing since 1935. * this excellent manual has proved....helpful to the engineering profession * The main body of this manual, which explains the presentation and interpretation of frequency distributions, gives direct help to engineers in presenting experimental results. The clear statements of statistical fundamentals help indirectly with other matters. The committee interpolates a number of comments which are of general interest to all statisticians. * Supplement A.... contains working rules for the number of places to be retained in computation and presentation which should be of general value to all statisticians. Supplement B....gives a concise description of the Shewhart control chart, might well be required reading for all practicing statisticians and teachers of statistics. Just as the engineering profession in general might profit by better acquaintance with statistical method, so also statisticians in general might profit by better acquaintance with certain major contributions to statistical theory which have been made by engineers. The most important of these contributions is the Shewhart control chart. Although Supplement B does a good job of explaining *how* to make control charts, it is too brief to give an adequate explanation of *when* or *why* to make them. For an exposition of the great value of the control chart as an instrument for the diagnosis of manufacturing problems, or an explanation of its general importance to statisticians as a test for the constancy of a system of chance causes, the reader must look elsewhere.

[20]

★AMERICAN SOCIETY OF MECHANICAL ENGINEERS. **Engineering and Scientific Graphs for Publication.** American Standard ASA Z15.3–1943. New York: the Society, 1943. Pp. 27. Paper, $0.75. *

J Am Stat Assn 40:378–9 S '45. Dudley J. Cowden. This concise booklet covers the planning and construction of engineering graphs, and their preparation for the printer. The types of graphs covered are line diagrams other than time series charts, and scatter diagrams. If one is interested in time series charts, he should consult also American Standard ASA Z15.2–1938. Brief mention only is made of logarithmic and probability ruling. In general there is no attempt to suggest different types of charts that can be used for specific purposes. * Well-executed charts illustrate most of the principles. Part 2, on construction of the chart, covers the field as well as could be done in such a short space. * It would be difficult to improve this manual without expanding its length or scope.

[21]

★AMERICAN STANDARDS ASSOCIATION. **Control Chart Method of Controlling Quality During Production.** American War Standards, Z1.3–1942. New York: the Association, 1942. Pp. 41. Paper. $0.75. *

J Am Stat Assn 40 379–80 S '45. Frederick Mosteller. * an excellent text on the control chart procedures developed by Shewhart * a well-organized text on control chart procedure * Although the American War Standards will be of interest primarily to people concerned with manufacturing, experimental workers in the sciences may also find them profitable reading.

[22]

★AMERICAN STANDARDS ASSOCIATION. **Guide for Quality Control and Control Chart Method for Analyzing Data.** American War Standards, Z1.1–1941 and Z1.2–1941. New York: the Association, 1941. Pp. 15, 47–66. Paper. $0.75. *

J Am Stat Assn 40:379–80 S '45. Frederick Mosteller. * an excellent text on the control chart procedures developed by Shewhart * Although the American War Standards will be of interest primarily to people concerned with manufacturing, experimental workers in the sciences may also find them profitable reading.

[23]

★ANDERSON, J. L., AND DOW, J. B. **Actuarial Statistics: Vol. II, Construction of Mortality and Other Tables.** Harry Freeman, Coordinating Editor. Published for the Institute of Actuaries and the Faculty of Actuaries. London and New York: Cambridge University Press, 1948. Pp. xvi, 281. *21s.*; $7.50. *

J Am Stat Assn 44:311–2 Je '49. T. N. E. Greville. * The principal topic, the construction of mortality tables from the records of insured lives, is rather fully discussed, and there is no doubt that this is the most complete treatment of the subject thus far published. The very detailed explanation of exposed-to-risk formulas will be especially helpful. Throughout ....the exposition is lucid and accurate. Clarity is assisted by numerous illustrative examples, which add greatly to the usefulness of this text. The absence of problems to be worked out by the student is a shortcoming which it has in common with other British actuarial textbooks. It is natural that the principal emphasis should be placed on developments in Great Britain. However....the book suffers somewhat from a certain insularity of approach. Certain useful contributions have been made by actuaries in the United States and Canada which....could most appropriately have been mentioned in a book purporting to deal comprehensively with a branch of scientific methodology. One is surprised, for example, to find no mention of abridged processes of life table construction, a subject in which there have been important developments on this side of the Atlantic, but in which British demographers have expressed considerable interest. Again, on page 255, where it is pointed out that occupational mortality statistics based on national population data "are not reliable guides for a life office to use for assessing extra premiums for occupation," some mention might have been made of the extensive studies of occupational mortality among assured lives in the United States and Canada made by the Actuarial Society of America and the Association of Life Insurance Medical Directors. This is, of course, a minor criticism * the authors have, on the whole, handled their material in expert fashion and have produced a text which will be most useful not only to the students for whom it is intended but also to any others having an interest in the subject matter.

J Inst Actuaries 74:385–6 pt 2 '48. G. G. The appearance of this volume completes the work undertaken in 1939 of providing for the first time a text-book for Part III of the Faculty and Institute Examinations. * Though the main object has been to help the students for these examinations there is nothing of the nature of "cramming" in the presentation of the subjects dealt with and the actuary who is called on to investigate a mortality or sickness experience will be glad to have this work to hand to refresh his memory. In this second

volume the subject is the construction of tables and the authors are to be congratulated on the thoroughness with which they examine its every aspect. Particularly is this the case in discussing the question of "Exposed to Risk," a frequent source of error in practice. * Spurious selection is another example of their successful handling of a difficult problem which has many pitfalls. The history of the chief British mortality tables based on assured lives and on the lives of annuitants is adequately presented and the theory of forecasting examined in detail. In their treatment of double and multiple-decrement tables their approach is essentially practical and illustrated by well-chosen examples. The last three chapters which are devoted to the construction of national life tables and sectional investigations and to sickness rates will provide a very useful beginning to the study of demography. Throughout the authors have by their clarity, their representative examples and general remarks made what is to many a dry subject very readable, a feature of no small importance. * an outstanding addition to British actuarial text-books.

[24]

★ANDERSON, R. L., AND HOUSEMAN, E. E. **Tables of Orthogonal Polynomial Values Extended to N = 104.** Iowa State College of Agriculture and Mechanic Arts, Agricultural Experiment Station, Research Bulletin 297. Ames, Iowa: the Station, April 1942. Pp. 593–672. Paper. Gratis. *

Trans Actuarial Soc Am 44:166 My '43. This bulletin gives a valuable presentation of tables of orthogonal polynomial values, illustrations of their use in fitting polynomials, an elementary description of the method introduced by Yeats, and a brief comparison of that method with Fisher's summation process and with the alternative procedure of A. C. Aitken.

[25]

★ARCO EDITORIAL BOARD. **Statistical Clerk and Junior Statistician: A Guide and Preparation for Civil Service Statistical Tests: Contains Actual Previous Examinations With Official Answers, Statistical Study Material, and Sections on the Various Other Types of Questions Found on Such Tests, 1949 Edition.** New York: Arco Publishing Co., Inc., 1949. Pp. [131]. Mimeographed. $2.50. *

[26]

★ARKIN, HERBERT, AND COLTON, RAYMOND R. **Tables for Statisticians.** New York: Barnes & Noble, Inc., 1950. Pp. vi, 152. Paper. $0.75. *

[27]

★ARLEY, NIELS. **On the Theory of Stochastic Processes and Their Application to the Theory of Cosmic Radiation.** New York: John Wiley & Sons, Inc., 1949. Pp. 246. $5.00. * (London: Chapman & Hall, Ltd. 40*s.*)

[28]

★ARLEY, NIELS, AND BUCH, K. RANDER. **Introduction to the Theory of Probability and Statistics.** New York: John Wiley & Sons, Inc., 1950. Pp. xi, 236. $4.00. * (London: Chapman & Hall, Ltd. 32*s.*)

J Am Stat Assn 45:459–60 S '50. John E Freund. * The authors define the probability of an event A, $P(A)$, as "the physical constant for which the relative frequencies are experimental values," at the same time criticizing the frequency theory of probability, as developed by von Mises and others, on the grounds that "it involves a mixture of reality and model which has been abandoned in all branches of mathematics in favour of an axiomatic treatment." This criticism of the frequency theory of probability is unreasonable, because, staying in the field of pure mathematics, the problem of "meaning" or "interpretation" is completely irrelevant. However, in order to employ a mathematical model for the description of reality, we have to coordinate to the fundamental elements and operations of the model a corresponding set of physical concepts and operations. The probability concept which is defined by Arley and Buch belongs to the model, being (as they call it) the "true value of the relative frequency." This is sheer mysticism, unless we are told something about the relations between this "true relative frequency" and the experimental frequencies, for which it is supposed to stand. This could be done by defining the probability $P(A)$ as the limit which the average of the relative frequencies will approach, if we have a very large number of such experimental relative frequencies. This is, of course, nothing but a somewhat different formulation of the frequency theory of probability, which the authors seem to desire to avoid. The definition of probability, as it is given in this book, defines probability as an idealized concept, standing, in some fashion, for something which involves the experimental frequencies. Unless the authors do specify what this relation is, their definition is, scientifically speaking, meaningless. This criticism does not, of course, affect the axiomatic calculus of probability, which can be developed independent of the problem of interpretation. One of the brightest features of the book is the large number of interesting problems, e.g. special distributions, drawn mainly from the field of physics.

Besides an axiomatic treatment of probability, the customary study of frequency distributions, and a brief introduction to the theory of estimation, it contains a chapter on what is unfortunately (so the authors agree) called the "theory of adjustment" * It is difficult to find a suitable place for this book, which is the translation of the third Danish edition, among the literature of the field of probability and statistics. It is a good deal too technical for the nonmathematician, while, on the other hand, it can hardly be called sufficiently comprehensive for a course in the mathematical theory of probability and statistics.

Q R Biol 25:264–5 Je '50. A. Chapanis. * American students in biology will find this a high-level textbook despite the word "Introduction" in the title. In order to understand all beyond the first three chapters, the student should have a background in calculus, linear equations, and the theory of matrices. One feature of the book which, in the reviewer's opinion, makes it thoroughly unsuited for an English audience is the entirely new system of symbols and notations the authors introduce. * a student trained on this book alone would almost certainly not be able to understand the statistical terminology used in current scientific literature.

Sci 111:416–7 Ap 21 '50. Thomas N. E. Greville. * "the purpose of the present book is to give an elementary introduction to the theory of probability and statistics with special regard to its practical applications." Although the book has some excellent features, it is the reviewer's opinion that the authors have been only moderately successful in the objective stated. In the first place, the treatment is far from elementary, and the style of exposition is condensed. It is doubtful whether it could be read with profit by....anyone who has not reached a considerable degree of maturity in mathematics. * Secondly, the emphasis seems to be very much on the theoretical, rather than the practical, aspects of the subject, and the practical illustrations included are taken from the so-called "exact" sciences—physics, astronomy, engineering, *etc.* This book would be an excellent introduction to the subject for a physicist (it is the author's impression that it is just the sort of book many physicists ought to read) or a mature mathematician without any previous knowledge of this field. It is difficult to see what other purpose it could serve, as it is too difficult for an elementary text, and not sufficiently comprehensive to be used as a reference book by one who has occasion to apply statistics and probability in his work. The first seven chapters deal exhaustively with the theory of probability distributions, and the illustrations include a number of such distributions arising in physics, which are probably not familiar to most statisticians. * Chapter 9 contains a brief but very able discussion of the relation of the theory of probability to experience and its practical importance. * Chapter 11 is devoted primarily to the theory of errors, as applied to physical measurements, but includes a somewhat sketchy discussion of the theory of tests of hypotheses. * The authors' statement of their philosophy of statistics is most refreshing and valuable. A highly commendable and unusual feature is the distinction clearly and consistently made throughout the book between the "mathematical model" and the "real world." Also noteworthy is the axiomatic approach to the theory of probability and the careful statement of the assumptions underlying various statistical procedures.

[29]

★BAIL, [SISTER] SAINT AUGUSTINE **Power Functions and the Distribution Functions Related to "Student's" Test.** Washington, D C · Catholic University of America Press, 1942 Pp vi, 25. Paper. $1.00. *

[30]

★BAYES, THOMAS **Facsimiles of Two Papers by Bayes: (i)An Essay Toward Solving a Problem in the Doctrine of Chances, With Richard Price's Foreword and Discussion; Phil. Trans. Royal Soc. pp. 370–418, 1763; With a Commentary by Edward C. Molina; (ii) A Letter on Asymptotic Series From Bayes to John Canton; pp. 269–271 of the Same Volume; With a Commentary by W. Edwards Deming.** Prepared under the direction of W Edwards Deming. Washington, D C · Graduate School, Department of Agriculture, 1940. Pp. xii, [50], xiii–xvi, [3] $1.00 *

Math Gazette 25:177–80 Jl '41. G. J. Lidstone. This slender, attractive and well-produced volume should be in every mathematical and statistical library. * It was....a happy idea and a valuable service to re-publish the Essay (as communicated by Price with commentary and notes), and to do so in facsimile (full size but with reduced margins). Since facsimile reproduction does not admit of the correction of errors, Dr. Deming in the Editorial Preface records those that have been so far detected * One of these errors considerably affects one of the numerical examples given in Price's Ap-

pendix, and shows that Bayes' Second Rule for computation is in that case considerably more accurate than appears from the example as printed. * Altogether, this stimulating little work is to be highly commended. It should be emphasized that it does not include Price's second paper [*Phil. Trans.*, LIV, p 296 (1764)], in which he gave Bayes' proof of his Second Rule of approximation, with some additions and improvements of his own.

[31]

★BLAIR, MORRIS MYERS **Elementary Statistics: With General Applications.** New York Henry Holt & Co, 1944 Pp. xiv, 690 $3 00. *

Am Econ R 35 969–71 D '45 Charles A. Bliss. * Blair's text.. is written from "the standpoint of consumption rather than with a view to creation." Yet it remains a textbook of statistics methodology and not a textbook for training in the skills of using figures—the skills so lacking in entering college students and often so poorly developed when they leave. As yet there is no textbook addressed four-square to this special problem and probably will not be until bold curriculum planning shall reveal its urgent need. For the most part the Blair book follows the organization of the typical textbook in statistics. The first section contains a short, usable discussion of use of numbers * a good summary chapter on use of ratios and percentages * The text is set at a rather simple level. Section II, Analysis of Large Samples, has the usual description of methods of computation of various measures pertaining to frequency distributions. The presentation is elementary and straightforward. For the curious student the text will have shortcomings at many points, for little is said about the reasons for or origins of the various measures. Included in this section is the problem of curve fitting, introduced interestingly enough not with respect to time series but as a correlation problem. * An interesting addition is an appendix of technical terms * There is much to commend the Blair text to one in charge of an elementary statistics course intended to carry the student part-way along technical statistical lines. Indeed there are some sections for students who are not interested in statistical procedures as such. The text suffers often in that many of the measures are presented without much discussion of their use or purpose with the result that, unless the instructor is careful, the student will be given a diet of smorgasbord However, by careful selection and supplemental work, the text should prove useful, particularly in view of the excellent review questions and exercises that are included at the end of each chapter

Am J Psychol 58 292–3 Ap '45 J P Guilford Written primarily for students of economics....this volume makes an effort to be useful also to teachers colleges, to agriculture, and to the social sciences in general. * the illustrations are drawn almost exclusively from social, economic and agricultural sources. The psychologist, student, teacher or professional technologist, will find in it a refreshing approach to familiar methods or fruitful suggestions of less well-known but useful procedures. Some features could well be noted by writers of texts on psychological statistics. The title "elementary" is a misnomer, for although the book begins with a brief review of arithmetic (the fundamental operations, fractions, square root, ratios, percentages and proportions), it proceeds eventually through multiple correlation, analysis of variance and covariance, and least-square curve-fitting. There is sufficient meat for a solid year-course, though by selection a one-semester introduction is provided. The author's presentation is generally quite clear and vital in an effort to meet the needs of students at the sophomore level. Certain features in which psychological statistics are weak are notable. One is the chapter on methods of graphic representation of data. Students who must present data to a lay reader would profit from such a chapter. Another is the chapter on writing statistical reports—another aid to the effective presentation of results either to a scientific or to a lay public. Methods of tabulation and of tabular analysis are also slighted by the psychological text. This is probably due to their more restricted virtues in connection with masses of enumeration statistics. The economist's harmonic mean, time series, seasonal variations, cyclical fluctuations, and index numbers have little psychological application, though there are many reasonable analogies. The book is not without its flaws, some of them being serious. The author defines statistics as a "science" whereas it is rather an exact language that is useful to scientists. Some loose analogies appear, such as the comparing of errors of sampling to deviations of the compass from true north (p. 473). The term "quartile" is used where "quarter" is meant (*e g*, p. 310).

A wrong statement of conclusion is given in connection with an analysis-of-variance problem on page 505. The statement reads: "This proves that these 6 samples are taken from 6 separate populations," which would read more correctly; "This indicates that these 6 samples probably *did not all arise from the same population.*" Equations are carelessly written on pages 512 and 518; in fact they do not strictly merit the equality sign. One miscalculation was noted on page 480. Typographical errors are more common than they should be and poor proof-reading is indicated. *

Am Math Mo 52:215 Ap '45. H. D. Larsen. * The plan of the book seems to be to present complete worksheets for the solution of those problems usually included in elementary statistics. * It is deplorable that the manuscript was not edited before publication by a competent mathematician, if not by a mathematical statistician. The chapters are replete with misuse of mathematical notation and terminology, as well as actual errors. To illustrate, equal signs are frequently used as punctuation marks; a "power" is a positive integral exponent; an "exponent" is a positive fractional exponent; a "ratio" is a proportion, and a "rate" is a "mixed ratio"; any curve is a "line"; any integer is an "even" number; *etc.* Some of the errors might be mentioned. The least squares line (page 243) is not necessarily "a line which on the average comes nearest to all the points or items of data." In Figure 53, the intercept a is drawn incorrectly. The denominator in Formula 72 should be $\Sigma p_0 q_0$. One can not say (page 481) that "the chances are 20 to 1 that the two small samples were drawn from separate parent populations" simply because the null hypothesis gives those odds against obtaining the given difference. The calculation of S_y (page 554) assumes $\Sigma Z = 0$, contrary to fact. The signs of a and b in the parabola $Y = a + b + bX + cX^2$ (page 556) depend on the position of the origin, not on the shape of the curve. A similar statement is true for the cubic parabola (page 565). Since the sum of the deviations from the arithmetic mean is zero, all the summations on page 582 vanish. The book is further marred by many arithmetical errors in the examples, as well as by a large number of typographical errors. In the opinion of the reviewer, this text can not be recommended in its present form.

J Am Stat Assn 40:139–40 Mr '45. Raymond F. Blackburn. * the businessman or statistician would find it a useful reference volume * a welcome addition to the expanding field of statistics. The tools of analysis offered the student are well selected, carefully illustrated with practical problems, and made understandable by the sympathetic attitude of the author.

Sci 100:592–3 D 29 '44. W. Edwards Deming. * The book....can be said to bring the subject of statistical methodology to the reader as it was perfected up to the impact of Shewhart researches. * The author....states....that his product is a result of fifteen years of teaching, and that he has sifted the material very carefully. He states also that the business man and practising statistician will find the text valuable as a reference book. Certainly the author's claims in these respects are admirably fulfilled so far as the book goes. The summary formulas at the end of the book (pp. 624 *ff.*) are extremely handy for reference. The leading questions and references at the end of each chapter will likewise draw appreciation from students, teachers and practising statisticians, as well as casual users. * the frequent suggestions for forms or work sheets and tables will be duly appreciated by many users. What is needed in statistical theory and practice is some arrangement for interchange of talent between universities, government and industry. Some day, sometime, arrangements will be worked out whereby writers having the gift of presentation like Mr. Blair and the enthusiasm to write text-books, can have interneships in government and industrial practise.

South Econ J 11:282–3 Ja '45. Edgar Z. Palmer. One aim of the author is stated in the preface ...to be the preparation of the students to become "*consumers* of statistics instead of *creators* of researches." * There is little evidence of this purpose in the text. To the reviewer it seems that the author aimed for comprehensiveness, conciseness, and clarity, and that he has attained each of these to a rare degree. On the score of comprehensiveness, he includes almost every topic which is considered to be a part of modern statistical method. One exception is that of the phychologists' "factor analysis." He is to be congratulated rather than criticized for not trying to put *quite* everything into one book. The type face sets the tone by being almost startlingly clear. The author shows that he tried to reach the mind of the student on every technical point. Occasionally he overreached himself * One wonders why, with all

this endeavor to meet the student half-way in the method of presentation, modern text book writers do not rethink their subject matter. Unfortunately, they have to sell to the statistics instructors rather than to the students, and any radical revision of the material might meet with objection. Like the table of ordinates of the normal curve, which is copied by text after text from the old Rugg book, always with the same mistake in the ordinate for .41 (Blair's table has it too), the new books keep on parroting the old subjects without much change. Why, for instance, give more than a sentence to the mode? What serious research ever uses it? Why retain the standard error of the coefficient of correlation, which has been outlawed by all but text book writers? The elementary student needs, not every alternative method of doing a thing, but a selection of the best methods. Nor is he likely to be much edified when he reads a section promisingly entitled, "Selecting an Average," to find it entirely composed of an essay on the topic, "Any technician, to get good results, must be well acquainted with the material on which he works." * In short, the book is the work of a good technician in the art of writing, but one who needs to consider more fully the material on which he works.

[32]

★Bliss, C. I. **Estimation of the Mean and Its Error From Incomplete Poisson Distributions.** Connecticut Agricultural Experiment Station, Bulletin 513 New Haven, Conn.: the Station, January 1948. Pp. 12 Paper Single copies, gratis; 10 or more copies, $0.08 per copy *

Math Tables 3.301 O '48. Will Feller. * The usual definition of complete randomness is that the probability p_k of having exactly k events in an interval, area, or volume of specified size is given by the *Poisson* distribution $p_k = e^{-m}m^k/k!$, where m is a positive constant, the so-called mean of the distribution. The problem then arises to estimate m from actual observations and to judge the reliability of the estimate. The usual methods are based on a complete enumeration of all cases where 0, 1,....events were observed. The author points out that very often it is difficult or impossible to obtain such a complete enumeration. Instead, the data are truncated at a class x so that only cases with 0, 1...., x events are enumerated and no information is available concerning cases more than x events. The author describes a technique of estimating m and its error from such incomplete data. * Table 1 (p. 3) gives to 5D the cumulated values $P_x = p_0 + p_1 + ... + p_x$ for $x = 0,1,2,3$ and $m = .1(.1)6$. Table 2 (p. 4) gives $p_x/(1 - P_x)$ within the same range. This table is to 6D or 6S. Table 5 (p. 8) gives values obtained from these tables and useful for the estimation of the error: this table is of interest only to specialized statisticians. Other tables refer to empirical observations.

[33]

★Bliss, C I.; Anderson, E. O.; and Marland, R. E. **A Technique for Testing Consumer Preferences, With Special Reference to the Constituents of Ice Cream.** University of Connecticut, Storrs Agricultural Experiment Station, Bulletin 251. Storrs, Conn.: the Station, November 1943. Pp. 20. Paper. Gratis. *

[34]

★Boddington, A. Lester. **Statistics and Their Application to Commerce, Ninth Edition.** With two chapters on index numbers by A. J. H. Morrell [also published separately, see 216]. London: H.F.L. (Publishers) Ltd., 1949. Pp. xvi, 359. 18s. * (New York: British Book Centre. $4.25.)

J Royal Stat Soc 112:484 pt 4 '49. F. A. F. This is one of the most readable and most disappointing books on elementary statistics. First published in 1921, it has now reached its ninth edition, which includes two chapters on index numbers written by Mr. A. J. H. Morrell in place of the very unsatisfactory chapter in previous editions. The book is intended for businessmen. It covers the various averages used in statistical work, the measurement of dispersion and skewness, correlation, methods of presentation and index numbers. Whether this is all the business man wants to know is debatable; it is certainly not all that the business statistician needs to learn. Methods for analysing time series and the application of sampling to market research and quality control are not dealt with at all. There are two main defects in this work: first, that much of what is covered is too sketchy to be of any value in practical work, and secondly, that it is out-of-date. In the chapter on measures of dispersion, for example, the standard deviation is shown without relating it anywhere in the book to the normal curve, yet in dealing with the measurement of error in the correlation coefficient the author gives the formula for the probable error, which was dropped long ago by statisticians. This sort of treatment is dangerous for students, who will learn by rote only, whereas they should be led to correlation through a study of regression and be taught measures of dispersion in terms of the normal curve. And it can only puzzle the business man, who may

justifiably ask why anybody should want to square all the deviations from the average before adding them up when the average deviation is quite clear. For some reason the author also gives the formulae for the third moment and the modulus. The normal curve is discussed in the chapter on "The Graphic Method" and the result is unfortunate. The normal curve is primarily of interest for its mathematical properties, and although this type of diagram should certainly be described, it would have been better, in the reviewer's opinion, to have done so in terms of the functional relationship of two variables with the normal curve as an important probability distribution. The examples given could be improved; they are not assymptotic to the abscissa and are all flat-topped (platykurtic). The two chapters on index numbers written by Mr. Morrell cover the subject adequately. The first deals with the general question of construction, and provides a better introduction than will be found in most British elementary text-books on statistics. Objection may be raised, however, to the order of the sections. In discussing the various methods of averaging the author introduces the concept of weighting without making it clear what the term really means until later in the chapter. There is much to be said for discussing the aggregative and weighted relatives methods together, for in this way the student gets a clearer idea of the meaning of the resultant index number. The geometric average can then be dealt with as an alternative, leading to a discussion of different bases, the time reversal and factor reversal tests, and Fisher's ideal index number. The outcome of the order in this chapter is that factor reversal is not discussed, and the reader is left wondering why the author, writing about Fisher's index, states that "theoretically it is almost perfect." The two sections on "The Chain Base Method" and "Changing the Base Year" could appropriately have been taken together, for a chain base is really only a method of splicing index numbers, whereas two other sections on weighting and the aggregative method come between them. The other chapter summarizes very well sixteen well-known index numbers and will be welcome to all students. Mr. Morrell's two chapters are available separately under the title, *An Introduction to Index Numbers* (H. F. L. (Publishers) Ltd., 4*s*. 6*d*.) Apart from these two chapters, most of the remainder of the book should be thoroughly revised and expanded.

For a review of the seventh edition, see 2 27.

[35]

★Boyan, Edwin A., Purcelli, Warren R.; Somers, O. H.; and Fay, Ernest L. **Administrative and Statistical Techniques of Quality Control.** American Management Association, Production Series, No. 180. New York: the Association, 1948. Pp. 34. Paper. $0.75 *

[36]

★Brearley, A., and Cox, D. R. **An Outline of Statistical Methods for Use in the Textile Industry.** Foreword by B. H. Wilsden. Leeds, England: Wool Industries Research Association, 1949. Pp. 74. Paper. 7*s*. 6*d* *

Res 3:285 Je '50. M. Hannah. * a small booklet designed to equip the practical man with an understanding of statistical terms and of the simpler procedures used for analysing results. No attempt is made to derive any of the formulae mathematically, but a logical development of the subject is given. Frequency distributions, sampling distributions, *F*- and *t*-tests and the analysis of variance are all covered, and there is a useful section on quality control. The book is so short that the treatment is necessarily very compressed, and such important topics as regression analysis and the χ^2 test have been completely omitted; references are, however, given to standard textbooks for additional reading. Illustrative numerical examples from textile testing, a glossary, and some useful tables complete the booklet, which should serve as a convenient summary for the industrialist or mill manager. *

[37]

★Brilla, Mary H. **The Outlook for Women in Mathematics and Statistics.** U. S. Department of Labor, Women's Bureau, Bulletin No. 223-4. Washington, D. C.: Government Printing Office, 1948. Pp. x, 21. Paper. $0.10 *

Am Math Mo 56:121-2 F '49. H. M. Gehman. * Although written primarily for women, much of the material in the booklet is of interest to all who expect to earn a living by following some mathematical profession. Estimates are made of the number of mathematicians in teaching and in other fields. The prewar distribution of mathematicians, the average number of annual additions, wartime changes, present earnings and advancement, and the outlook for the future are other topics treated in detail. The appendix contains a bibliography which should prove useful to all who are concerned with the advisement of students of mathematics.

[38]

★BRITISH STANDARDS INSTITUTION. **Fraction-Defective for Quality Control.** British Standards 1313·1947. London: British Standards Institution, 1947. Pp. 40. 6*s* (New York. American Standards Association. $2 25) *

J Am Stat Assn 44 132–3 Mr '49 Albert H. Bowker. * a revision and extension of a small part of British Standard 600R:1942 *Quality Control Charts* * The discussion of the first control chart assumes the product....is already in control and discusses appropriate action when an occasional point falls on or beyond the control limit. A considerable number of cases have been reported in American literature in which the initial application of control charts leads to the discovery that the process is badly out of control, with, in some cases, a majority of the points falling outside the control limits. Statistical control is apparently achieved only after a lengthy study and modification of the process. A description of this phenomenon might keep initial users from becoming discouraged if their individual sample qualities fail to cluster neatly around the process average, as in the examples provided here The discussion of control limits based on a given standard assumes the specification of a maximum permissible average level for defectives. Control limits are found by treating the specified percentage defective as the process average. It is clear that, if articles are produced with quality equal to this specified average, only an occasional point will be outside the control limits. Indeed, the presented quality would have to be a great deal worse than this maximum permissible average level before we could state with high probability that an out-of-control point would be obtained. Thus, the terminology "maximum permissible" is somewhat confusing. * The pamphlet is well done and has several desirable features. The directions for setting up charts are very clear; the use of symbols has been almost entirely avoided; the instructions are reproduced conveniently in sample instruction sheets at the end of the pamphlet; there are several examples with practical advice; and there are references for further study.

[39]

★BRITISH STANDARDS INSTITUTION. **Memorandum on Sampling Clauses in Specifications for Manufactured Articles.** P.D. 488, formerly CH (OC) 3599 London: British Standards Institution, March 1946 Pp 6. Paper. 1*s*. * (New York: American Standards Association. $0 50.)

[40]

★BROOM, H N **A Selected and Annotated Bibliography of Literature on Statistical Quality Control.** University of Texas, College of Business Administration, Bureau of Business Research, Bibliography No 6 Austin, Tex the Bureau, May 1940. Pp 15 Paper, mimeographed. Gratis *

[41]

★BROWNLEE, K A. **Industrial Experimentation** Ministry of Supply, Directorate of Royal Ordnance Factories (Explosives), Memorandum No. 18 London Ministry of Supply, June 1945 Pp. 87. Paper * For latest edition, see 45

J Am Stat Assn 41 125–7 Mr '46 John W. Tukey * The author has carried out....[his] task with clarity and precision, using chemical engineering examples. The pamphlet can be highly recommended to all interested in industrial experiment as a satisfactory manual of Fisherian statistics * It should prove particularly interesting, of course, to those interested in chemical engineering problems, but workers in other fields will find transfer a simple problem This is a brief manual for those without a full knowledge of the background of the tests—in short, a cookbook. It is a very good cookbook, whose recipes have been developed in agriculture and well tested in many other fields * The distinction between statistical significance and practical significance is nowhere made clearly and precisely. The manner in which confidence intervals are used in some discussions indicates the author's appreciation of this difference, yet there is no discussion of what to do if an immediate decision must be based on statistically insufficient data. There appears to be an undue tendency to believe all effects zero until statistically proved otherwise and to leave no place for parallel experience. The brief discussion of control chart procedures gives little guidance in choosing between control chart and Fisherian methods in a specific instance, yet many of the examples which the author treats simply and directly would be difficult or impossible to treat by control chart methods. The control chart procedure was designed and is fitted to study processes which are or should be in control—that is, the successive values resemble a random sample. The Fisherian methods were designed and are fitted to study processes which are not in control, but where auxiliary data or the recurrence of the uncontrolled effects allows the partial separation of different effects. This distinction is fundamental. In general, the possible use of methods based on order statistics is given insufficient consider-

ation. In particular, the "maximum efficiency" of the variance is stated without restriction on page 9. This is, of course, related to the general tendency to assume normality. Many small errors operating independently are said to produce normality—no mention that the effects must behave additively. The general principle is enunciated (p. 11) that departure from normality must be "very severe" before significance tests become appreciatively inaccurate. This is not the case for Bartlett's test for the homogeneity of variances, which is described on page 18. The examples of pot life on pages 14, 28, and 31 do not seem to represent even nearly normal distributions. This is not surprising, since life is rarely normally distributed. In carrying out the analysis of variance, the procedure used is to test doubtfully significant mean squares and, if they are not significant at the 5 per cent point, to then pool them into a new estimate of error mean square. The possible pitfalls in this process require much careful consideration. The estimation of contributions of different sources to variance is done in a similar way, making the flat assumption that each σ^2 is either actually zero or statistically significantly different from zero. By requiring a minimum cell frequency of 5, the author restricts the usefulness of χ^2 to what now seems to be an excessive extent. In discussing variance on page 25, the author states unreservedly that, if several factors contribute to a variance, then that variance is the sum of the component variances. This statement tacitly assumes that the factors are independent and that they act additively. In discussing the two regression lines on page 43, the author states that he is concerned with predictive relations and not with structural relations. The reviewer cannot accept this as a general principle and feels that there are many problems of chemical engineering where the structural regression is important. On page 34, the author assigns a certain component of variance to "bagging the material." While this is possible, it seems more likely to be associated with the process of taking samples. This pamphlet has now been criticised on several lines. But—the reviewer knows of no book to which the reader may go for a better treatment of these critical points. The faults are those of the current statistical literature, not of this pamphlet alone. On page 17, the author makes his only direct slip. He uses a two-tailed F test in comparing two variances without stating that the 5 per cent level has now become the 10 per cent level, and so on.

J Am Stat Assn 41:127–8 Mr '46. J. Wolfowitz. * This reviewer would prefer to see more emphasis on fundamental ideas. The assumptions underlying each technique should be clearly expressed and carefully described. * it is....possible in most cases to explain the fundamental assumptions to the intelligent layman without recourse to any complex mathematical ideas. If space is lacking, it seems desirable.... to obtain it by reducing or eliminating the considerable detail in which computational techniques are usually described, since misapplication of statistical methods is more likely to be serious than the use of inefficient computing techniques. Much circumlocution could be avoided and considerable clarity and precision gained if formulae were stated in algebraic symbols, and not described in words and computational procedures designed to be imitated. Omissions of mathematics implies to the reviewer's mind the omission of mathematical ideas or arguments of any complexity; the knowledge required to read the elementary algebraic symbolism in which the classical statistical formulae are expressed is now taught at a comparatively early age and is a part of the knowledge of a large section of the population. The present book contains a number of errors, which are the more serious in that the book is intended for a type of reader who lacks the technical training to be competently critical. A few examples follow: (*a*) No distinction is made between the population variance and its sample estimate, either in symbolism or in the text (*vide* bottom of page 12). (*b*) The author fails to realize that a population parameter being estimated is not a chance variable. This occurs in a number of places; for example, on page 14 the author states "....the mean has a 95% chance of lying anywhere between 0.18 and −2.38," where the mean referred to is the population mean. (*c*) The author defines the variance ratio F as the ratio of the larger variance to the smaller. The effect of this is to double the intended size of the critical region under the null hypothesis. The present book is prefaced by a short introduction written by an official of the British Ministry of Supply, and it is only through his brief acknowledgment that we learn the name of the author. The proper allocation of scientific credit is important not only as a matter of justice, but also because, in

the present atomic era, it seems likely that more and more research will be done in large organizations and by scientific teams, and only proper allocation of credit will bring true merit to the fore. A book should bear the name of its author and not that of any administrative bigwig who is his senior in some organizational hierarchy.

[42]

BROWNLEE, K. A **Industrial Experimentation, [Revised Edition].** Ministry of Supply, Directorate of Royal Ordnance Factories (Explosives). London: His Majesty's Stationery Office, 1946. Pp. 116. Paper. * For latest edition, see 45.

Chem & Eng News 24:3105 N 25'46. Walter A. Shewhart. * a manual of value not only to chemists but all others engaged in industrial experimentation * The methods presented rest upon a sound theoretical basis and have long proved to be of great value in other fields of experimentation, notably agriculture. They have also been used to great advantage in several large industrial laboratories and it is reasonable to believe that, within a few years, training in the use of these methods will be considered a necessary adjunct to the training of the industrial experimentalist. The use of illustrations for the most part chosen from the field of chemistry should be particularly helpful and interesting to the chemist. * it would be very helpful to many industrial scientists if, in future editions of this manual, the author would at least give some references to literature discussing the theory behind the methods. The manual is limited almost exclusively to an exposition of methods based upon the work of R. A. Fisher, and hence does not discuss the applications of the theory of runs and many other statistical tests such as the "eta-test" developed by Von Neumann and others, all of which play a useful part in industrial experimentation. No mention is made of the importance of "errors of the second kind" in determining the practical significance of observed differences. In fact, no discussion is given of the relation of statistical significance to practical significance of observed differences in experimental work. The meaning of the important concept of confidence limits is not made clear and, in fact, on page 21 the statement is made that the true mean has a 95% chance of lying anywhere between two stated confidence limits, whereas in fact the true mean is not a chance variable and either does or does not lie within the stated range. On pages 25 and 37 and elsewhere, it is indicated that component variances may be added without cautioning the reader that this implies statistical independence and linear additivity of the effects of component factors. Occasionally statements are made that may be misleading. An example occurs at the top of page 5—namely: "Thus, suppose we require to reach a particular *level of certainty in our proof* of a hypothesis, say 100 to 1" (italics ours). This is what an experimentalist would like to do but cannot do. Although a few critical comments have been made that may be helpful to the industrial experimentalist without knowledge of the theoretical background, the reviewer knows of no better introduction to the application of statistical methods in industrial experimentation. This short monograph deserves careful study by all interested in this field.

J Am Stat Assn 41:595–7 D '46. George W. Brown. * "a very good cookbook" of statistical methodology, and could, with more careful attention devoted to the basic hypotheses underlying statistical methodology, evolve into a manual of considerable stature in the field. * An added remark on page 26 seems to imply that, in testing homogeneity of variances, if the extreme estimates did not differ significantly by F, then Bartlett's test would not show significance. * the remark in question should have been accompanied by a certain amount of caution. The recommended procedure, given on pages 21 to 23, for comparing the means of two samples, depends on the sum of the sample sizes. It is not clear whether the author realizes that the following procedures are really different, but he suggests, without clarification, that if $n_1+n_2<30$ the variances be treated as homogeneous; that the Behrens-Fisher test be used when $n_1+n_2>30$. The important point is that from the very outset no mention is ever made of the importance of background hypotheses and parallel information. A multiple regression example presented in chapter 10 has independent variables x_w, x_a, x_s. The regression on x_s alone is significant at the one percent level, but the effect of x_s is not significant when x_w and x_a are included. In discussing this situation on page 63, Mr. Brownlee says, in referring to the regression on x_s alone, "x_s would appear significant at the 1% level, an entirely erroneous conclusion." Why call this erroneous? The author is certainly aware that the regression on x_a and/or x_w might turn out not significant when

adjoined to x_n. In any case, the very important question of the order of elimination of independent variables, or the corresponding question in analysis of variance problems, seems nowhere to be mentioned. This is not a question of mathematics, it is an operational question whose solution is dictated by consideration of the problem at hand. Similarly, when two independent variables are correlated, the author says that the individual regression coefficients are fictitiously large. This would seem to imply that it would be incorrect to use an individual regression coefficient if either one of the independent variables is *used* alone. Again, the reviewer is certain that what was meant was that if two independent variables are to be used jointly, the regression analysis should be the joint multiple analysis. On page 107, it is implied that the analysis of variance is impossible when the data are haphazard or when units are missing. This is not strictly true, although the analysis in such cases may be extremely difficult because of the large number of linear simultaneous equations which may have to be solved. On page 108, it is pointed out that the computation for a multiple correlation, with say 5 independent variables, is much more severe than for a five factor analysis of variance. It might be noted that the analysis of the conventional design has been simplified by the introduction of various orthogonalities; similar orthogonalities in a multiple correlation analysis would simplify the analysis correspondingly. When hypotheses are properly formulated in the analysis of variance situation and in the multiple correlation situation, the computations coincide as well as the significance tests. The major difference between the two situations is primarily with respect to the way parametric hypotheses are stated. On page 31, it is remarked, in connection with 2×2 contingency tables, that in borderline cases the correction for continuity is important. Since the chi-square distribution is still an approximation, in this case, with or without the correction for continuity, and since the statistician rarely has adequate quantitative basis to set precise significance levels, it would appear to this reviewer that no really important decision should rest on the correction for continuity. This reviewer feels that the value of this pamphlet could still be increased by further revision to include expanded background exposition of the hypotheses behind the statistical tests, discussion of "practical" significance and perhaps points such as those raised above, where further clarification might be useful as well as informative. Nevertheless, the pamphlet in its present form is potentially useful to a large class of people and contains a considerable amount of material for the rather low price of sixty cents.

J Am Stat Assn 41 597–9 D '46 Alan E. Treloar. * interesting manual * It is....stated without reservation that the probability corresponding to any given $|F|$ is double that for F, but this is true only when the samples are of the same frequency * The reiterated conclusion that an insignificant F means that an initially assumed component of the numerator variance does not exist is most disturbing to this reviewer. Perhaps the author is uneasy about this point when he concedes that values of F somewhat below the accepted critical level for a claim of significance suggest situations worthy of further investigation. However, he follows the beaten path in usage of the 5 per cent level rather assiduously in the actual analyses. On page 13 one finds the following statement, which is not uncommon in statistical texts: "For many purposes the 5 per cent level is accepted, but we must realize that this means that 1 in every 20 times we will assert that an effect exists when it really does not." The assumption implicit here that all responses are in fact expressions of chance variation is a strange one, and quite out of line with much of the argument in this book. The *maximum* proportion of errors "of the first kind" corresponds to the significance level adhered to; usually, the proportion may be expected to be very much less. While the author seems aware of the dangers of assuming that actual data conform in structure to the mathematical models in terms of which the statistical procedures have been elaborated, he does not discuss the assumptions intrinsic to the models at all adequately. Indeed at one point (p. 108) he goes so far as to say: "we can disregard the underlying assumptions [of the analysis of variance] with comparative impunity." Many will challenge this point. This book will prove useful to teachers of statistics, despite its failure to maintain desirable technical standards in the respects mentioned. It broadens the horizon with applications in a field where before there was but little illustrative material. Although the theme is pursued with missionary zeal, unusually good balance with practical considerations is preserved. Provided that the

reader is aware of the deficiencies discussed in these reviews, the presentation should prove very helpful as accessory reading in connection with statistical courses.

J Royal Stat Soc 109 159 pt 2 '46. O(scar) K(empthorne). * contains a description of most of the statistical tests and processes which industrial experimenters will require, but it cannot be recommended as an adequate treatment of the subject. The elementary statistical concepts receive scant treatment, and the book consists almost entirely of a description of the arithmetical aspect of statistical techniques. Incorrect application of statistical methods will often result from knowledge of this one aspect only. The author's treatment of the analysis of variance is particularly unsatisfactory. He has devoted approximately half of the book to particular cases, none of which presents any difficulties once the general procedure is understood. Few, if any, of the difficulties which may arise in the application of this technique are described. The emphasis throughout is on the estimation of components of variance, which is more relevant to sampling studies than to experimentation. Finally, it is surprising that a book on industrial experimentation should contain so little discussion of the design of experiments: as far as the reviewer could see, there was no mention of the necessity of randomization to ensure unbiased estimation of treatment effects and experimental error.

Nature 158 687–8 N 16 '46. D. J. Finney. * Brownlee presents examples of the application to industry of methods well known in biological research; both statisticians and industrial research workers should be grateful to him for his attempt to increase their collaboration. * Unfortunately the book, so good in intention, is much less satisfactory in execution. The systems of computation for many of the simpler techniques may be learnt rapidly, but without some critical appreciation of their meaning they may easily be misapplied; even a statistical "cookery-book" needs to appeal to the reader's critical faculty as well as to his arithmetical facility. Mr. Brownlee gives very full instruction in calculation, but often seems to suggest that application of inflexible (and sometimes apparently arbitrary) rules is sufficient for the interpretation of experimental data. Furthermore, the description of the subject-matter of many examples is so condensed that the reader unfamiliar with this particular field of industrial experimentation (the manufacture of explosives) may not readily see the relevance of the methods to his own problems. The section on the comparison of two samples revives unnecessarily the practice of making arbitrary distinction between "small" and "large" samples; the trivial simplification in computation resulting from the "large sample" rule is more than counter-balanced by its confusion of the reader who does not realize that one rule is an approximation to the other. The discussion of correlation and regression is useful so far as it goes, but it is marred by complicated notation, and the existence of further extensions of the methods is not mentioned; the statement of the fiducial limits of a regression equation takes no account of errors in the estimated regression coefficient, and no distinction is drawn between the precision of prediction of a single value and that of the mean value of the dependent variate for a given value of the independent variate. In his main chapter on the analysis of variance, Mr. Brownlee first tests the significance of high-order interactions, and pools non-significant components with the error sum of squares; he then tests interactions of lower order against the new error mean square, and continues the pooling process. Though pooling of components in this way may occasionally be excused, it will tend to produce underestimation of error mean squares, and its general adoption might lead to serious biases in tests of significance. The whole of this chapter exemplifies the uncritical presentation of the subject, for the analysis of variance is shown as an entirely automatic method of interpreting data. In the account of factorial experiments, no mention is made of factors at more than two levels, and, in spite of their detailed description, the methods of computation shown are not always the most expeditious. Apart from faults in theory such as have been noted in the previous paragraph, the chief reason why this book fails to satisfy is that its aims are too many. It appears to be intended as a general description of the potentialities of statistical science in industrial experimentation, as an elementary manual of instruction, and also as an introduction to the use of various more advanced analytical techniques. Whether the combination of these within a single book is desirable may be doubted; its successful accomplishment in 116 pages is impossible.

For reviews of the first edition, see 41

[43]

★BROWNLEE, K. A. **Industrial Experimentation, Second Edition.** [First American Edition.] Ministry of Supply, Directorate of Royal Ordnance Factories (Explosives). London: His Majesty's Stationery Office, 1947. Pp. 151. Paper. (New York: Chemical Publishing Co., Inc., 1947. Cloth.) * For latest edition, see 45.

J Hered 39:51+ F '48. H. W. Norton. This little book is a guide to modern statistical methods, including the design of experiments, intended for those engaged in pilot-plant and plant-scale experiments in chemical industry, whence all its many examples are drawn. * Because of the lengthy discussion of the analysis of variance and of the factorial scheme of experimentation, including confounding, it will be of considerable value to research workers generally. For the geneticist, however, it cannot compete with books such as Mather's *Statistical Methods in Biology,* because so little space is given to the statistics of attributes * The book has several important technical defects. It neither makes clearly nor maintains the fundamental distinction between sample and parent population, nor is the essential importance of randomization in experimental design effectively emphasized. In tests of significance in the analysis of variance, Brownlee habitually uses high-order interactions as estimates of "error"; unfortunately the discussion of this practice is vague and inconclusive, and there is nowhere a plain statement of the desirability of experimental designs which yield estimates of "pure error." In addition, he recommends and employs the practice of testing the smallest "effect" variance first, pooling it with the test variance if non-significant, proceeding to test the next smallest, and so on. This scheme should be avoided. Pooling always raises awkward questions, not yet answered, as to the meaning of the subsequent tests, but the arbitrary selection of the smallest "effect" variance to be the first tested results in roughly doubling the "significance" in subsequent tests; that is, the probability read from the table is markedly too small. There are less important defects also, of various kinds, a particularly frequent one being the sweeping or extravagant statement, such as that the variance is the best measure of variability and that $r = 0$ means no relation at all. The minimum class expectation frequency for chi-square calculations should be set lower than 5, and the continuity correction should be restricted to cases of but one degree of freedom. Many worthless digits are retained in the worked examples. The typography and printing leave much to be desired; besides many last-place errors, there are several gross errors in the tables. Textual statements of statistical significance are not always in agreement with the actual results of the corresponding tests. To summarize, this book will be helpful to many who desire further understanding of the form and arithmetic of the analysis of variance and of factorial design and confounding, but (as always) the reader should be alert for erroneous or unqualified statements. Other books will be needed if a full treatment of statistics of attributes is desired.

Q R Biol 23:286–7 S '48. A Chapanis. Despite its title, this is a book on statistics. * The author's emphasis is on the analysis of variance as a statistical tool. Rectilinear, curvilinear, partial, and multiple correlation, for example, are all treated as variance problems. Considerable stress has also been placed on experimental design as an integral part of statistical analysis. On the whole, one cannot help but be impressed by the amount of solid statistical material the author has crammed into this small book. It is especially noteworthy that the author makes explicit many assumptions about the analysis of variance which are often ignored in longer texts on this subject. As an illustration, this is the first text the reviewer has seen which states explicitly that a Latin Square type of experimental design is valid only if there are no interactions between factors. This is not an easy book to read, but it is highly recommended to statisticians and scientists with some background in statistics, whatever their fields of specialization.

For reviews of earlier editions, see 41–2.

[44]

★BROWNLEE, K. A. **Industrial Experimentation, Third Edition.** [Second American Edition.] Ministry of Supply, Directorate of Royal Ordnance Factories (Explosives). London: His Majesty's Stationery Office, 1948. Pp. 168. Paper. * (New York: Chemical Publishing Co., Inc. Cloth.) For latest edition, see 45.

For reviews of earlier editions, see 41–3.

[45]

★BROWNLEE, K. A. **Industrial Experimentation, Fourth Edition.** [Third American Edition.] Ministry of Supply, Directorate of Royal Ordnance Factories (Explosives). London: His Majesty's Stationery Office, 1949. Pp. 194. Paper 3*s.* 6*d.* (New York: Chemical Publishing Co., Inc. Cloth. $4.50.)*

Chem & Eng News 28:284 Ja 23 '50. Henry Eyring. Several additions have been made to

earlier editions including a chapter dealing with a fractional replication of factorial experiments and another which expands an earlier treatment of Latin squares. * a useful beginning book on applications.

For reviews of earlier editions, see 41–3.

[46]

★Bruce, Donald, and Schumacher, Francis X. **Forest Mensuration, Second Edition.** New York: McGraw-Hill Book Co., Inc., 1942. Pp. xiv, 425. $4.50. (London: McGraw-Hill Publishing Co., Ltd. 28*s*.) *

J Forestry 40:510 Je '42. John C. Sammi. * a most desirable reference work for those who are interested in investigation or research in forestry * the proportions devoted to each part are not the same, owing to some excellent additions and some deletions * Part two....deals almost exclusively with statistics * The technique is developed sufficiently for practical purposes. The chapter on "Sampling"....has been carefully rewritten and brought up to date. The approach to sampling has been treated from a practical viewpoint and will be found helpful both to the man in the field and to the research worker. Part three, "Indirect Estimate Based on One or More Independent Variables" covers a little more than half of the book. * The last section, "Prediction of Growth and Yield" covers about fifteen per cent of the book * There are few changes in this section but the several paragraphs that have been added contribute to the clarification of ideas and concepts. * In addition to the major changes which have been mentioned there are many additional modifications that add to the value of the publication. Included in these are the use of the engineer's transit as a dendrometer, which by implication recognizes the desirability of a ready means of obtaining diameters at different points on the stem of the standing tree, the short cut to the method of least squares, the use of probability paper in comparing certain curves, the presentation and analysis of Girard's method of volume table construction, the table of values of the Scribner log rule computed by formula for diameter values to the nearest tenth of an inch, and the greatly improved index. This book contains 49 pages more than its predecessor. The additional material is timely and well presented. The authors are to be highly commended for bringing this scientific treatment of the dynamic subject of forest mensuration up to date.

For reviews of the first edition, see 38:B564 and 2:44.1.

[47]

★Brumbaugh, Martin A., and Kellogg, Lester S., with the collaboration of Irene J. Graham **Business Statistics.** Chicago, Ill.: Richard D. Irwin, Inc., 1941. Pp. xv, 913. Text price, $5.00; trade price $6.00. *

Accounting R 17:418 O '42. R. Parker Eastwood. * Complicated derivations of formulas are avoided and the techniques are generously illustrated by examples that have an extremely practical ring. It is one of the characteristics of the book as a whole that the authors seem not only to be keenly aware of the elementary student's need but also to have a real appreciation of the sort of prob'ems that confront the business statistician. * Chapters IX and X which deal with library sources of data fill a very real need. * In an effort to include....some discussion of the more technical analytical procedures the authors have been forced to treat them in a superficial manner. Any well-rounded and adequate discussion of such techniques as the *t*-test, analysis of variance and Chi-square would have taken the authors beyond the limits of an elementary treatise. * the treatment of these important topics should either have been made adequate or omitted altogether. Chapter XXVI is really a case study in production planning. Its inclusion leaves the reader in doubt as to whether it was intended to illustrate a time series analysis or to make time series incidental to the management problem of production planning. In any case the contents of this chapter, interesting as they are, appear as part of a principle of organization that is foreign to the rest of the text. Here the problem seems to take precedence over the techniques while the material for the other chapters has been organized around the methods. The order of presentation could have been improved in a few places. The chapters dealing with library sources should precede rather than follow those dealing with the collection of data from direct sources. Since Chi-square is a test of significance the section dealing with it seems misplaced. It really belongs in the chapter that deals specifically with tests of significance. The organization of the material on index numbers is a little confusing because quantity indexes are treated in two places, parts of Chapters XIX–XX and then again in Chapter XXV. This difficulty arose out of the author's attempt to discuss index numbers of volume before time series had been treated. The points of criticism that have here been raised are very minor blemishes and de-

tract little from the merits of this excellently written text. The book definitely bears the earmarks of experienced teachers of the subject. They have written a text which beginning students of statistics will not only comprehend but enjoy.

J Am Stat Assn 37:151 Mr '42. Kenneth Duncan. * designed for the statistical consumer rather than the statistical producer; for the ordinary user rather than the specialist. The emphasis is on the simpler techniques of collecting, presenting, and analyzing business data and upon affording sound bases for the interpretation of statistical materials. The authors do not introduce mathematics beyond arithmetic and intermediate algebra, including series and the use of logarithms. The majority of business men and economists who have occasion to make use of statistics are not helped by the mysterious symbolism and the involved refinements of the mathematical statistician. * The authors have devoted considerable space to those aspects of statistical method that are especially pertinent to business and economics. The principles of sampling, the collection and tabulation of data, the use of graphs, and the treatment of time series make up the bulk of the text. Less attention is given to averages and frequency distribution than to trends, index numbers and cycles. The book includes a rich variety of illustrative matter not strictly "business statistics" * The reviewer notes with satisfaction the attention given to the limits of the reliability of the various statistical measures; it would not have been out of place to have included also a caution against some of the "horrible examples" of misleading graphic and pictorial representation which unfortunately abound in popular business and general literature. A helpful innovation in a text on statistics is the inclusion of two chapters on the collection and use of materials from library sources.

Social Service R 16:566–7 S '42. W(ayne) McM(illen). * [includes] considerable material that has not usually been covered in previous publications of similar character * very clearly written and copiously illustrated * [measures up] to high standards of scholarship. Since *Business Statistics* is addressed primarily to students of business administration, the illustrative materials are drawn chiefly from that field. * Nevertheless, the text contains an abundance of material that should prove very useful as supplementary reading for students in other fields. * the various mathematical procedures have been set forth in considerable detail and with unusual clarity. Most students should experience comparatively little difficulty in following them. Unquestionably, large numbers of students approach the study of statistical methods with the initial handicap of a fear of mathematics. Chapter ii in this book, entitled "The Use of Numbers," should help to smooth the way for those who permit this obstacle to impede their progress. This chapter provides a quick review of basic arithmetic and equips the student to proceed with increased confidence to more elaborate methods. Likewise, logarithms—from which many students shrink—are treated in Appendix C with a degree of clarity that should help in breaking down the resistance that teachers encounter in that area. * the basic methods of summarization, analysis, and presentation have been treated very fully. There are three good chapters on graphs, several on the planning and conduct of an investigation, and two on ratios. The chapters on classification and use of library sources cover an aspect of research that has frequently received too little attention in textbooks and from teachers. * [this book inspires] respect * obviously the product of extensive teaching experience; for....[it deftly] identifies the points at which students stumble and....[is] at special pains to provide guidance at such junctures, not only positively by giving illustrations, but also negatively by barring the path to incorrect interpretations * does not include problems and exercises * contains much useful material not always provided in textbooks—for example, detailed directions for the preparation of graphs, a description of machine tabulation, and instructions relative to the use of some of the machines commonly used in statistics laboratories.

South Econ J 8:517 Ap '42. Montgomery D. Anderson. The authors have succeeded admirably in doing what they sought to accomplish....namely, to develop the "elementary or foundation methods of the subject....with unusual emphasis." The reviewer does not know of any text other than this in which the exposition is better suited to the needs of the elementary student. There is an abundance of good illustrative material in all the chapters, and the organization proceeds in a connected manner which gives a sense of unity to the whole presentation. For example, the reviewer likes especially the inclusion of the broad aspects of the

problems of sampling as an integral part of the discussion of planning an investigation. * In the matter of content the text in hand is unusual in that it gives three or four times as much space as the average elementary work to a discussion of the planning and execution of investigations, either in the field or in the library. The treatment of this topic is in the reviewer's opinion incomparably the best he has seen in elementary works. * On the other hand the other topics usually considered are not neglected in favor of investigational methods *

[48]

★Buchanan-Wollaston, H. J. **On the Statistical Treatment of the Results of Parallel Trials With Special Reference to Fishery Research.** Scientific Publication No. 10. Ambleside, Westmorland, England: Freshwater Biological Association, Wray Castle, 1945. Pp. 55. Paper. *2s. 7d.* *

J. Am. Stat. Assn. 41:128–9. Mr '46. A. M. Mood. Fishery research enters only incidentally (in some of the illustrative examples) in this booklet which is primarily concerned with tests of significance for 2×2 tables and for samples from binomial populations. The author addresses himself to people with little or no knowledge of statistics, it being his aim to encourage greater use of statistical techniques by workers in fishery research. While such missionary efforts deserve the highest praise, especially in this case because the author's methodology is excellent, the beginner is warned not to read this booklet for his introduction to statistics. The sentences are complex; the ideas are expressed in very general language; and many technical terms of statistics are used without explanation or definition. For statisticians, the booklet may be described as an elaboration of Fisher's treatment of 2×2 tables and binomial populations in his *Statistical Methods for Research Workers*. Exact and approximate methods for computing probability levels are fully discussed and illustrated. The author urges research workers to report exact probability levels rather than state merely that P is less than .01 or between .05 and .01 for example. To this end he does not hesitate to recommend quite burdensome arithmetical computations when there is no simpler method of obtaining the exact value. Most statisticians would be less insistent on this point. A table is provided of the exact probability distributions for 2×2 tables in which one pair of marginal totals are equal. Distributions are given for n 2, 3, · · · , 15, 20, 30, where n is one of the two equal marginal totals. The table would be quite useful to research workers who commonly encounter data of this kind. The author also presents an interesting technique for combining several experiments in one test of significance when the data are not sufficiently homogeneous that they can be combined directly. The method consists of finding the normal deviates corresponding to the probability levels of the separate experiments, then testing the hypothesis that the deviates are a random sample from a normal population with zero mean and unit variance. This method would be used when the deviates could be given meaningful signs, and would in this circumstance be preferable to Fisher's method of taking minus twice the logarithm of the probability levels to be chi squares with two degrees of freedom.

J. Am. Stat. Assn. 41:129–30. Mr '46. Milne B. Schaefer. * The material is presented almost in the form of a manual of procedures. Each "test" is presented in a separate section, and numerical examples are given in each case. Toward the end of the paper is included a section on "suggestions as to choice of method for testing for significance in particular cases," which will assist the user in selecting tests for his own data. A final section gives examples of problems to which the various methods may be applied. The theoretical basis of the paper is left to eight pages of "theoretical notes" near the end. This method of presentation will facilitate the use of the procedures by biologists and others wishing to employ the tests in the analysis of their own data. However, some unity of subject matter is thereby lost, and it could be wished that the interrelationships of the various sections had been more clearly indicated. For example, the method (of Yates) given in section 6 for computing $P(d)$ in cases where there are over 50 individuals in the trial may be equally well applied to cases with fewer individuals, and, indeed, the formula employed therein is the same as that of sections 1 and 2, but here the factorial products are evaluated by means of the table of binomial coefficients. The null hypothesis as a basis for tests of significance is discussed in the introduction, and is again emphasized in connection with the various procedures. This, together with a separate section "on the philosophical basis of tests for significance," should give readers with a limited background of statistical theory a valuable insight into the logic underlying the methods of

this paper. The examples employed in illustrating the procedures are drawn from various problems arising in fisheries studies, but the methods will be found generally applicable in other fields.

[49]

★Bureau of the Census, Sampling Staff. **A Chapter in Population Sampling.** Washington, D.C.: Government Printing Office, 1947. Pp. v, 141. $1.00. *

Am J Sociol 53:153–4 S '47. Ethel Shanas. * The statement of the problem and the development of the sampling theory are presented clearly and concisely. Persons interested in the use or gathering of population data should find this book of value.

Am Sociol R 13:636–7 O '48. Leslie Kish and Charles A. Metzner. * should be of interest to social scientists * The forms used and the instructions for their use are subject to criticism by social scientists, but such criticism is not germane, as interviewing is unimportant to the present discussion. The organization of the material should help social surveyors to arrive at an appreciation of the sampling method described. The reviewers found no annoying typographical errors, and the Government Printing Office is to be congratulated on the job. This monograph is necessarily condensed and in parts technical. But those who contemplate survey work for any purpose will find here a manual for sampling method of increasingly wide application. The method is mathematically exact, it satisfies administrative time and cost considerations, and it is well adapted to the social organization of the sampled population. It is designed to give maximum precision for fixed cost, or minimum cost for a fixed standard of precision. That is to say, the mathematical model is rigorous, precise, and efficient. The importance of using techniques that satisfy the requirement of obtaining fiducial limits on estimates is recognized more frequently, and it is becoming more widely known that sampling designs in which the probability of elements of the universe getting into the sample is unknown (as when interviewer or "purposive" selection of respondents is allowed) do not satisfy this requirement. The advantages of mathematical rigor and the necessity of meeting cost limitations can only be obtained by a sample in which the physical properties of the population to be sampled are taken into account. The close relationship of the mathematical model with the universe implies that variances, intra-class correlations, and other statistics which are used in the evaluation of the sample, are also sociologically meaningful: they represent characteristics of the population under consideration. It is here that social scientists have a dual interest in these procedures. They may find data obtained by sampling technicians of great interest in themselves, and their knowledge of social structure could contribute to the design of samples better fitted to that structure. In the derivation of the theory the assumptions are clearly stated; furthermore the social conditions which allow these assumptions are given. These are important features because they point to the modifications necessary when adapting the formulas to different circumstances. The notation is systematic and clear and itself helpful in shedding light on the problem. Each summation sign, for example, stands for a stage of subsampling, or of stratification. The formulas may look formidable to the non-technical reader, but a knowledge of algebra is sufficient to follow most of the derivations. There is a regularity of recurrence of the same basic forms. During the derivations considerable help is given to the reader by cross references and explanations of the meanings of the mathematical expressions. The manner of applying the formulas is shown in arithmetical detail in illustrative examples taken from the surveys. The manual accomplishes admirably what it sets out to do. Paradoxically, one is inclined to criticize the book for not being what it was not designed to be: a full text on the method. The material as given may have to be modified for application to other situations. The assumptions made in the derivations (and therefore the formulas as stated) will not hold for some other types of surveys without modifications. These limitations in the present manual point to the growing need for a full text on the subject. Judging from the present volume, and other publications by the same authors, they are best qualified to fill that need. Meanwhile the present volume will be of great help to social surveyors who desire to use sampling methods which are both scientifically sound and administratively efficient.

J Am Stat Assn 42:638–9 D '47. S. Lee Crump. * a welcome addition to the somewhat skimpy literature on the theory and practice of the design of samplings. The decision....to publish the work "without waiting for the incorporation of further research and application"

seems....a commendable one. Sample censuses to estimate the total population and characteristics of the population of several congested production areas in the U.S. in 1944 provide the illustrative material for the discussion. * Part I describes the origin of the censuses and the desired precision of the results in the first few [illegible] and then moves on to a detailed discussion of the choice of the sample design with regard to the requirements on the results and the available resources. The importance of balancing theoretical advantages against practical limitations is emphasized throughout. This part of the discussion provides a good illustration of the kind of thinking that must go into the planning of a successful survey. In Part II, the theory involved in reaching the decisions and results described in Part I is developed systematically. * This reviewer was particularly impressed with the discussions of the validity of the assumptions made and the errors introduced by the approximations used. Such discussions are very helpful to the uninitiated but are frequently missing. * this little book seems to be adaptable for use as a text in part of a second-quarter course on the theory of the design of samplings.

J Royal Stat Soc 110:147 pt 2 '47. L. W.

* The particular problem discussed is that of population "census" by sampling methods, although the writers' belief is that "similar applications can be made in other fields." It is not, however, likely that the average Market Research or similar organization in this country will find much of direct application in this publication, at least, not until such time as the Government statistical organizations have first broken the back of the task, set up "block cities" and made the information available. Those responsible for the planning of official statistics generally, and in particular those who are interested in the next census of this country, should find the book stimulating. It reveals considerable differences between the American and British approach to the problem of population census. * Some interesting and useful techniques for measuring and correcting for human errors in listing and sampling are given. In general, however, it is difficult to see how similar methods may be used in this country except for Government statistics, where, the reviewer believes, a lead should be given in the study and application of areal and other sampling techniques.

R Econ & Stat 30:322 N '48. Edwin B. Wilson.

The preface states that this book....is published without waiting for fuller development because of the widespread interest in sampling and the dearth of literature of this kind. If by "this kind" the authors mean their particular techniques and formulas, there is presumably a dearth of literature; but if they mean to cover intelligent discussion of sampling problems in relation to census undertakings, the literature is not so very scanty as their dearth of reference to it would imply. They might have cited the intelligent discussion of R. H. Coats, "Enumeration and Sampling in the Field of the Census," *Journal of the American Statistical Association,* September 1931, and that of the International Statistical Institute's Commission of 1923–25, published in their *Bulletin,* Vol. 22, 1926. I mention the matter chiefly because it seems to me that scholarship requires the maintenance of a sense of continuity of scientific development, that appraisal of new contributions cannot be made except against such a background which authors should supply, and that publication of government research is all too prone to fail to supply it. With the increase and improvement during the past fifteen years of the scientific staff and advisors of the Bureau of Census ....one may be confident of the technical competency of this little book. Particularly interesting are the discussions of cost. As the cost of enumeration by sampling is considerably greater per person than for total enumeration, it is clear that for a given expenditure small places should be totally enumerated and larger places enumerated by sampling; the break-even point appears to be in the neighborhood of 50,000 to 60,000 population; but, to play safe, this study used a total count on populations of up to around 100,000. It is pointed out that such estimates of the break-even point depend upon the information available when the particular job is undertaken. The discussion of sampling theory and sampling errors is excellent; it may be noted that the authors do not rely upon the assumption of normal distribution in estimating the sampling error of a variance or standard deviation, but discuss the observed or estimated value of β_2, the fourth moment statistic. About two-fifths of the book is theory and the remaining three-fifths consists of appendices in which methods for the field procedures of enumerating and a long list of resulting tables of populations and some of their characteristics are given.

There is no index, but the table of contents is well detailed. It is very doubtful that the book could sell for $1.00 if printed commercially.

[50]

★Buros, Francis C, and Buros, Oscar K. **Expressing Educational Measures as Percentile Ranks.** Highland Park, N J.: Gryphon Press, 1940. Pp. ii, 27. Paper. $0.60. * [Reprint of edition originally published by World Book Company in 1930]

[51]

★Buros, Oscar Krisen, Editor. **The Second Yearbook of Research and Statistical Methodology Books and Reviews.** Highland Park, N J.· Gryphon Press, 1041. Pp. xxi, 383. $5 00 *

Am J Psychol 55·298–9 Ap '42. Jack W. Dunlap. * The collation in one place of reviews of a particular book furnishes the reader with various critical points of view upon the merits or demerits of the book. In all, Buros presents eleven reasons justifying the publication of such a volume, not the least of which is the fact that the book will stimulate editors to secure competent reviewers and reviewers to be more critical. * The · · · · , composition, and arrangement are excellent, so that one can readily locate either book, author, or reviewer. * All reviews have been carefully cut and edited leaving only the essential portions. Certain criticisms may be levelled against the book. In the first place, 69% of the reviews are of books released more than three years ago, 18% are of books out for more than five years, and one book is more than ten years old. This practice of citing reviews of older books was condoned by the author on the grounds that as long as current reviews appear, they should be listed. The reviewer can justify the listing of older books only to provide a complete record of the books available, but, most logically, the older books of merit should have appeared in Volume 1. Since this is the "Second Yearbook," the practice seems hardly justifiable. A frequency count of the number of times each book is reviewed shows that for 62 or 17% of the books cited, no review is given, and for another 17%, only one review is available. Thus, for over one-third of the citations, the reader is unable to compare different points of view as to the value of the book. The median number of reviews per book is 3.3, with a range of from zero to 42 reviews per book. Two major criticisms of the Yearbook are, therefore, (1) failure to provide more than one review for a third of the books, an omission that may not necessarily be the fault of the author but still a weakness of the book, and (2) inclusion of reviews of books that have been in circulation so long that their merit is a matter of common knowledge. An age limit of three or possibly five years for a book might be set for the inclusion of its review. The author might then provide in an appendix an alphabetical listing by title of all books in the field previously reviewed in the series of yearbooks. Notwithstanding these comments, the book is a contribution to librarians, teachers and students of statistical methodology, and others wishing to secure evaluations of work of this type. This volume should be in every library and available to all departments engaged in research employing statistical methods.

Am Math Mo 49 52–4 Ja '42. J. H. Curtiss. * a large, excellently printed volume, very adequately indexed. Indeed, a list of the indices alone gives some idea of the thorough nature of the book; at the beginning, there is a list of journals used, classified by fields, while at the end, there is a periodical directory and index, a publisher's directory and index, an index of titles, an index of names, and a classified index to books. The author states no less than eleven objectives of the book, or more properly, of the proposed series of similar volumes to appear every two years. These objectives may be summarized by stating that the primary idea is to elevate the standards of statistical literature by giving publicity to criticism written from a broad variety of viewpoints; a secondary aim is to elevate the standards of the criticism itself. After this catalog of some of the more imposing features of the work under review, it will sound almost frivolous to say that, at least in the opinion of this reviewer, the book is really quite entertaining to read. This is undoubtedly a biased judgment, because several of this reviewer's own reviews are reprinted in juxtaposition to reviews on the same subject by better qualified reviewers, and the resulting comparisons were personally interesting and instructive. But the wide variety of opinions expressed on any one work, and the subtle light which they often throw upon their author's competence, would almost surely provide some entertainment even for a person not directly interested in statistics. Incidentally, the new edition covers an even greater variety of scientific fields than the older one did, which is really saying something. Perhaps this is in line with the definition of statistician which Dr. W. E. Deming likes to give in his lectures, at least by implication: a

statistician is absolutely anyone who makes any measurements whatsoever. The listings still do not include English reviews of foreign language books, an omission which was criticized adversely when it occurred in the earlier edition. In his preface, the editor expresses hope of remedying the situation in later editions, and also suggests two more major improvements toward which he is working. The first is to establish a noncritical abstracting service for the periodical literature on statistics, and the second is to publish original criticisms of articles and papers in the periodical literature. As far as mathematical statistics is concerned, the first of these services appears to be adequately supplied by *Mathematical Reviews*. As to the second part of the program, the plan sounds good at first hearing, but on second thought, the idea of supplementing each of the numerous "important" papers by several critical appraisals and (presumably, to be fair) a spirited rejoinder by the author, all sounds just a little appalling. Considering the amount of work required to establish and maintain *Mathematical Reviews*, one wonders if Professor Buros knows just what he is letting himself in for. But to return to the present volume, we can say that the work as it stands is both actually and potentially extremely valuable. Let us urge by all means that the series be continued. Every teacher of statistics courses will find the series indispensable, and it is now rather apparent that scientists engaged in a wide variety of activities will find these volumes useful.

Ann Am Acad Pol & Social Sci 220:276–7 Mr '42. Abraham Wald. * As the title indicates, the book is not restricted to reviews of publications on statistical methods. Books on scientific method, social relations of science, general histories of science, and so forth, are also included. These fields are only loosely connected. Perhaps more satisfactory results could have been achieved by concentrating on statistical methods and closely related subjects. The books listed in the present volume are limited to those written in the English language. It would be very desirable to include also foreign language books. An important part of the literature on statistical methods is not available in books published so far, but is contained in articles scattered over a large number of periodicals. It would be valuable if short critical reviews of such papers could be included. In spite of some shortcomings, the present volume will be of interest to all those desiring critical information about the recent developments in research and statistical methodology.

Biometrika 32:349–50 Ap '42. E. S. P(earson). * The editor has attempted with considerable success to cover the whole field of statistical and probability theory, as well as their applications in every possible direction. He has also included reviews of a number of books on the general history of science, on scientific method and on the social relations of science on the ground that they are—or should be—of general interest to scientific workers in every special field. Included in this category are books such as J. D. Bernal's *The Social Function of Science*, J. G. Crowther's *The Social Relations of Science* and J. B. S. Haldane's *The Marxist Philosophy and the Sciences*. This large volume of several hundred pages has been admirably produced and arranged. * The objectives of the *Yearbook* as set out may be classed under four general heads: (1) To help students, teachers and librarians to select text books with greater discrimination and to point out to them the weak and strong points of particular books. (2) To indicate the width of the subject of statistics and the many fields in which it is applied. (3) To make students and teachers aware of the inadequacy of much that is now presented in text books and classes; to discourage the publication of books written by persons ignorant of the latest developments in their subject. (4) To improve the quality of reviews by encouraging editors and reviewers alike to take their responsibilities more seriously. With the last three objectives it is hardly possible to quarrel, and it is likely that the wide circulation of this volume would provide one of the most direct methods of attaining these ends. The first objective is, however, presumably the most important, and there are bound to be differences of opinion on the probable success of the book in this direction. In the ordinary event the teacher will no doubt be made aware of new books in the field with which he is concerned by reading the notices in one or two journals specially devoted to his subject. Having obtained a suggestion of a likely book he must surely get hold of it and determine by reading it himself whether it is suitable and abreast of the latest developments. If he is not competent to do this, but must base his decision on the advice of 6–10 reviewers, it seems doubtful whether he should be teaching the subject at all. After reading

through the reviews on some dozen books contained in the present *Yearbook,* I am inclined to the following conclusions. Regarding books of outstanding but perhaps rather controversial character, as those of Harold Jeffreys and Richard von Mises, the reader will certainly gain a useful impression from the collected reviews. This is partly because in such cases the standing of the reviewers is high and their reviews interesting and fairly written, even if critical. But in the case of the more elementary text book, the position is rather different. Quite often the opinions expressed are diametrically opposite. In cases where I knew nothing of the book or its author I found myself inevitably forced to form an opinion from my own personal knowledge of the experience, the special interests and even the character of the reviewer. Such inside information will generally not be possessed by the College instructor and certainly not by the student. We cannot, I think, to select a text book for his students must be escape the conclusion that the teacher who has competent to decide on its merits himself and, if he is not, he may be only confused by the varied opinions contained in the *Yearbook.* Three future directions in which the volume might be enlarged are contemplated: (1) The inclusion of reviews of foreign language (*i.e.* not English) books. (2) The addition of a section devoted to non-critical abstracts of periodical literature on research and statistical methods. (3) The publication of original criticisms by one or more persons (according to the importance and controversial nature) of articles and papers in the periodical literature. The first addition is clearly desirable; the publication of translations of reviews in foreign journals of our own American and British books would probably be useful too; it would help us to see ourselves as others see us. With regard to the second and third proposals, the great difficulty is of course to secure the services of sufficiently competent abstractors or critics for so large an undertaking. If, quoting the Editor, the statistical student and teacher are to be kept "abreast of modern developments in statistical theory"; to be warned "to ignore much of the literature which either presents nothing new or presents inefficient or incorrect methods of statistical analysis"; to be told what are "sloppy, valueless, and erroneous articles" and what are "well-written, significant contributions," it is clear that a very great responsibility will lie on the Editor of the *Yearbook* and his collaborators. As Prof. Buros indicates, the organizing and editing of such a comprehensive service would need the support of a foundation interested in fostering the advancement of research. Indeed, to avoid duplication the organization must be built up on an international basis, possibly in collaboration with such bodies as the American Statistical Association and the Royal Statistical Society between whose representatives some discussion of a similar project took place a few years ago.

J Forestry 39:1041–2 D '41. R. M. Brown. In size, appearance, and typography this *Second Yearbook* is so vastly superior to the first edition that the reviewer failed to recognize it. In fact, it resembles the original so little that he emphatically denied having ever seen the book—much less reviewed it. In every respect it actually is that much better. For the benefit of those who may not be familiar with the first volume, this series of so-called yearbooks is a collection of excerpts from reviews of research and statistical methodology textbooks written in English and published since 1933. To compile this list, the author and staff made an exhaustive search of journals from all over the world. This revised edition contains 1,652 review excerpts of 359 books from 283 journals. This is more than two and one-half times as many reviews, more than twice as many journals, and almost three times as many books as were reviewed in the first edition. Furthermore, the reviews are longer and a greater number of critical reviews have been included. Books on such subjects as mathematical economics, population studies, and general histories of science, which were given little space in the original volume, are more adequately covered in this. A periodical directory and index, a publishers directory and index, and title and name indexes are valuable additions to this edition. This *Second Yearbook* should, therefore, be of interest to a much wider range of readers. * If this series of books continues to be published and is widely read, and accomplishes but a fraction of the editor's objectives, it should contribute much to the proper analysis and interpretation of scientific data. This *Second Yearbook* has already proved of value to the reviewer in several ways. He has purchased a number of books for his library that have clarified some points of theory that were a bit hazy. In some of his books he has also corrected

errors that he did not know existed. He has gleaned much concerning fine points of both theory and method from the critical reviews of authorities. He has located a reference on a specific procedure that he has been trying for some time to run down. In addition, he has recommended several books to the Division and College librarians that were not previously available on the campus. Because of this helpful service, the reviewer, for one, would hate very much to see this book discontinued because of lack of support. As stated in the review of the first edition, the reviewer is of the opinion that this *Second Yearbook* should be in the library of every organization carrying on research that involves numerical data. Furthermore, he strongly recommends to all individuals handling such data that they read over the critical reviews of the authorities.

J Franklin Inst 233:202 F '42. R. H. Oppermann. * Research workers seeking information in this field of endeavor will find here an invaluable tool, a means of saving time, a short-cut to completion of their work. Because each book listed contains numerous reviews by different reviewers from different points of view and various sources, an accurate appraisal of the value of each book is obtained. Anyone who has ever done research through the literature will immediately recognize the worth of such a work.

J Royal Stat Soc 104:373–5 pt 4 '41. M. G. K(endall). * Gradually enlarging his field, Mr. Buros has now produced the *Second Yearbook,* which is in many ways a great advance on its predecessors. It contains 1652 review excerpts from 283 journals relating to 346 books; the excerpts....are longer; and the book is excellently printed. * The usefulness to the general reader of having reviews of books which concern him assembled under one cover requires no comment. What will particularly interest both producers and consumers of reviews is Mr. Buros' declaration of the secondary objectives of his compilation: "To emphasize that there are usually marked differences of opinion even among the more advanced students of statistical theory in their appraisal of a particular book; To discourage the writing and publication of stereotyped textbooks written by persons ignorant of modern developments in statistical theory; To improve the quality of reviews by stimulating editors to take greater pains to choose competent reviewers who have the industry and courage to contribute frankly critical reviews following a careful study of the book being reviewed; To improve the quality of book reviews by stimulating reviewers to 'Take their responsibilities more seriously' by refusing to review books which they cannot, or will not, appraise competently and honestly." Now, this gives a reviewer something to think about. Everybody knows that there are a great many bad books on statistics at large in the world. In a recent address Professor Hotelling has explained how many of them come into existence. But this is the first published suggestion I have seen that there is also something wrong with statistical reviewers. It may be worth while examining briefly how far the charges implicitly brought by Mr. Buros will lie. A glance at the reviews collected in the *Second Yearbook* will be sufficient to establish the point that there is a great deal of variability between reviewers of the same book. Part of the variation is due to the fact that the reviews were written for different journals—readers of the *Lancet,* for instance, expect something rather different from readers of the *Economic Journal,* and certainly get it. If we could analyse the variance between reviewers, we should, I think, find that after eliminating this effect there was a substantial residual, which could be split into two parts: legitimate differences of opinion on contentious matters, and variations according to the reviewers' ability to review. Apart from matters of presentation and emphasis, the former ought not to be important; but there is distinct evidence that its effect is larger at the present time than it should be. Impartiality is not one of the most prominent statistical virtues. It is not easy to be just to an author who declares, often somewhat dogmatically, that probability is simply relative frequency, when you have spent years declaiming from the house-tops that it is nothing of the kind. It is not easy to give due weight to an author who claims to be able to analyse time-series by regression equations, when you have tried the method in your own particular sphere with negative results. It is very difficult indeed to keep the scales level when the author refers slightingly to work by the reviewer himself. Statisticians, unlike precious odours, are not most virtuous when incensed or crushed, and the fact reveals itself in the reviews they write. I think that perhaps reviewers *could* be a little more objective with-

out loss of critical power. However, Mr. Buros seems to feel that reviewers are not severe enough, or rather that they suffer from an undesirable diffidence in expressing disapproval. Here, I think, he has a point in relation to current textbooks. In the old days, and in the worlds of art and literature, reviewers and authors said what they thought about each other with devastating candour. * Nowadays, in the austerer realms of science, we use the different technique of damning with faint praise. We are mildly encouraging, we are faintly commendatory, we are gently reproving, we are diffidently laudatory, we castigate with the delicate touch of a gardener trying not to brush the bloom off a bunch of grapes, root-and-branch condemnation has gone out with the bell, book and candle. This is perhaps just as well. It is better to give several offenders the benefit of the doubt than to convict one wrongly. But the danger is that we are apt to let indulgence of the author's feelings interfere with our duty to readers of the review. Amid the welter of slightly eupeptic pontification which greets the average textbook nowadays it is almost impossible to discern whether the book is good or bad, and, when this is so, the reviews might just as well not be written. And this brings us to the second cause of variability: the quality of reviewers themselves, for mild commendation may be due to the timidity of ignorance as much as to the benignity of experience. Perhaps it is not for a reviewer to comment on this subject. Dog does not eat dog, and I for one am not prepared to try to lay down the canons of the recensorial art. But I should like to loose just one broadside against a recognizably distinct type of review which ought never to be permitted by any conscientious editor. It is constructed after the following formula: (1) Always use the editorial "we" or the third personal form "the reviewer" in making statements of opinion. This gives the review an impressive *ex cathedra* air of authority. (2) Always find a misprint and point it out. This shows that the reviewer has read the book with complete understanding, and not merely copied his review from the dust-cover or the preface. (3) Definitely approve or definitely disapprove of the author's treatment of the theory of probability, if any. This is quite safe, and shows that the reviewer is capable of forming an independent [illegible] (4) Always introduce a reference to the analysis of variance. This shows the reviewer to be fully abreast of the current of modern statistical development. There are other tricks of the trade, but I have said enough to indicate the sort of review I have in mind. Let us at least join with Mr. Buros in suppressing this synthetic abomination. Coming back to the main point, I feel bound to say that in my humble judgment statistical reviewers in this country do their job reasonably well. There are exceptions, of course, but there are also some masterly pieces of criticism quoted in the *Second Yearbook*. Pope, writing of what passed for poetry in his time, considered that the number of bad critics greatly exceeded the number of bad authors.

> 'Tis hard to say if greater want of skill
> Appear in writing or in judging ill. . .
> Too few in that, but numbers err in this;
> Ten censure wrong for one who writes amiss.

I should say that, as regards statistical textbooks at the present time, the situation is reversed. Perhaps reviewers are to blame in not being frank enough. Perhaps a little invective now and then would be useful. But shall we not tackle the disease nearer its source, and try to discourage publishers from scrambling into a new market with very poor wares to offer?

Math Gazette 26:68-9 F '42. Frank Sandon.

* The origin of the book is evidenced by the 44 volumes under education and psychology as well as the 11 on factor analysis. These last are stimulating reading, for we have here contributions from the chief protagonists in this many-angled fight. The books reviewed include most of those of importance of the time covered. Some of the titles that the reviewer expected are, it may be suggested, not found here because in his enforced removal from libraries he cannot check the dates (of such titles as Political Arithmetic, Leybourne on the falling school population, Dublin and Lotka on 25 years of American Life Experience, Huntingdon on Season of Birth, Vernon on Rating Scales and some of the recent English social surveys), and they may all have been completely dealt with in the earlier edition. The reviewer in this journal of the first volume found that there were more entries from his pen than from anyone else: Dr. Wishart still leads with 22 entries. Another British statistician, M. G. Kendall, follows with 17. There are extracts of 32 reviews from the *Gazette:* it is not often that a reviewer of a second edition can find out what

the reviewer of the first said by consulting the text of the book in question. Though the book reviews are excerpts only, yet the unused portions, judging from the very limited sample we have available, are very small and of the order of 5% of the whole. So we have here practically everything that has been written in the journals surveying all the new material. A humbling experience it is to read these extracts. Your present reviewer tried to assign marks, first to the books reviewed on the basis of the reviews, and then to the reviews, on their value to the intending reader and purchaser. Both attempts failed. What is a good review? What is a good reviewer? What has gone wrong when one writer describes a book (87) as beautifully got up and elegantly printed (Sarton in *Isis*) and another as inartistically printed (Comrie in this journal), when one reviewer describes a book (313) as good humoured and another speaks of the "note of bitterness" in it, when one reviewer says of the writer of book 341 that "the author has grasped the tail of something which she does not fully comprehend," another says the work is uniformly scholarly, and a third that the book is imbued with the scientific spirit. The most glaring example perhaps is in connection with the reviews relating to Sherwood Taylor's *Short History of Science* (not reviewed in the *Gazette*), where there are some dozen pairs of mutually contradictory verdicts. These, and similar discrepancies, are not merely on matters of value and of judgment but also of fact. The volume has been prepared with the object, *inter alia,* of improving the quality of book reviews. And there is clear evidence here that certain journals hand reviewing over, as the editors of this book say, to individuals unable to appraise competently or honestly. The worst offenders on this side of the Atlantic appear to be the general and literary weekly periodicals. It seems clear that publishers do themselves no good by sending books for review where they will not get treated by writers with the necessary technical knowledge, intelligence, and disinterestedness. Some reviewers fail for lack of one or other of these qualities; some by reason of excessively jaundiced or genial temperament; whilst others are merely exhibitionists displaying through superficial showmanship their ignorance and their distorted rationalisations. The book should thus be very valuable for illustrations in a course on book reviewing. The editors think that it should help students and librarians to select books with greater discrimination: it is undoubtedly a great convenience to have all the relevant matter brought together within one cover, particularly when there has been review, reply, and counterblast. The editor suggests that the volume should be extended to (1) deal with foreign language books, (2) abstract from periodicals and (3) review articles in periodicals. These three features would well make the book even more valuable than perhaps the present objectives, and it is to be hoped that the financial position of statisticians will make it possible. The present work is praiseworthy in its efforts and it has undoubtedly been a source of instruction and benefit to at least one reader. The book, although large (2 column pages, 10½" by 7½") is light to handle and the type is very pleasant. Misprints there are, but they are usually unimportant. Cross references are usually complete, or are easily made with the help of the very useful indices (journals, books, publishers, titles, topics, writers).

Med J Austral 29¹:139–40 Ja 31 '42. An unusual book....from America. * The editor is naturally anxious about the fate of this book. Of its value to teachers and librarians there can be no doubt. Unfortunately it is not the type of book that will call for a large sale. * We trust that this venture will meet with success. It is surely worthy of endowment by some far-seeing scientific body with money, if such a body exists.

Nature 149:9 Ja 3 '42. R. A. F(isher). The second issue of this Yearbook maintains the high standard of the first issue, covering the years 1933–38. Being greatly enlarged, it exhibits more fully the advantages of this original method of gathering in a single work of reference the critical and descriptive reviews which have appeared upon the literature in this branch of science. The excerpts presented in this Yearbook are longer and more informative than those in the first volume. The material covered has been extended, especially in mathematical economics, population studies and general histories of science. The appearance of the volume has been improved in many ways, including the use of larger type, and, although a work of this kind was particularly needed in respect of statistical methodology, the value and convenience of this venture should encourage the application of the same principles with re-

spect to other branches of scientific literature. Within the field with which the reviewer is most familiar, the excerpts from reviews have been made judiciously, and adequately represent the point of view and critical contributions of the reviewers, in addition to giving indirectly a good idea of the works noticed. Since review notices are particularly liable to be scattered and inaccessible, it is a very great convenience to have them collected, reproduced, and well arranged.

Psychol B 39:184–5 Mr '42. Dewey B. Stuit. * The editor lists eleven objectives to be achieved by the publication of this yearbook series. In the opinion of the present reviewer these can be condensed to three. The first is that of helping students and teachers keep abreast of the times in research and statistical methodology and making them more keenly aware of the inadequacy of much of what they are teaching. In the selection of textbooks this information would be particularly helpful. A second significant objective is to encourage a higher quality of work on the part of those who publish books in this field. Through an examination of reviews written for books on related topics, a prospective author can profit from the mistakes of others as they have been pointed out by various reviewers. A third purpose is to stimulate reviewers to take their responsibilities more seriously, writing more critical reviews where they are competent to do so and declining to write reviews of books which they are not qualified to evaluate. There can be no disagreement with any of the objectives listed. Whether they will be achieved by publishing reviews in yearbook form is another question. At present many books are adopted for class use before the reviews appear in the journals and certainly long before they can be compiled in a yearbook. As a result, it is doubtful whether a project of this nature will have much immediate effect upon the textbook problem. Because of the brevity of many reviews, the wide differences of opinion which they represent, and the nonevaluative character of some, it is a bit optimistic to hope that much educating can be accomplished by merely bringing the reviews together in convenient form, granted that only the best are selected. In any event, such an educational process will proceed very slowly. The realization of the second and third objectives appears more hopeful. An author writing in the field of statistics and scientific methodology and interested in the improvement of his manuscript is likely to consult the *Yearbook* for helpful suggestions. To search for them in the original in a wide variety of journals would be too arduous a task. The same could be said for book reviewers. Indeed, to this reviewer it seems that the third objective is the more likely to be achieved. In later issues of the *Yearbook* it might be advisable to include a section on the subject of book reviews. For example, suggestions could be made regarding the amount of space which should be devoted to description and evaluation, criteria for evaluation, and style of presentation. If the improvement of reviews could be achieved through such means, the publication of this yearbook series would be well worth while. A commendable improvement proposed by the editor for the yearbook series is the publication of original criticisms of articles and papers in the periodical literature. The need for such criticisms is clear, but, in view of the limitations in funds and machinery which would likely be encountered, it would seem best to confine the series to book reviews, at least for the present. The present *Yearbook* is an ambitious undertaking and one of which the editor may well be proud. In the fields of psychology and education, the excerpts of reviews as presented are of high quality. The only limiting factor is the original quality of the reviews themselves. It is a fair presumption that reviews in other fields are equally good. Advanced students of statistics, progressive college teachers, and research workers will find this book useful and will welcome future publications in the series.

Q R Biol 17:92 Mr '42. * Unquestionably a useful source of information, this yearbook is also entertaining, and sometimes embarrassing for book reviewers. The editor would like to make the *Yearbook* an annual publication if funds could be obtained; otherwise it will remain biennial. Other and more ambitious changes are contemplated, including the review of articles as well as of books. The value of this proposal is doubtful.

R Scientific Instruments 13:183 Ap '42. S. S. Wilks. * Buros has performed a real service for teachers, research workers, and librarians * *The Second Yearbook* contains many journals not included in the earlier book. The two books together cover in a rather exhaustive manner reviews of books in statistical methodology, history of science, and social relations of science

published in English after 1932. * The book is beautifully bound and printed. It will be found interesting and useful by teachers, research workers, librarians, and others who are concerned with procuring books dealing with statistical methods and related topics. If in future volumes in his series of yearbooks the author could arrange to include competent critical reviews of papers dealing with statistical methods appearing in current periodical literature, the usefulness of the book would be greatly increased.

Sci 95:225–7 F 27 '42. C. Eisenhart. In 1625 Francis Bacon, in his essay "Of Studies," wrote: "Some books are to be tasted, others to be swallowed, and some few to be chewed and digested; that is, some books are to be read only in parts, others to be read, but not curiously, and some few to be read wholly, and with diligence and attention." Had he lived to-day, he might have added that some books ought not be read at all. At no time in the past has there ever been such a need for guidance in selecting books for reading, study or reference. Presumably, book reviews are written to provide such advice. If this is the case, then a reviewer is placed by his role in a position of trust; especially when his prominence is such as to give special importance to his opinions. It is regrettable, therefore, when prominent individuals write inconclusive reviews of books the subject-matter of which is well within the domain of their proficiency. It is likewise unfortunate when reviewers venture outside their competence. Nowhere are these regrettable occurrences more prevalent than in the reviewing of books on statistical theory and methodology. Furthermore, the consequences are serious, for the majority of readers and users of statistical textbooks and manuals are not qualified to judge the validity, accuracy or limitations of the material before them. In selecting a book on statistical theory or methodology, it is often necessary at the present time to examine several reviews of the same book. This comparison of evaluative statements appearing in diverse journals and periodicals is greatly facilitated by the book under discussion here. * Only one journal, *Economica,* did not grant permission to excerpt its reviews; suitable reviews in this journal consequently have been indexed but not excerpted. The journals utilized represent a wide variety of fields. * The index of names provided does not distinguish in its references between books and book reviews by the individual concerned and could be made more useful by printing in different kinds of type the numbers which designate books and book reviews by a given individual. * The excerpts in "The Second Yearbook" are longer and more informative than those in the first volume of this series. Other improvements are a better format, larger type and a more natural numbering system—the curious system employed in the first volume was bewildering to many users. "The Second Yearbook" is on the whole a marked improvement over the first of the series. The editor seems to have profited from the reviews of the first volume, excerpts from these reviews being included in the present volume. * "The amount of space devoted to excerpts for a given book is in direct proportion to the number of evaluative reviews located and not necessarily to the importance of the book." As a result of this editorial policy, "The Second Yearbook" is somewhat encumbered with inconclusive excerpts from inconclusive reviews. * The present reviewer feels that the editor would do well in the preparation of future yearbooks to strive for maximum guidance in the selection of books, by including only the most informative and provocative statements. * The excerpting seems to have been done without noticeable bias. From a comparison of numerous excerpts with the original reviews, it can be said that on the whole the excerpts faithfully reflect the opinions of the original reviewers relative to the authors' choices of subject matter and their presentation of it. By making available in one place some really evaluative statements originally appearing in very diverse journals, the editor has rendered a great service to all who try to select the best from the mass of current literature on statistical theory and methods. Incidentally, from a comparison of some of the reviews presented here, the present reviewer wonders whether it might not be desirable in certain instances to have reviews jointly written by an expert on the theory involved and a person experienced in the field of application. While the excerpts in "The Second Yearbook" provide a good summary of the reviewers' opinions of a given book, they generally fail to give an adequate guide to its contents, even when all excerpts for this same book are viewed collectively. In most instances the original reviews contained a listing of the contents, but these portions were generally omitted in the excerpts.

Since such information is most essential for objectives (*a*) to (*c*), the present reviewer feels that the editor should devise some scheme for including this information in future yearbooks. On account of its cost, which really is not excessive considering the work involved, it is unlikely that "The Second Yearbook" will find its way into the libraries of all persons interested in statistical theory and methodology. On the other hand, it should be available in departmental libraries of all departments employing statistical methods in their research, and, on account of its fairly comprehensive listing of books on history of science and scientific method, it should be a useful volume in almost every scientific library. As noted above, only books written in English are included in the present volume, but the editor comments, "If 'The Second Yearbook' is well received, foreign-language books will probably be included in the next yearbook." The continuation and improvement of this yearbook series are thus placed squarely on the shoulders of the scientific public.

Scientific Agric 22:208 N '41 W. C. Hopper. * No one can read all the books that are written on any particular subject and few, if any, have time to search the periodicals to see what reviewers think about each new book. In the field of research and statistical methodology such tasks are now unnecessary because Dr. Buros has put in his *Second Yearbook* an invaluable compilation of critical reviews of all the recent books published in English on this subject. * The book is unique, it is timely and it is a fine contribution to the needs of all those, including editors, reviewers and writers, who have any interest in research and statistics in many fields of scientific endeavour.

For reviews of an earlier volume in this series, see 2:47.

[52]

BURT, CYRIL. **The Factors of Mind: An Introduction to Factor-Analysis in Psychology.** London: University of London Press, Ltd., 1940. Pp. xiv, 509. 21*s.* (New York: Macmillan Co., 1941. $5.00.) *

Am J Psychol 54:613–4 O '41. Anne Anastasi. * The book seems to be somewhat loosely organized and would probably gain in clarity and effectiveness by a rearrangement of the sequence of topics. The extensive use of small type passages and lengthy footnotes in still smaller type further handicap the reader's progress. These weaknesses are understandable in the light of Burt's own statements in the Preface that the book evolved from lectures and mimeographed notes for class use and was published rather more hastily than had been planned. It might be remarked, however, that clarity of presentation is of especial importance in a field such as factor analysis which is notorious for its amazing misunderstandings and the protracted and wordy controversies arising from them. Many examples of such controversies are cited by Burt himself. Finally, it might be questioned whether the material presented by Burt is suited to publication in book form. Much space is taken up with controversy and the refutation of criticisms. Most of the points regarding the nature of factors, furthermore, have been made before by other writers; no reference is made to a number of highly relevant American studies on this problem. For readers familiar with factor analysis, the book is too repetitious and many points are unnecessarily drawn out. On the other hand, it is doubtful whether the statistically unsophisticated reader, to whom the book seems to be especially addressed, can learn much from it. To such a reader, one of two alternatives seems to be open: either he must accept on faith many of the points presented in large type; or he must postpone reading the text proper until he has mastered the appendices and perhaps also studied some of the suggested mathematical readings to fill in the gaps in his preparation.

Brit J Psychol 32:324–31 Ap '42. Robert H. Thouless. * While there are now several books on the subject of factor analysis, it has been difficult for the student of psychology to gain a satisfactory understanding of the subject, since most of these have been written primarily in defence of the methods of their authors, and their tendency to deny any "psychological meaning" to rival methods may well have led the not very sympathetic enquirer to doubt whether any of the methods had sufficient psychological meaning to be worth studying. Burt has his own contributions to make to method, but gives a sympathetic and understanding account of other methods which he regards as different but not necessarily erroneous ways of achieving what is virtually the same result. So his book succeeds in giving the student not merely an introduction to a particular method of factor analysis but an understanding of the whole subject. * The early part of Burt's book is an admirable discussion of the

purpose of factor analysis. It is possible that this would more appropriately have followed the description of methods, since it is only possible to understand the theoretical questions involved if the reader has already understood the practice and the results of factor analysis. The question of order is not, however, important, since it is to be hoped that the reader after finishing the book will return to the earlier chapters, which may then be read with increased insight. * One of the demands, therefore, which may reasonably be made of Burt's book is that it should provide sufficient guidance as to the methods used for any student of psychology to be able to master them for himself. This requirement it fulfils very well. There are adequate examples fully worked out, and with so much knowledge of matrix algebra as can be obtained in a few hours' study of the more elementary parts of any text-book of the subject (such as A. C. Aitken's *Determinants and Matrices*), and by working out for himself some factor analyses under the guidance of Burt's book, any psychologist without any particular mathematical gifts should be able to understand the essential methods of factor analysis. * Thurstone believes that if, after a centroid analysis, the axes are rotated in such a way as to reduce to a minimum the number of negative saturations, and to increase as far as possible the number of zero saturations, factors will be obtained which correspond to real unitary mental capacities. This belief depends on the somewhat subjective criterion that the factors so obtained have more "psychological meaning" than have other possible factor systems. Burt adopts the more radical alternative of abandoning the aim of distinguishing unitary mental capacities as a goal of factor analysis and regards his factors rather as analogous to the lines of latitude and longitude on a map. They "are to be thought of in the first instance as lines or terms of reference only, not as concrete psychological entities" (p. 18). This does not, however, mean that the factors are without scientific value or validity. "In order to give an adequate description of persons we must first discover in what *independent* directions a person may vary, and, at the same time, so far as possible, choose the direction so that each may carry with it a maximum amount of *dependent* variation" (p. 18). The last clause seems to be not quite exactly worded. The condition required for the greatest usefulness in description (and that actually secured by the method of weighted summation preferred by Burt) is not that each factor shall carry a maximum amount of dependent variation but that any small number of factors shall carry the maximum possible amount of dependent variation which can be carried without increasing the number of factors. This means that the maximum amount of variance is accounted for by the first factor, the maximum amount of the remaining variance by the second, and so on. This means that a general factor is retained in Burt's analysis and that it accounts for as much of the test results as can be explained by a general factor. This retention does not, however, necessarily imply that there is any psychological reality in the general factor, since it may be sufficiently justified as a measure of practical convenience. The requirement that the greatest possible amount of the variance shall be accounted for by the smallest possible number of factors is obviously the most convenient condition to make for a purely descriptive analysis. It is, indeed, one that would commonly be recognized in everyday life. * It may seem to some that Burt makes a disappointingly modest claim for a technique which is often regarded as the one scientific method of finding out what are the unitary constituents of the mind. To this objection, the reply may be made that the usefulness of lines of latitude and longitude is not dependent on any correspondence they may have with real characteristics of the globe. Moreover, the problem of what are unitary constituents of the mind (if it is agreed that this is a real problem) cannot be solved independently of the results of factor analysis. If factor analysis cannot, by itself, tell us what are the unitary capacities of the mind, it can tell us what are and what are not possible ways of making an analysis of mental capacities. * An important feature of Burt's book is its adequate treatment of the problem of the statistical significance of factors. There is a considerable amount of published factor analysis in which this problem is disregarded or treated by quite inadequate methods, and factor saturations have been published when the numerical evidence for the existence of the factor in question has been very slender. It has probably often been the case that the later factors in published analyses have been characteristics only of residuals which are merely random collections of figures. Burt's interest is in scientific research and not

the working out of mere arithmetical puzzles, and he provides adequate safeguards against this source of error. While, however, he employs means of testing whether there is statistically significant evidence for the existence of a further factor at any stage of the analysis, it is unfortunate that no means seems to be provided for estimating the limits of reliability of the saturation coefficients calculated for a factor which is proved to be really present. Thus when it is said that the saturation of a particular test with a particular factor is 0.372, one does not know whether this means that there is sufficient evidence that the value lies between 0.370 and 0.374 or whether it is only known to lie between 0.2 and 0.5. Perhaps factor analysts will supply this need in the near future. The few defects which dim the lustre of this book are probably to be attributed to the haste in its preparation for the press which was necessitated by the outbreak of war. Some of the physical analogies in the early chapters seem to have been not very happily chosen. There are occasional patches of unnecessary obscurity, as, for example, the treatment of analysis of variance. Sometimes, there is a looseness of phrasing, as when, on p. 379 and elsewhere, the author speaks of the "variance" of a trait. The mathematical term "variance" can properly only be applied to a measurement, not to the thing measured, and it may be dangerously misleading to ignore this distinction in psychological measurements, since it leads to an overlooking of the arbitrary element in every psychological measurement. There are many similar points with which a critic might quarrel, and perhaps one of the services of Burt's book when more normal times return will be to stimulate controversies which will elucidate many of the obscure points of factor theory. If there are defects, these are trivial; the merits of the book are great. It may safely be judged to be one of the most important contributions to psychology made during recent years.

J Ed 73:358–9 Ag '41. T. Raymont. * It will be inferred that, when Dr. Burt tries to help the "general" reader by having certain sections printed in small type, he really means the scientific reader who seeks an explanation of the sharp differences—one might almost say the clamorous quarrels—between the leading factorists. For such a reader, as well as for the research-worker desiring to apply factorial methods, the book is meant. As a controversialist Dr. Burt appears in the light of a healer of differences, but he performs this function, not by amiably evading the point of an opposed doctrine, but by stressing an aspect which he believes it to have missed. He holds throughout that the primary object of factorial methods is neither causal interpretation, nor statistical prediction, but exact and systematic description. In this connexion he has a word in season for the educational or vocational psychologist who offers confident predictions based upon some such factor as *g* or general intelligence. His book should be a godsend to younger workers in the same field. As for the general reader, he who runs may not read. *

Math Gazette 25:188–90 Jl '41. H. T. H. Piaggio. Readers of the *Gazette* may ask what interest a treatise on Psychology can be expected to have for them. The answer is that factor analysis, a subject whose origin was in problems of educational and vocational guidance and in metaphysical theories, and later took a statistical form, has now developed into a field of application of matrices. It may even lead to new discoveries in this field. Professor Burt found it necessary to investigate the latent roots of certain compound matrices, and obtained a result which appeared to be new, although it was afterwards found that it had been obtained long ago by Sylvester. Strangely enough, both psychologists and quantum physicists have been working with matrices on similar lines, until recently in complete ignorance of each others' work. The reason for this identity of method in two such very different subjects may, in Professor Burt's opinion, be ultimately traced to a common dependence on some more abstract branch of mathematics such as the theory of groups. Factor analysis may also be linked up with the statistical methods associated with the name of Professor R. A. Fisher, in particular the analysis of variance. * Burt himself has contributed to several of the older methods, but his latest work is on rather different lines. As before we start with a matrix of scores, and then reduce those in each row by the average of that row, so that the sum of the reduced scores in each row is zero. What is new is that by a suitable choice of units we contrive to make the sum of each column also zero. This introduces a symmetry between the relation of the matrix to the n tests and the p persons. If we post-multiply this matrix by its transpose we get a square matrix of n rows and

columns whose elements are the unaveraged variances and covariances for the tests. Similarly if we pre-multiply, we get the corresponding results for the persons. By the Sylvester-Burt theorem the non-zero latent roots of these two product matrices are the same. Burt's final results consist of general and group factors, which can be calculated exactly. There is no indeterminacy, a great weakness of some of the older methods, and Thurstone's laborious "rotation of the axes" is not needed. There are no specific factors. The subject is still in the realm of controversy, but it may be said provisionally that in several respects Burt's methods appear the most promising yet found. * The mathematician who is not also a psychologist may leave it to others to dispute over the interpretation of the work, and be content himself with the interesting occurrence of matrix and even quantum theory in an unexpected place. *

Mental Hyg 26:488 Jl '42. W. Line. * Burt has made a very challenging attempt to....put an end to a cavalier attitude toward factor analysis, on the one hand, and to dispel the sacrosanct atmosphere surrounding any one factor school on the other. In a clearly written volume packed full of detail and experimental experiences, he has tackled three things: (1) a logical approach to the factor concept; (2) a demonstration of the common denominator underlying the main apparently diverse schools and systems of analysis; and (3) an examination of experimental data, using various techniques, but resulting in a common outcome. While there is little classification of psychological theory or systematic principles, a good deal of theoretical implication pervades each section of the work. The total effect is extremely valuable. Analytical techniques are shown to be dangerous if used without care and understanding, as regards both the techniques themselves and the psychological problems to which they apply. At the same time the necessary appreciation is not grounded in unattainable or remote mathematical logic; rather, is it a matter of systematic and straightforward reasoning. The student will be impressed, and greatly helped. The book is a unique contribution to the field.

Mind 51:170–80 Ap '42. W. J. H. Sprott. * the writer of this book, Professor Burt, is not only a distinguished authority on factorial analysis, he is also an eminent psychologist. He has, therefore, great sympathy with the non-mathematical psychologist, and he is prepared to discuss the nature, validity and usefulness of such concepts as *"g," "v," "f,"* and *"p"* from a purely psychological point of view. He has written a monumental book on the subject—monumental in more than one sense. It is a very long book, the production of which in war-time is in itself a triumph, but it may almost be regarded as a monument erected over the grave of mathematical pretentiousness. Psychologists who cannot follow the detailed technical material of Part II, will read with pleasure, not unmixed with relief, the pages of Part I, in which Burt reveals to us that the mathematician has no technique up his sleeve, by means of which he can make discoveries which cannot be made by any other means. In point of fact the mathematician can only make more precise what we know, or suspect, already, and make suggestions which have to be confirmed by observation. * Unfortunately the book gives one the impression of having been built up out of papers and essays written at various times. There is an exasperating array of footnotes, sometimes answering criticism which has appeared since the main text was written, while one's pleasure in reading the main text is diminished by the interpolation of large sections of small print which give the unhappy impression of being after-thoughts. Furthermore, we should have liked a little more mathematical assistance, but to this it may be objected that the technical pages were written for people sufficiently educated to understand them. Certainly the book cannot be understood at all by anyone who knows nothing about factorial analysis to begin with. For such a person a book like—if there are any others comparable—Thomson's *Factorial Analysis of Human Ability,* a masterly work and crystal clear, is an indispensable preliminary to Burt. However, though the book is difficult to read, it is extremely important, because, as was said above, it discusses the relation between Mathematics and Psychology. * We find an interesting chapter on the mathematical assessment of psychological traits, but it must be admitted that such assessment is extremely precarious. * It is noticeable that in....[Part III] the tone is far more confident than that which pervades the earlier theoretical discussions. We have no elaborate phrases devised to get over philosophical difficulties, Burt is here drawing on his enormous experience as a practising psychologist.

He has made predictions in real life and he has found that his predictions are frequently validated by experience. It is all very well for us to say: "Yes, but what would have happened if you had taken a different battery of tests, or measured different qualities?" The fact that his procedure has pragmatic sanction cannot be lightly dismissed. We must beware lest our head-shaking, and our moans of "very dubious" become a trifle too automatic and obstructive. Such are the main themes of the book. Part II in which Burt claims to show that the differences between the various ways of analysing correlations are more apparent than real (I mean the various *techniques,* not the variety of alternative answers within each technique) is of greater interest to the technician than to the non-mathematical reader, and does not affect the main issue: what is a factor? The concluding pages are of interest to everyone. Is there any evidence as to the distribution of temperamental traits throughout the population? Are introversion and extraversion opposite ends of a continuous distribution such that a "mixed or relatively well-balanced mind" is "the commonest of all"? Evidence is produced in favour of this suggestion, and Burt urges that further investigation be done on this subject. It is impossible to pass a single judgment on the book. It is obscure and difficult, the footnotes and varieties in type are well-nigh intolerable, and the student may be bewildered by the numerous definitions of "factor" that appear from page to page, but there is no doubt about its being an important contribution to the subject. Whenever one reads anything written by Professor Burt, one feels oneself to be in contact with a lively philosophical mind. He is, if one may so express oneself, fundamentally "un-slick."

Q R Biol 16:511–2 D '41. * A lucid and informative presentation of current viewpoints in this interesting field of psychological research.

For additional reviews, see 2:48.

[53]

★BURTON, CLEMENT. **A Concise Manual of Statistics: With Special Reference to the Requirements of Students for Municipal Examinations, Second Edition.** London: Gee & Co. (Publishers) Ltd., 1946. Pp. 182. 15*s.* *

J Am Stat Assn 43:137–9 Mr '48. Harry Pelle Hartkemeier. * In England it is necessary for a person to pass an examination in the field of statistics before he is allowed to practice with something equivalent to our C.P.A. This is an excellent practice and the authorities responsible are to be congratulated. It would be a very good idea if accountants in the United States were required to demonstrate a similar knowledge of statistics before they are recognized as Certified Public Accountants. Most accountants are deficient in a knowledge of sampling techniques and tests of significance or reliability. This book is an excellent one in view of its purpose as a manual or handbook. It will serve an accountant well when he wants to refresh his memory about a statistical formula or process. Presumably, the accountant has already known something about statistics and needs primarily a rapid review. This book is not so well suited to be an elementary textbook for a new student to use to obtain an introduction to statistics. * The book seems a bit jerky at some points. One gets the impression that it was written a little longer and parts were deleted to shorten the book. This could have been the work of some editor not familiar with the material or subject. At most places the material reads smoothly and for an American reader the book has some delightfully surprising expressions. * Everyone has the right to select his own symbols, but the American reader is not apt to like the choice of a for the arithmetic average, Z for the mode, and M for the median. The usual meaning for the probable error is found on pages 123 and 124 in connection with the explanation of correlation, but there may be some confusion when the reader compares this meaning with the statement on page 29, "When figures are taken, for example, to the nearest 100, the maximum possible error is 49; but as the error may be anywhere between 0 and 49 the average or probable error is 24.5." On page 124 the reader encounters eight statements dealing with the interpretation of the value of r. Two of them are: "If r is less than .3—little evidence of correlation." "If r is more than 3 times the probable error —evidence of correlation." No mention is made of the possibility that r could easily be 3 times the probable error *and* be less than .3. The two different conclusions conflict. * Very careful type setting or very good proofreading was responsible for the fact that very few errors are noticed. One of the principal virtues of the book is the honest recognition of the value of the work of the statistician. "The position of the statistician lies between

the accountant or cost accountant and the economist or executive authority." No doubt this will sound like heresy to accountants in the United States, who for years have claimed the position of being the right-hand man of the executive. At long last, people are beginning to realize that accounting is but a part of the much broader science of business statistics.

Sankhyā 8:286–7 O '47. T. Choudhury. * The main features of the book are its conciseness and non-mathematical nature and it is specially suited for non-mathematical readers who are satisfied with the routine type statistical applications without bothering about the basis of such : · · : Even within the limitations under which the book is written, the presentation of data classified under two or more heads might have been described, as these are very often necessary in the presentation of statistical data that come under the review of municipalities. The short-cut methods of calculation of mean, of standard deviation *etc.* might have been added in view of their frequent use in lessening the labour of computation.

For reviews of the first edition, see 38:B567 and 2:49.

[54]

★Butsch, R. L. C. **How to Read Statistics.** Milwaukee, Wis.: Bruce Publishing Co., 1946. Pp. vii, 184 $2.50. *

Am J Pub Health 36:1169–70 O '46. John W. Fertig. * The book....will probably be of no interest to public health workers, since the data and many of the techniques considered are limited to the educational field. In fact, many of the data appear to be highly artificial. While the section on the frequency distribution and graphical methods makes interesting reading, the long section devoted to the various correlation coefficients is rather poorly done and certainly of no interest to the public health worker. The section on chance variation is likewise of limited utility and appears to be very ill-balanced.

Chicago Sch J 29:93 Ja-F '48. Denton L. Geyer. Since most people are in acute need of ability to read and interpret reports cast in statistical form, while few people are obliged to compile such reports, a book stressing interpretation rather than computational ability has long been needed. The present volume fills the need admirably. Anyone who will work through these non-technical explanations will markedly raise his ability to understand educational, psychological, sociological, and other social science books and journals.

El Sch J 47:175–7 N '46. Frances Swineford. There has long been a persistent demand for some kind of instruction in the interpretation of statistics which would avoid the actual manipulation of formulas on the part of those teachers, social workers, personnel directors, and businessmen who are interested in the subject solely from the standpoint of the consumer. There has been an equally stubborn resistance to this demand on the part of teachers of statistical method, who maintain that real understanding depends on a familiarity with the formulas and mechanical procedures involved. As a result, a large group of individuals, who have avoided or escaped formal instruction in statistical method, lack the ability to comprehend even the simplest of statistical terms. Whether or not there can be a satisfactory solution to the problem, this reviewer is unable to say, but an able teacher of statistics has made an attempt which does, indeed, appear promising. * The general plan of presentation is good. Each new statistical term is italicized and carefully defined in simple terms and without recourse to formulas. A brief paragraph at the beginning of each chapter links it with the preceding chapter and indicates previously defined concepts that the reader should keep in mind. Numerical examples which illustrate the statistical ideas are offered in generous number. Through the manner in which these illustrations are presented, the reader will learn how to interpret the results, just as though he were reading a published research report, rather than to verify the results arithmetically. A few of the topics might have been treated in somewhat greater detail. In the section on the percentile method, cautions to be observed in using percentile scores are not pointed out. References to the "population," as distinguished from a "sample," leave the impression that the population is always a finite number. The assumption of an infinite population, used in the derivation of statistical formulas, should have been made clear. The definition of the null hypothesis is incomplete and implies that "null" refers to "no difference" rather than to any hypothesis which may be either accepted or nullified. The treatment of analysis of variance and covariance is sketchy, probably necessarily so in view of the fact that no formulas are used at any point. There are a few typographical

and some computational errors, which probably would have been corrected in proof by the author had he not died before the volume was published. * The treatment of sampling error is largely in terms of the probable error instead of the standard error, which is in more general use today. * the volume could be broader in its appeal were some of the examples closer to the interests of the social worker, the personnel director, and the businessman mentioned in its Introduction. * It would probably be easier for the reader to follow the discussions of the normal curve, t, χ^2, and F if a short table for each were included. Such tables would also provide him with a rough check on data in published reports and thus render the book more generally useful. It is not suggested that these tables need be detailed enough for use in computing, because such detail would not be consistent with the aims of the author. The material of this volume is well organized and clearly presented. It is difficult for a person who is acquainted with statistical terms to evaluate the book from the standpoint of one without this type of background. Nevertheless, the book ought to serve its purpose admirably for any reader willing to learn the statistical language which is used, and it could also well be used as a means of motivation for students of statistical method. One is more likely to desire the answer to "How is it obtained?" if he first has the answers to "Why is it done?" and "What does it mean?"

J Am Stat Assn 41:602–3 D '46. Louis Guttman. * The presentation is simple and lucid, on the whole. Indeed, it is one of the best written statistical books this reviewer has seen. * A number of faulty statements that should be pointed out include the following: The author states that statistical treatment is required by sciences dealing with living things, but not by the physical sciences (p. 2); that dispersions of distributions cannot be compared unless they have the same average (p. 28); that standard scores are more "strictly mathematical" than percentile ranks (p. 73); that a correlation ratio cannot be computed for a quantitative variable from a qualitative variable (pp. 102–104); that probability statements about sample statistics can also be properly interpreted as probability statements about population parameters (p. 143); that probable errors should be used for standard deviations and correlation coefficients (pp. 145–146); that the t-test should be used to test whether or not a sample could have been drawn at random from a known population (where the population variance can be known as well as the population mean) (p. 157); and that in most instances the number of degrees of freedom for t is just one less than the size of sample (p. 159). The biserial and tetrachoric correlation coefficients are introduced as new measures of correlation rather than as equivalent to the product-moment coefficient; their underlying assumptions are not stated; and indeed the examples used do not fulfill the assumptions (pp. 108–110). The connection between partial correlation and prediction is misconstrued by introducing a vague notion of a "real" correlation instead of using the definition of correlation used earlier (pp. 127–128). In general, the assumptions behind the various significance tests are not given, especially those of analysis of variance and covariance, although —in contrast to other psychologists—the author introduces the normal distribution where it belongs, namely in connection with sampling problems. Deficiencies noted in the discussion of graphic presentation include the following: Grid lines are drawn through the bars of a histogram (p. 9); in another there is a mixing of light and heavy lines for bar outlines (p. 16). The impression is given that the median is graphically represented by a line segment, whereas the mean is shown as a point (p. 16). Pie charts are endorsed liberally for complicated comparisons (pp. 43–44). Vertical "frequency" scales are retained for a frequency polygon and a smoothed curve, instead of using an area key (pp. 63–64).

J Am Stat Assn 41:603–6 D '46. Helen M. Walker. The attempt to explain the meaning of commonly encountered statistical terms without using any formulas whatever and using almost no computations is a task requiring considerable courage as well as great skill in exposition. This book has been more nearly successful than the reviewer anticipated it could be, knowing only too well the difficulties to be encountered. The language is clear and simple; the illustrations are well chosen and within the understanding of the sort of person likely to read the book; almost all of the terms ordinarily used in nontheoretical studies are included although the coverage is more complete for education than for biology, business, or economics; no previous preparation is presumed except an alert and inquiring mind. The first major prob-

lem to be faced by the writer of such material is the choice of topics. Shall he treat the topics the reader is likely to come upon in published research or only those topics which he considers appropriate to use? If he omits certain outmoded statistics, the person who reads his book in the hope of finding enlightment on the meaning of published research is doomed to disappointment. Dr. Butsch apparently decided to include in the first part of his book (and to treat with respect) statistics which are far less efficient and more ambiguous than other more modern statistics which he treats in later chapters. The reviewer would question this decision. * it is practically impossible to be intelligible on an elementary level and also completely correct if one is dealing with topics beyond the simplest ones * Therefore it seems pedantic to point out incorrect statements and inconsistencies in a book which on the whole creates a very favorable impression, but nevertheless it seems necessary to mention a few such. There are about 16 pages devoted to the probable error written in the manner of 20 years ago * After reading this, it is a real surprise to come upon a rather good elementary treatment of *t*. * The relation between the critical ratio and the *t*-test is left in some confusion. * The term, "sigma," is used throughout instead of the more straightforward "standard deviation." * The treatment of partial correlation is particularly happy though it might have been made still better by the use of the concept of residual error. The illustration of the *t*-test on page 157 seems to suffer from errors in printing and will be most confusing; it refers to ten scores but prints only nine. However, the mean as stated is not the mean of this nine. * Certain topics such as the correlation ratio, bi-serial *r*, and tetrachoric correlation are treated so briefly that one wonders if their introduction will not be confusing. The book might have been made more useful by the inclusion of well selected annotated references to more extended treatments available elsewhere. The person making his first acquaintance with statistical method will gain much by a cursory reading of this book. It can be recommended to one who wants only to know the general spirit of statistical investigation, and that is the person for whom the book was written. *

J Bus 19:245 O '46. * The author has the commendable aim of explaining the purpose and interpretation of statistical measures rather than their construction. The scope, however, is too fragmentary, even for a primer. Substantially only four topics are considered: frequency distributions, graphs, correlation, and reliability. There is no treatment of the collection and misuses of data, tables, ratio charts, time-series analyses, index numbers, or other subjects basic in statistics. Illustrations are limited to hypothetical examples from school teaching. Not recommended for businessmen.

Social Service R 21:277–8 Je '47. W(ayne) McM(illen). The author of this useful book has a gift for lucid writing. * [he] has done an amazingly good job of explaining complex ideas simply and clearly. Readers can certainly understand the material even though many of them may continue to be too insecure in their knowledge to trust their own reactions. * Another volume of this same type is needed to teach the neophyte how to judge whether there is validity in the basic data from which these various statistical measures are derived.

[55]

★BUTTERBAUGH, GRANT I. **A Bibliography of Statistical Quality Control.** Published for the Bureau of Business Research of the College of Economics and Business, University of Washington. Seattle, Wash.: University of Washington Press, 1946. Pp. viii, 114 Paper. $1.50. *

Ind Qual Control 3:18 N '46. * The value of such a bibliography in a comparatively new field is apparent. * A comparison between this work and other bibliographies on statistical quality control....reveals several omissions. However, this reviewer did not notice omission of any important reference. The absence of a subject index will seriously curtail the value to students and to those, with a limited background in statistical quality control, who are seeking assistance for practical applications. Its greatest value will undoubtedly be to those who have been following the literature as it appeared, and are familiar with the type of contribution each author has made. For this group, the bibliography will be a handy reference—a short cut in research.

J Am Stat Assn 42:173–4 Mr '47. Paul C. Clifford. * Butterbaugh has accomplished a herculean task in compiling this bibliography * The reviewer would have been inclined to include a few more articles from the biological and chemical fields as well as several more from the *Proceedings of the American Society for Testing Materials.* The notations on each

article give the reader sufficient information about the content. The non-mathematician might wish that the level of mathematical difficulty were more clearly indicated. The lack of a subject matter index may curtail the usefulness of the bibliography. Such a subject index would be difficult to make, since many of the articles during the war attempted to present the fundamental concepts of quality control with applications in several fields In view of this difficulty the author's device of listing articles by periodicals is probably as useful as any. The engineer with interest in one specific field will thus be able to find the articles of most interest. The student of statistics looking for outstanding illustrations of the application of statistics to industrial problems will have more difficulty. The teacher of industrial statistics or statistical quality control should find the bibliography extremely useful.

Nature 159:387 Mr 22 '47. F. J. Anscombe. * The compilation has been made carefully, and will be of service to many "statisticians, teachers, students and businessmen directly responsible for quality control." It is a pity that a subject index has not been included, but the book is not too large to be read completely by anyone searching for particular applications. The theory of quality control is developing rapidly, and it is to be hoped that up-to-date editions of the bibliography will be available at not too long intervals.

[56]

★CARNAP, RUDOLF. **Logical Foundations of Probability.** Chicago, Ill.: University of Chicago Press, 1950. Pp. xvii, 607. $12.50. * (London: Cambridge University Press. 94s.)

[57]

★CAZIER, MONT A., AND BACON, ANNETTE L. **Introduction to Quantitative Systematics.** Bulletin of the American Museum of Natural History, Vol. 93, Article 5. New York: the Museum, 1949. Pp 343–88 Paper. $0.50 *

[58]

★CHAN-MOU, TCHEN. **Mean Value and Correlation Problems Connected With the Motion of Small Particles Suspended in a Turbulent Fluid.** English with Dutch summary. Hague, Netherlands: Martinus Nijhoff, 1947. Pp. vii, 125. Out of print. *

[59]

★CHARLIER, C. V. L **Elements of Mathematical Statistics.** Including *Table of Poisson's Frequency Functions* by L. v. Bortkiewicz. Edited and translated by J. Arthur Greenwood Brooklyn 25, N.Y.: J. Arthur Greenwood (25 Winthrop St.), 1947. $3.00.

Am Math Mo 55:436–7 Ag–S '48. A. T. Craig. * follows essentially the 1920 edition. Part One, which consists of eight chapters, deals with homograde statistics; that is, with data in which each individual who has been measured with respect to an attribute either possesses (or is assumed to possess) the attribute to the same degree of intensity. Successive chapters treat the arithmetic mean, the dispersion, the mean error, the theorems of Bernoulli, Poisson, and Lexis, and observed statistical data. Part Two, which consists of seven chapters, is concerned with heterograde statistics; that is, data in which the degree of intensity of a measured attribute is of concern. There are chapters on the Normal, the Type A, and the Type B frequency curves; on correlation; and on certain abridged methods of calculation. * The reader should consult the translator's preface concerning both the tables in the appendix and those in the text. This reviewer believes the translator should be commended not only for making this monograph more available to beginning students, but also for his work on the tables.

J Am Stat Assn 44:313–4 Je '49. Burton H. Camp. * The translator has also made occasional emendations of the text and an improvement in the tables. He himself has computed new tables for ϕ_2, ϕ_3 and ϕ_5, these functions being derivatives of the function defining the normal curve, he has made some corrections in the original tables; and has added a new table, No. 44. The meanings of Tables 43 and 44 are not indicated in the appendix where the tables occur. It can be learned from the preface that Table 43 is the table of Bortkiewicz, that is, a table of the Poisson function, the reader being left to infer the meanings that must be attached to the numbers at the top and side of the table. There is no easy way of finding out what Table 44 does mean, but the thorough reader will find it explained in a footnote on page 60. So far as the reviewer can judge the translation is sufficiently accurate. The English is often awkward but not without a quaint charm so that perhaps by its very defects the phraseology makes one the more aware of the originality of the [illegible] author who is thus being presented to us. In fact one would read Charlier's book now more to become acquainted with Charlier's way of looking at things rather than to study the material which the book contains. This material has been worked over many times since 1920 and has been presented in various forms in several

books; but there is much value nevertheless in going to the original source, and this translation makes it possible for the English reader to do this. *

J Am Stat Assn 44:314 Je '49. Alexander M. Mood. It is always interesting to read an older book and compare the state of statistics then with now. The present little volume was written in 1910 (the translation was made from a 1920 German translation) just two years after Student's famous paper was written and before the full import of that paper was recognized. Fisher's paper on the foundations of statistics was not to appear for ten more years. * there is much in the book that can be found in the best sellers in statistics today, but unfortunately that fact cannot be interpreted as a compliment to Charlier's sagacity—it is merely an indictment of our best sellers. I refer to such things as the detailed computational instructions in terms of class frequencies all outmoded by modern computing machines, the hoary errors about skewness and kurtosis still fed our students today, the confusion between population parameters and their estimates, estimation by the method of moments only, the great faith in the standard error whether the distribution is normal or not. But Charlier, at least, cannot be much blamed for these shortcomings because they were either not relevant or had not been pointed out at the time. The real trouble with the book is simply that it was written before the Fisherian revolution in statistics. It was written in that period when statisticians were trying to develop and formalize statistical inference in terms of relatively simple classes of frequency functions—the Pearson curves and the Gram-Charlier series. Looking back, it is easy enough to see that such a course was actually a blind alley, that a fitted curve contains no more information than the data to which it is fitted. But at the time that approach must have looked promising and Charlier did significant work in the field. Today the book is of little interest except possibly to students of the history of statistics, and the reviewer is at a loss to rationalize the presentation of this translation.

Math R 9:194 Ap '48. J. Wolfowitz. This book will interest the bibliophile and student of the history of mathematical statistics. It was a good book in 1910, but is now obsolete.

[60]

★Chaturvedi, J. C. **Mathematical Statistics.** Agra, India: Prakash Brothers, 1948. Pp. vii, 260. Rs 6. *

J Am Stat Assn 45:473 S '50. Carl F. Kossack. This textbook, which apparently was prepared to be used in a second course in statistics in which some mathematical background and interest could be assumed, contains little to commend it. The author approaches the subject from the more classical descriptive point of view and almost completely ignores the more vital design and sampling approach to statistical problems. * The lack of vitality exhibited by such an approach decreases the usefulness of any text attempting to meet the needs of students at the particular level involved, but this text suffers also from the fact that it is poorly written and printed and contains numerous errors and half-truths. The text needs to be carefully edited so as to improve the English since the grammar and choice of words are very poor. The text does contain some of the standard elementary algebraic derivations and proofs which sometimes are hard to find in print, but on the whole, the edition would suffer the least if it were quickly forgotten

[61]

★Chrétien, C Douglas **Culture Element Distributions: XXV, Reliability of Statistical Procedures and Results.** Anthropological Records, Vol. 8, No. 5. Berkeley, Calif · University of California Press, 1945. Pp. 111, 469–90. Paper. $0.35. *

J Am Stat Assn 40:526–7 D '45. C. C. Craig. *confined to the use of the χ^2 test and association coefficients, principally $Q_6 = \sin(\pi/2\sqrt{\chi^2/N})$. I get the impression that the χ^2 test is being offered for consideration to a group which has been accustomed to rely on association coefficients which have well-known [illegible] This is a worthwhile service. But it appears to me that it is not entirely clear in the minds of Mr. Chrétien and the group he is addressing that mathematical statistics....only affords models or frameworks into which one tries to fit observable phenomena. This makes it necessary not only to thoroughly understand the material which one is working but also to have a sufficiently critical grasp of the tools he applies to know when the appropriate ones are being used and what one may expect of them. Two types of illustrations are considered. In the first, which is treated rather briefly, χ^2 as a test of goodness of fit is applied to two kinds of examples. In the first of these there is an observed distribution of the number of times pairs of informants differed between themselves on the presence or absence of the same culture

element, there being a pair of informants for each of four tribes. The hypothesis tested is that these differences occurred at random but it does not appear to be realized that if the calculated frequencies are obtained from the binomial distribution, it is implicitly assumed that differences concerning the same element occur independently among the four pairs which, it seems to me, might be a matter for doubt. * The second example is an interesting application of the χ^2 test to show that a reduced element list, which contains culture elements on which there are reports from several tribes, may be an extremely poor sample of the complete list from any one tribe. It seems to me that this instance alone might be convincing evidence that statistical methods can be valuable aids to scientific work in ethnology. The greater part of Mr. Chrétien's space is given over to an examination of the application of the χ^2 test to fourfold contingency tables together with a comparison with the results indicated by the calculation of Q_6 for the same tables. * the criterion used for Q_6 is only supposed to be valid for large samples; the result of Mr. Chrétien's investigation is that in samples of about 500 or more the two tests seem to be in agreement. But this does not warrant the conclusion that neither method is to be trusted for smaller samples. If the data are such as to permit the use of the χ^2 test, it may be used for smaller samples since it makes the proper allowance for sample size; if the conditions which make a valid test are not fulfilled for sample of, say, 200 they are not likely to be changed by the accumulation of more data of the same kind. Mr. Chrétien's three ways of justifying a test for independence in a fourfold table are exactly equivalent and they all rest on considerations in the theory of probability. There is also some misconception of the role of Yates' correction for discontinuity. Ethnologists and others who rely on the analysis of numerical data to reach scientifically valid conclusions cannot escape the problem of making inferences from the sample to the universe. Mr. Chrétien's paper will help the uninitiated to see that such inferences can be made with valuable results.

[62]

★CHURCHMAN, C. WEST. **Theory of Experimental Inference.** New York: Macmillan Co., 1948. Pp. xi, 292. $4.25. (London: Macmillan & Co. Ltd. 21s.) *

Am J Sociol 54:571–2 My '49. Nathan Keyfitz. Professor Churchman's book was received by this reviewer with the highest anticipation. The author is a former practicing statistician who has been trained in philosophy and is now teaching that subject. The development of modern statistical inference certainly constitutes a new stage in the history of logic; this volume is particularly to be greeted because no statistician hitherto has had a sufficiently sure philosophical tread to explore that history. * This book.... investigates the meeting place of the pragmatism of James and Dewey with the Shewhart philosophy of statistical quality control and Fisherian experimental design. The volume starts with a clear description of one of the common situations in which a simple collection of data plus the calculus of probability furnish the material for an exact inference. Five units of a new product are compared for breaking-strength with five of the old. In this test the new product shows a higher average breaking-strength than the old. Fittingly enough, in the exposition of statistical method, the problem is posed in the form, "What action should be taken?" "Should the laboratory offer the new product as a definite improvement, worthy of such expense as might be involved in the change-over?" This is what the textbooks are asking when they test a difference for significance. The hypothesis is set up that there is no difference between the old and the new populations of breaking-strengths and that the difference observed in the sample results from extraneous factors which cause variability in the material. A precise calculation on this null hypothesis of the probability of securing the results which have appeared or a more extreme difference is then easily made. The assumptions required seem acceptable enough, including that the two samples have been randomly selected from their respective populations and that the populations are normal (this may be dispensed with at some cost in efficiency). As in the application of any theory, some judgment on the part of the investigator is called for, not as to whether the assumptions exactly fit the facts, for this they never do nor would it be possible to ascertain if they did, but whether the deviation of the facts from the assumptions is sufficiently great to vitiate the conclusions drawn. So far we are dealing with accepted practice; we have yet to get new light on the way in which modern statistical theory is integrated into the historical development of philosophy. If the essay has any unity, this presumably is its interest. And yet how the Kantian categories, the schemes of rationalism and em-

piricism, enable us to understand any more clearly what statistical inference is and does is hard to see even after careful reading of the volume. It seems that in some basic sense the statistician's formulation of "true" and "false" in terms of regions in space is not adequate: "It is not this sort of formal defining that interests our laboratory technician; he wants to know about truth in a much more 'practical' sense.... he would say he had made an error if his prediction 'runs him into trouble' later on. The task that faces us is to....define truth and falsity on non-formal grounds." Such a definition carries us outside the theory of statistics and apparently aims at defining the place of that theory, taken as a whole, within the framework of traditional philosophy. It is to be hoped that the book may be more successful in explaining statistics to philosophers than philosophy to this particular statistician. This attempt to bring together the fields of statistical inference and philosophy also embraces sociology. As an exposition of the logic of statistical inference the present work is sound, though not, of course, exhaustive; as philosophy, its language will often seem confused to a nonphilosophical reader. Its sociological assertions are not easily identified as part of any tradition of sociological investigation and hence are most difficult to assess. Churchman makes use of the Neyman-Pearson conceptualization to assert that "the science of ethics is basic to the meaning of any question the experimental scientist raises." "The chance of accepting an hypothesis when it is false is not sufficient basis for....selecting hypotheses....We must evaluate the 'loss' or 'cost' of a decision." In the case of ball bearings, for instance, the acceptance of defective bearings may result in a breakdown of costly machinery, and the size of test will have to be adjusted to reduce the probability of acceptance to a suitably small amount. The probability would not, however, need to be so small as in a test to decide whether a widely used food is free of a certain deadly bacteria. Because, therefore, "the so-called objective 'facts' and theories of the scientist depend for their confirmation upon the estimation of losses and these losses are a function of individual and social purposes" (p. 5), it is essential that "the sciences, and society in general, collaborate in setting up a controlled science of losses and risks, *i.e.*, ...of ethics" (p. 263). The synthesis combining these concepts with modern trends in the philosophy of science is called "experimentalism." A scientist must sympathize with this theory in its iterative approach; its precluding of final answers is wholesome. Perhaps the book fails—for this reviewer believes it will fail to interest practicing statisticians—because there is no gain in setting so elaborate a philosophical foundation for experimental inference, or else because the author has not thought far enough into his subject to present it with simple clarity. Which of these applies can be decided only by the success or failure of further attempts, and further attempts will certainly be made to exploit in philosophical discussion the overwhelming triumphs of statistical inference.

Am Math Mo 57:49–50 Ja '50. V. G. Hinshaw, Jr. * However praiseworthy his endeavor, Churchman has substantially failed in giving clear statement to his brand of "modernism," and his lack of clarity suggests fundamental weaknesses, inaccuracies, and confusions. * One wonders whether the complexity of the machinery developed under the name of experimentalism, is warranted by the questions Churchman seeks to answer. * To the professional philosopher, further objections occur. Churchman seems to have confused methodology of science with epistemology, and (at times) both of these fields with metaphysics. Another serious confusion is the author's repeated claim that science requires ethics and that ethics can be a science. Perhaps the only way to understand his claim is to realize that, throughout, a form of utilitarianism has been tacitly assumed, but surely not scientifically established.

J Am Stat Assn 44:136–9 Mr '49. John W. Tukey. The author has tried to write a challenging book—and has succeeded. By mixing modern statistical inference and classical philosophy he has written a book which could serve to introduce statisticians to philosophy and philosophers to modern statistical inference. The book is a far from perfect tool for either job, but it will....have substantial influence both on philosophers and on statisticians. * The most striking point to the statistician....is the complete acceptance by the author of a definite methodology of statistical inference as *the* methodology. The reviewer feels that the present methodology of statistical inference has been significantly biassed by desires for (i) analytic manageability, (ii) mathematical simplicity, and (iii) unwarranted uniqueness. The philosopher and the statistician now need to collabo-

rate in working toward the ideal basis of statistical methodology. Another striking point is the insistence of the author on security. He admits that complete freedom from risk is impossible in practice, but he insists that the possibility of reducing the risk to an arbitrary small value is essential. Again: "And he *must* be sure about these things, or else he would find it impossible to act efficiently; he cannot even entertain the notion that there are risks involved in his decisions, for if such doubts creep in, he finds it impossible to act quickly and efficiently" (p. 236). This sentence is supposed to refer to every day decisions, but it expresses the authors' general philosophy. Finally: "...we must have criteria of the most efficient methods of solving problems before we can give responses to any questions" (p. 243). This statement is the more surprising when we recall that a "response" to the author is only an approximate step toward an answer. The author's discussion of presuppositions and their importance in statistical inference (p. 12) should be read by all statisticians interested in methodology. The author holds that: "In a sense, the problem of the best 'design' of an experiment is exactly the problem of the philosophy of science...." (p. 21). This is closely related to his quotation from R. A. Fisher: "The more thorough the design of the experiment, the more meaningful is the question asked" (p. 208). The author and the reviewer are in agreement as to the validity and importance of these quotations, but we draw differing conclusions. The author concludes that design of experiment transcends statistics, while the reviewer concludes that the philosophy of science is a part of statistics, since he defines statistics as: "The science, the art, the philosophy, and the technique of drawing conclusions from the particular to the general." * Since the author's philosophy does not provide explicitly for the criticism of statistical presuppositions, it is not particularly surprising that, on page 284, he holds that tolerance limits can be set with equal validity from small as from large samples. For this would be correct if the usual presuppositions were correct. * the author goes on to insist that:—"The reason that the relative frequencies must approach some limiting value is that the question of probability is otherwise meaningless; one is 'guaranteed' that they do by the natural image which is presupposed in all experimental problems" (p. 203)—and to insist that: "The fundamental postulate of experimentalism, therefore, is the following: *There exists a formalization of nature, such that stochastic limits exist for certain sequences of mathematical functions of the observations which are pertinent to a given question of fact*" (p. 178). This seems to the reviewer an overstrong and unwise requirement of *security*. The pertinence of the observations is, according to the author, to be settled by "formal" methods: "....the justification for assuming that a certain set of actions produces pertinent observations depends upon theoretical (formal) considerations on the part of the experimenter. These considerations must be presupposed by him in conducting his experiments. The more aware he is of the nature of these presuppositions, the more exact is his experimental method" (p. 271). In the same vein, the author holds that *"every statistical hypothesis should be a consequence of a formal theory of nature"* (p. 218). The direction of this proposition is undoubtedly good, but it goes much farther than the reviewer would care to go. In his approach to control, the author emphasizes the stochastic limit again: *"....an experiment is said to be controlled if we state all the formal conditions under which a mathematical function of a series of observations approaches a limit stochastically"* (p. 182). This strong definition is then used in: *"No question of fact can be said to have meaning unless there exists a controlled experiment for its answering"* (p. 183). The reviewer feels that this is a roundabout way to say that no question of fact has a meaning. In discussing the adequacy of formal probability theories, the author seems to confuse "determination in theory" and "determination in practice." He demands: "Let $O(x_1, x_2, ..., x_n)$ be any random sample, with known elementary probability law; let t be any statistic of the sample with degrees of freedom at least 1; then the theory should be able to state the elementary probability law of t" (p. 19), and then he asserts (pp. 19 and 30) that this demand has not been met in the present probability theory. While the mathematical statistician may not be able to provide a compact and usable answer to many problems of distribution, he can provide a systematic and finite process for determining the distribution within any preassigned limits. In the author's sense of "answer" it seems to the reviewer that modern probability theory provides "answers" to all problems of distribution involving a finite number of observations. * The real difference be-

tween the author and the reviewer is in their approach to models, whether mathematical or formal. The author is prepared to take a model on its face value, apparently without consideration of its weak points. It does not seem to the reviewer that this is how science has made its great gains by the use of models. It is by combining a working model with a more detailed, and probably unmanageable, model which indicates the soft spots of the working model that science has progressed. Passing now from matters of opinion to matters of fact, there are a few specific points. On page 7, the author states that, when the null hypothesis holds and sample size increases to infinity, "t will have a limiting value of zero." This is incorrect. On page 35, the author states that the problem of confidence intervals for means of later samples is "the so-called problem of Tolerance Intervals." This is a slip. On page 257, the author suggests that the best test is obtained by minimizing the integral of the risk over the parameter space. This is not invariant, and of doubtful utility. A similar difficulty occurs at the top of page 211. The wording of the next to the last paragraph on page 9 and the two-valued use of n on page 16 seems sloppy. On page 12, the author asserts that "we could—find a best test" for slippage with an arbitrary continuous distribution. The reviewer would be interested in the definition of "best" and the resulting test. The book is singularly and pleasantly free from typographical errors—the only ones noted were "procedure" on page 207 and "m_1/m_2" for "m_2/m_1" on page 211—and is excellently printed and bound. The reviewer would not have taken so much space to review a book he judged of little use. Although he disagrees with the author on almost all the really basic points, he plans to use the book in connection with a course in the design of experiment this fall.

Nature 163:784–5 My 21 '49. Norman R. Campbell. The first duty of a reviewer is to say what his book is about; but that is not easy here. The title suggests to a British reader that the work will be cognate with that of Harold Jeffreys and with the later writings of Bertrand Russell. But neither of these writers is mentioned, nor does the author show any signs of being aware of their existence. Again, in his preface the author says that "we are making the much stronger claim" (and it is, indeed, a startling claim) "that the science of ethics (like all the principal branches of science) is *basic* to the meaning of any question that the experimental scientist raises." But I have not found a word in the book concerned with what is called ethics by the plain man; it seems to be taken for granted that all problems of value are ethical, so that there is no distinction between the good, on one hand, and the true or the beautiful, on the other. The author's thesis is then still startling; for experimental facts have often been distinguished from other things on the ground that they are free from the differences of opinion that attend all judgments of value. And it is still not immediately clear how his discussion bears on his thesis. The first chapter of the book expounds the elements of statistical theory, as it has been developed by such men as Karl Pearson and R. A. Fisher; the second discusses the application of this theory to experimental inquiry. The treatment here is completely dogmatic; no sort of reason seems to be adduced for believing that the theory is in any sense true, or the method based on it valid in any sense relevant to experimental investigations. The author appears to hold that all other doctrines must be judged by their conformity with Pearson-Fisher statistics rather than conversely. On this basis he finds that the recognized systems of philosophy differ primarily in their view whether facts are logically prior to laws or vice versa. The discussion of these systems, professedly on this view, occupies the central and main part of the book; actually, much of it is scarcely distinguishable from what would be expected in any university course of lectures on general philosophy. Finally, more particular problems are introduced, until the last chapter is a not very abstruse exposition of statistical "quality control" in manufacture, which attracted so much attention during the War. Of course, Mr. C. W. Churchman will consider this a caricature of his book, and say that I have ignored all the ideas to which he attributes most importance. If so, the error is due to genuine misunderstanding and not to malice; he should consider whether his own heed and respect for the views of others entitle him to complain. Surely he can scarcely be really ignorant that there are alternatives to the frequency theory of probability; that facts and laws have been held to be mutually defining, so that neither can be prior to the other; and that to some people his "ideal" of errorless measurement is as sensible as the ideal of a round square. But if he allowed any

trace of such discrepant doctrines to intrude, most of what he has written would have to be completely transformed. The chief interest of Mr. Churchman's book is that it represents the extreme of a tendency that has been growing ever since the present sceptical generation (apart from the Marxists) abandoned all hope of a universal philosophy; philosophers tend to segregate into groups, distinguished, not by the answers that they give to questions of universally recognized urgency, but by the questions they ask, which have usually developed from a single focus in a narrow direction. The practice has the advantage that any question that once engages the attention of a group of experts may hope to receive a definite solution; doubtless the pupils and associates of E. A. Singer, jun., regard this work as a very serious contribution to knowledge; and it might have a wider audience if it had a less wide title. But the practice has the disadvantage that questions which, from their very nature, are unlikely to attract experts—for example, the treatment of certain topics in the text-books on which we have all been reared—receive no attention at all; it becomes increasingly difficult to convince those who approach science from the outside that it has any general principles which could form the basis of a cultural education.

Psychometrika 14:257 S '49. T. G. Andrews. * Churchman has attempted to unravel a snarl of many threads and then weave them into a nice tapestry, one which even has social significance. In some cases, however, the strands chosen for exhibition are far too short for the purpose. The nature of statistical tests is "covered" in 13 pages where many of the major concepts of statistical inference are mentioned, but of course not explained. If the reader is a statistician he does not need the first three chapters in their present form, and if he is not a statistician these chapters will be merely confusing. The reviewer informally tested this hypothesis to his satisfaction on two available non-random engineers. In the remaining chapters, however, Churchman presents a stimulating and provocative account of the philosophical backgrounds of modern concepts of scientific methodology. These sections are.... very useful analyses, to be read by all serious students of science. This work is not easily read, and the important implications will not be arrived at by scanning. Admiration and real results do, however, come with a little labor. The main thesis presented is one on which most experimental researchers in psychology will agree, but they will now be able to acknowledge *why* they agree. In the last chapter but one, there is presented an important analysis of scientific and non-scientific problem-solving in terms of social phenomena, motivation, and ethical considerations. * Churchman has produced an extremely important analysis and synthesis of many of the problems of scientific methodology. Researchers in the human sciences especially will profit from a deep and careful reading of this book.

[63]

★CLARK, WALLACE. **The Gantt Chart, Revised Edition.** London: Sir Isaac Pitman & Sons, Ltd., 1948. Pp. xv, 151. *7s. 6d.*

[64]

★CLARKE, P C. **Statistical Methods in Quality Control.** Lansdale, Pa.: Hunter Pressed Steel Co., 1945. Pp. 100 (pagination irregular). Out of print. *

J Am Stat Assn 41:130–2 Mr '46. G. R. Gause. This book presents in looseleaf style a description of the quality control methods which have been found useful by the Hunter Pressed Steel Company. The pages are exact reproductions of data sheets which were prepared by the company for their inspectors and inspector trainees, being in large part specific operational procedures to be followed by the inspection personnel. As such, the book lacks some of the continuity which is desirable in a textbook. However, the simplicity of presentation and the wealth of practical illustrations should make the book of much value both to the young engineer who is starting out in quality control work and to the teacher of industrial statistics. To the young engineer, this book, supplemented by one of the standard texts, should be invaluable in bridging over the gap between the more abstract considerations and the practical applications. To the teacher, it provides both techniques for the presentation of some of the fundamental concepts of quality control and also many numerical examples of practical applications. * The method given for calculating $\bar{X}$ and σ from the observed fractions defective in two tails of a distribution is, as far as this reviewer's knowledge goes, here published the first time. The method should be of practical value in many instances. However, as the author undoubtedly realizes, the method given can be dangerous if not handled with caution. Had the book been prepared for the general public rather

than for use by a particular company under careful supervision, it would have been desirable to include some cautioning remarks as to the dangers inherent in making predictions from such calculations, particularly when the observed fractions defective are both in the neighborhood of .50. The illustrations of the effect upon frequency distributions of such things as tool wear, heat treating operations, and other factors should be particularly helpful to the practical man who is trying to understand what frequency distributions have to do with making a satisfactory product. * The last portion of the book deals with control charts. In general, the methods presented are those of the American Standards Association with several additions which have been found useful by the authors. One of these additions is the use of "reject limits." The "reject limits" are placed inside the specification limits by a factor depending upon sample size and observed average range. Sample averages falling outside these "reject limits" are considered by the company as sufficient cause for stopping production and making adjustment. The limits are of the same nature as those described by E. H. Sealy in his book *A First Guide to Quality Control for Engineers,* in which book the limits are termed "modified control limits." It is interesting to note that the Hunter Pressed Steel Company has found such limits to be of considerable value in their day-to-day work. Another addition is the "control gaging" technique. This is provided as a substitute for the routine keeping of control charts by variables and consists in setting go not-go gages at the control limits for averages of samples of five. The inspection procedure then consists in gaging with the "control gage" a sample of five pieces at periodic intervals. If more than two pieces fail either the go or the not-go gage, an adjustment of machinery is required. It is pointed out that this procedure eliminates the measuring of individual pieces, the calculation of averages and ranges, and the plotting of points, yet furnishes a practical means of control where more refined methods are not justified. It would be interesting to know if the company has tried setting the "control gages" inward from the specification limits by a factor of observed range rather than outward from the center of the specification tolerance range. Such a setting of the control gages would correspond to the "reject limits" which apparently have been found to be so successful and would automatically take care of situations such as that described on page 114 in which there is a relatively small range but a pronounced trend in averages. Another addition to techniques described in the ASA Standards is a procedure to be followed on short-run jobs which cannot be treated as a continuous production situation. The procedure given illustrates the fact that applications of quality control methods need not be confined to continuous mass production. *

[65]

★COCHRAN, W. G. **An Examination of the Accuracy of Lattice and Lattice Square Experiments on Corn.** Iowa State College of Agriculture and Mechanic Arts, Agricultural Experiment Station, Research Bulletin 289. Ames, Iowa: the Station, August 1941. Pp. 398–415. Paper. Gratis. *

[66]

★COCHRAN, W. G **Some Additional Lattice Square Designs.** Iowa State College of Agriculture and Mechanics Arts, Agricultural Experiment Station, Research Bulletin 318. Ames, Iowa: the Station, May 1943. Pp. 729–48. Paper. Gratis. *

[67]

★COCHRAN, WILLIAM G., AND COX, GERTRUDE M. **Experimental Designs.** New York: John Wiley & Sons, Inc., 1950. Pp. ix, 454. $5.75. * (London: Chapman & Hall, Ltd. 46*s.*)

J Am Stat Assn 45:454–5 S '50. Palmer O. Johnson. The authors have written this book primarily for the experimenter, who will find here the description of the most useful designs that have been developed up to this time. It is a handbook to which he may refer for intelligent guidance when he contemplates an experiment. The experimenter should possess, besides first-hand knowledge of the problems in his field, a working knowledge of the analysis of variance. With this background he opens a book unexcelled in its exposition of the scientific and statistical basis of the principles of experimentation and their transition into designs. * an unusually successful attempt has been made to exemplify the processes by a comprehensive selection of examples. These are for the most part drawn from biology, particularly agriculture * Useful tables, based on the statistical solution of the problems, are made available, such as the table for determining the number of replications needed for a given probability of obtaining a significant result. Chapter 3, "Notes on the Statistical Analyses of the Results," is perhaps the most fundamental and informative chapter. * Beginning by writing down the mathematical model, the assumptions

made in the model are then succinctly stated. * The role of the analysis of variance is carefully developed and the complete analyses discussed and illustrated. Particularly important is the clear explanation of the subdivision of the sum of squares for treatments, of the calculation of the standard error for comparison among treatments, and of the subdivision of the sum of squares for error. * The statistician would likely desire a more comprehensive discussion of the analysis of variance including its use in estimating the several variance components. Some consideration might well have been given in this chapter to the role of presupposition in the design of experiments. * The final chapter gives useful tables of the random permutations of 9 and 16 numbers. This book will set the standard for a long time to come. * The principles of experimentation have stood the test of time and are finding increasing application in many fields of science. This book will undoubtedly serve to increase and elevate the standards of their use and in doing so demonstrate the most important practical application so far made of statistics.

Math R 11:607 S '50. A. M. Mood. While this is not a mathematics book at all, it is worth a brief comment here because it will be of considerable interest to most mathematical statisticians. * consists of a thorough exposition of the practical aspects of experimental designs * a detailed presentation of all the important designs * The special properties of the designs are clearly described and the analyses of the designs are completely illustrated by experiments that have actually been performed and with all the data and computations included. The book is then an excellent reference work, and also a much better textbook for a nonmathematical course than Fisher's "The Design of Experiments," although it does not have any problems for the student to solve. The reviewer had hoped to find a chapter on how, in general, one goes about designing experiments; this is more of an art than a science, at least for the present, but certainly two of the foremost experts in this field could have had some very useful things to say in such a chapter. This is not to imply that authors refrain from giving advice, for there is much safe counsel to be found throughout the book.

Sci 111:637 Je 9 '50. F. M. Wadley. * The present textbook has been eagerly awaited for several years, and a preliminary mimeographed version has already proved useful. The book follows the path of useful and usable application of techniques, opened up by Fisher, Yates, Snedecor, the authors, and others. The book is put together substantially and printed clearly. Material heretofore widely scattered, if available at all, is here given organized treatment. Two short chapters on the philosophy of statistics in experimentation, and a longer one on basic methods of analysis, are followed by ten chapters on specific designs. Completely random designs, randomized blocks, and latin squares (including switch-backs) are first considered. Then factorial designs, confounding, split-plot designs (treated as designs with main effects confounded), quasi-latin squares, and various incomplete block designs are discussed. The last-named group includes various lattices, lattice squares, balanced incomplete blocks, and Youden squares. In each case the discussion includes not only the description and adaptation of the design, but methods for arrangement, randomization, and analysis of results. In numerous cases results from actual experiments, in field and laboratory, are cited in illustration. The extensive tables of plans of treatment combinations, in some cases indexed, should be very useful. * A little more space might well have been given to the philosophy of experimental proof at the start. On the whole this volume will be indispensable to forward-looking experimenters and biometricians.

[68]

★CONRAD, VICTOR. **Methods in Climatology.** Cambridge, Mass.: Harvard University Press, 1944. Pp. xx, 228. (London: Oxford University Press, 1945.) * For latest edition, see 69.

J Am Stat Assn 41:249–52 Je '46. H. C. S. Thom. * the first full-length book in English on methods in climatology * The book definitely reflects the author's long experience as a meteorologist, and he is to be complimented for pioneering a text in this increasingly important field. The book covers a rather large but perhaps somewhat biased sample of the older climatological methods. Many who have been hoping for a text in applied climatology will be disappointed to find that this text does not fulfill their desires since it discusses no applied problems. * The main defect of the book is the inadequacy of the discussion of statistical methods. While the author mentions modern statistical methods largely by references, few of these methods have found their way into the text.

The distinction between the sample and the population is not made clear, and tests of significance are barely mentioned. The fact that statistics themselves are random variables is not explained and little use is made of standard errors of statistics. The statistician will readily recognize the statistical method as that of twenty or more years ago even though references are made to more recent papers on climatological method. Specific criticisms of the statistical method are principally those of vagueness, inadequacy, or omission. On page 19 the problem of choosing the size of the class intervals is summarized with "The choice of the size of class intervals is dependent upon the number of observations included in the sample and on the degree of exactness required." This gives the reader no method for making the choice. Again on pages 24–29 median quartiles, and deciles are discussed separately but could better have been treated generally as quantiles which are important in climatology. No mention is made of the standard errors of these statistics and their variability is described by "these methods assume their real value only if the size of the sample is so large that half the number of its items represents a series of many hundreds." On page 34 the "more correct" description of the normal distribution of the footnote might have been incorporated in the text. At the bottom of page 35 *et seq.* the fact that distributions must be normal in order that such an interpretation of the standard deviation may be made is too vaguely expressed. Many distributions in climatology are not normal and care must be exercised in the use of the standard deviation. Neither tests of goodness-of-fit nor errors of forecasts are discussed in the chapters on curve fitting. The discussion of curve fitting and regression could have been simplified by use of the analysis of variance. An early introduction of the analysis of variance would also have meant a great improvement in all of the statistical discussion. In the chapter on comparison of observational series clearer and more meaningful exposition could have been attained by extensive use of regression theory. On page 152 the non-normality of the distribution of r is not mentioned and the student who has acquired the level of statistical knowledge offered by the rest of the book might get into trouble using the probable error of r. A number of statistical concepts important in climatology such as contingency tables, autocorrelation, the tendency to normality of the distribution of certain statistics, special distributions of climatology, the chi-square test and others, and goodness-of-fit of frequency curves are either not mentioned or inadequately treated. On the climatological side, the book is definitely continental in scope. References to papers of a theoretical nature are largely to the author's own papers or to those of continental writers. The excellent modern works of the Russians have been ignored. * References to American and English theoretical works are also few. Both of these countries have been more active in the development of modern statistical methods than the continental countries and both have consequently applied these more extensively to meteorology. Such concepts as the recurrence interval, Thiessen method of weighting, area-depth curves, and others all typically American and important methods in climatology are omitted. * The author characterizes his own book well in his conclusion which the reader would do well to read first:

> The reader who runs over the pages of this book is perhaps disappointed in not finding this or that special method. In the first pages, it was shown that the number of derived elements is not limited theoretically; thus completeness is unattainable.
>
> Moreover, it is intended to present only a system of methods which facilitates the step from the qualitative to the quantitative. Many ways are offered for attaining this purpose, and they all should lead not only to an exact and comparable description of the climate but, in the end, to a physical explanation.

The number of elements being unlimited does not mean that the number of methods cannot approach adequate completeness. The second paragraph of the conclusion is a broad claim hardly justified by the contents of the book. *

[69]

★CONRAD, V., AND POLLAK, L. W. **Methods in Climatology, Second Edition, Revised and Enlarged, Including Some Methods in General Geophysics.** Cambridge, Mass.: Harvard University Press, 1950. Pp. xxvii, 459. $7.50. * (London: Oxford University Press. 48*s.*)

[70]

★CORNISH, E. A. **The Recovery of Inter-Block Information in Quasi-Factorial Designs With Incomplete Data: 1, Square, Triple, and Cubic Lattices.** Commonwealth of Australia, Council for Scientific and Industrial Research, Bulletin No. 158. East Melbourne, Australia: the Council, 1943. Pp. 22. Paper. Gratis. *

J Am Stat Assn 41:132–3 Mr '46. G. H. Goulden. [Also a review of 71.] These papers are a continuation of a series in which the author presents correct methods of analysis for

incomplete block or quasi-factorial experiments when the data are incomplete. * the author presents first the fundamentals of the theory underlying each type of experiment with which he deals. The formulas for the estimation of missing values are then presented clearly and detailed instructions are given for the solution of the rather more perplexing problem of making adjustments to sums of squares for use in tests of significance. The methods described, together with those given in previous papers, bring up to date the methods of analysis for quasi-factorial designs for the three situations that arise in the use of experiments of this type. *

[71]

★CORNISH, E. A. **The Recovery of Inter-Block Information in Quasi-Factorial Designs With Incomplete Data: 2, Lattice Squares.** Commonwealth of Australia, Council for Scientific and Industrial Research, Bulletin No. 175. East Melbourne, Australia: the Council, 1944. Pp. 19. Paper. Out of print. *

J Am Stat Assn 41:132–3 Mr '46. G. H. Goulden. [See 70 for joint review.]

[72]

★COWDEN, DUDLEY J., AND COWDEN, MERCEDES S. **Practical Problems in Business Statistics.** A revision of *Exercises and Problems in Business Statistics* by Frederick E. Croxton and Dudley J. Cowden. New York: Prentice-Hall, Inc., 1948. Pp. vii, 161, plus 40 leaves of graph paper. Paper, looseleaf for insertion in ring binder. Text edition, $3.25; trade edition, $4.35. *

[73]

★COX, E. L. **Mathematical Bases of Experimental Sampling for Estimation of Size of Certain Biological Populations.** Virginia Agricultural Experiment Station, Statistical Laboratory Report. Blacksburg, Va.: the Station, June 1949. Pp. ii, 42. Paper, mimeographed. Gratis. *

[74]

★COX, GERTRUDE M.; ECKHARDT, ROBERT C.; AND COCHRAN, W. G. **The Analysis of Lattice and Triple Lattice Experiments in Corn Varietal Tests.** Iowa State College of Agriculture and Mechanic Arts, Agricultural Experiment Station, Research Bulletin 281. Ames, Iowa: the Station, September 1940. Pp. 66. Paper. Gratis. *

[75]

★CRAMÉR, HARALD. **Mathematical Methods of Statistics.** Uppsala, Sweden: Almqvist & Wickells, 1945. Pp. xvi, 575. 27 Sw. Cr. (Princeton, N.J.: Princeton University Press, 1946. $6.00.) * (London: Oxford University Press, 1946. 33*s.* 6*d.*)

Ann Am Acad Pol & Social Sci 249:203–5 Ja '47. Bruce D. Mudgett. * the author develops, with a clearness that will be welcome to beginning students of the subject, the notion that a probability distribution is a mathematical creation designed to serve as the model for, or the conceptual counterpart of, the regularities observed in empirical frequency data * An important chapter on the normal curve * the thing of central importance in this chapter is the central limit theorem, underlining the conditions under which the sum of a set of random variables approaches the normal form * One of the few surprises of the book is the failure to find the binomial and Poisson distributions brought into this list, both as sampling distributions and as exact distributions. * The organization of the material is a magnificently successful job and is one of the reasons why the book will be for some time to come, in this writer's judgment, the outstanding expository treatise on the subject. The whole logical process is built up step by step from the statement of the first axiom of the mathematical theory to the last example illustrating an application. In all this process the author's grasp of the literature which has preceded him is nothing short of amazing. It would seem that not an article has been left out and, far more important, not one has failed of analysis and of placement in its proper historical setting in the development of modern statistical theory. The author admits omission of some topics he had originally intended to treat, and it will be evident to any careful reader that space limitations exacted their toll, particularly in the way of illustrations and applications. That leaves the book as an exposition of basic theory and gives all necessary leeway to the able student and teacher of statistics to supplement, illustrate, and apply. Thus the book should make the teaching of modern statistical theory easier from now on, and therefore better. The book is a milestone in progress.

Ann Math Stat 18:136–9 Mr '47. Will Feller. This book represents a contribution of a novel kind to the statistical literature and will render valuable services both as textbook and reference book. * the masterly exposition succeeds in creating the impression of natural unity and harmony. The ideas are developed with elegance and apparent ease as if the line of presentation followed a well explored path. The uninitiated will not notice how unconventional the treatment is and how the very selection of topics depends on the author's scientific personality. It is hardly necessary to point out that Cramér's book fills an urgent need. The emergence of statistical theory and methodology as an exact science, firmly grounded in mathematical probability, is only of recent date. Its rapid develop-

ment went hand in hand with an extraordinary increase of the number and importance of its various applications. Under such circumstances there was naturally little time for an exposition of the theoretical foundations and ramifications. Modern statistical inference has its roots in the classical limit theorems of probability. Now classical probability used to consist of a bewildering collection of special and mutually uncorrelated problems; unified guiding principles and methods are a rather new development and have not yet found expression in the textbook literature. The original investigations are usually written in an exceedingly abstract language and the existing close ties to applications are not apparent. Consequently, there is no easy access either to probability or statistics and it is often difficult to establish whether, or to what extent, various assertions have actually been proved. The present book therefore closes a serious gap in the literature and will greatly facilitate both teaching and research. Of the 12 chapters of the *Mathematical Introduction* 9 are devoted to the theory of measure and integration. The antiquated theory of the so-called Riemann integral (kept alive by elementary textbooks) considered only point functions $y = f(x)$, where the independent variable is a point. * Many mathematical considerations simplify greatly if from the very beginning also set functions $y = F(A)$ are introduced, where the independent variable is a set. * The Lebesgue-Stieltjes theory frees the concept of integral from artificial devices and reduces it to the natural notion of mean values with respect to set functions. * The Lebesgue-Stieltjes integral is conceptually simpler than the Riemann integral and can be presented in as simple a way with rigor adequate for elementary textbooks. It has become an indispensable tool in probability, statistics, physics, and other applied fields. Since it has, unfortunately, not found its way into calculus textbooks, physicists are compelled to use the less flexible notion of the Dirac δ function, and the formal mathematical apparatus in general becomes unnecessarily clumsy. It is a curious anomaly that so many calculus textbooks profess to be written with a view to applications and yet completely disregard the most obvious practical needs and that the teaching of practical mathematics should remain uninfluenced by the great developments of the last fifty years. In such circumstances the chapters on integration will be particularly welcome to statisticians as probably the only place in the literature where they will find easy access to the theory. Of course, this exposition leads far beyond what the average statistician will require under ordinary circumstances and beyond the necessary prerequisites of the main body of the book. Of the 88 pages roughly half can be omitted at first reading in accordance with detailed instructions given in the Preface. The remaining half will form a valuable reference book for theorems and tools used occasionally in connection with more delicate parts of statistical theory. * The title to the second part, *Random Variables and Probability Distributions,* is the same as that of the author's well-known Cambridge Tract of 1937. Both start with a discussion of the foundations along axiomatic lines. The new treatment does not differ essentially from the old one, but some changes are introduced which are regrettable in the reviewer's opinion (in particular axiom 3). Otherwise there is practically no overlap between the two expositions. The 1937 booklet devoted much space to the asymptotic expansions connected with the central limit theorem which are due to the author himself. This topic is not touched upon in the present book. This is a judicious procedure since the 1937-booklet is generally accessible (although at present sold out). Instead we now find a detailed study of some univariate distributions such as χ^2, Student's t, Fisher's z, the Pearson system, *etc.*, none of which were mentioned in the Cambridge tract. Similarly, there is now a section on correlation and regression, and the normal distributions in several variables. The theory of probability is developed only to the extent of the formal theory of distribution functions. This implies that even so important a notion as stochastic convergence is treated only summarily while the strong law of large numbers falls completely outside the framework of the book. This is regrettable inasmuch as the strong law is of greater importance than the classical weak law (whose fame rests essentially on a classical misunderstanding). It should be mentioned that this second part of the book contains some 39 well chosen illustrative exercises the solution of which is left to the reader. In the main part of the book, entitled *Statistical Inference,* the outer form changes inasmuch as the text there is accompanied by numerous practical examples. However, the exposition remains mathematical in nature and the main emphasis rests on exact formulations; much attention is paid to the

establishment of the precise conditions of validity of the individual theorems, their logical interrelations and their connections with general probability. The expert will find many minor and major improvements in formulations and proofs. They are too numerous to be listed here. Suffice it to point out, as a typical example, the theorem on pp. 426–27 concerning the limiting form of the χ^2 distribution with estimated parameters; this theorem appears to be more general than usually stated and also the proof seems to be novel. * If an expression of wishes for a second edition were permitted, most statisticians would probably give first choice to non-parametric and sequential tests. It is needless to point out that the latter became public only after completion of the Swedish edition of the present book. Even this short account will show the extremely wide range of topics and theories covered in the book, from abstract integration to randomized experiments. They are all presented with uniform lucidity. The exposition throughout is formal, and yet inspiring, rigorous and yet never pedantic. It will serve as an example worthy of imitation and is an achievement on which the author deserves our sincere congratulations.

B Am Math Soc 53.733–5 Jl '47. Henry Scheffé. This book has long been needed, and its effect on the future development of mathematical statistics in both teaching and research will be sharp and lasting. The achievement of the author is to present the first treatise on statistics in which the mathematical developments are carried through according to standards of rigor comparable to those now customary in pure mathematics and excelling those in many fields of applied mathematics. He has accomplished this by integrating modern statistical concepts developed by the English and American schools of statisticians, with the mathematical methods of the modern work in probability of the French and Russians. While uniting these two streams he has added important contributions of his own. * Actually only a little over a fourth of the book deals specifically with statistical testing and estimation, and here the treatment is not exhaustive but limited to fundamentals. Much recent work of a fundamental character in statistical inference is omitted because the author's contact with foreign publications was curtailed by the war; for example, there is no reference to any of Wald's work. The main value of the book will be to supply mathematical background for those working in advanced mathematical statistics. In his preface the author states that he has tried to make his book accessible to the reader with "a good working knowledge of the elements of the differential and integral calculus, algebra, and analytic geometry." However, a student not previously familiar with ϵ-δ analysis would find the book too difficult. On the other hand, the level of difficulty is much below that of the author's Cambridge Tract. The reviewer would guess that American students beginning graduate mathematics should be able to handle the book. At its chosen level of difficulty it is a masterwork of exposition. The student is led with skill and charm from the familiar to the new * Among subjects usually developed in a mathematically questionable way but here presented with rigor we may mention (1) the asymptotic normality of large classes of statistics, (2) the asymptotic distribution of Karl Pearson's chi-square statistic for goodness of fit in cases where parameters of the theoretical distribution are estimated from the sample, (3) the optimum properties of R. A. Fisher's maximum likelihood estimates. All of these developments are enriched by original contributions of the author; especially exciting is the new small sample theory of efficiency of estimates created by him in relation to (3). One hesitates to make any adverse criticisms of this book for fear of giving a wrong impression of the balance of good and bad: the weight of the mathematically praiseworthy is overwhelming, while the few features which are possibly objectionable are mainly so for nonmathematical and subjective reasons based on one's statistical taste and philosophy. Of the half dozen such features which troubled the reviewer two may be worth mentioning. A correct exposition is given of the meaning of Neyman's confidence intervals, in which the interval is a random interval such that the probability that it cover the unknown parameter value θ is a fixed preassigned number α, independent of the true value of θ. But after this the author gives a new twist to the method. A fixed interval (a, b) is preassigned. A "confidence coefficient" α for the statement $a \leqq \theta \leqq b$ is then calculated from the sample, so that α is a random variable. While there seems to be no definitely wrong statements made, nevertheless the result may be confusion of the reader as to the meaning of confidence intervals. The simple frequency interpretation is lost: Thus with Neyman's confidence inter-

vals if the statistical assumptions were satisfied in the applications, the user would know that of all statements he makes with confidence coefficients $\alpha \geqq \alpha_0$, the fraction of these statements which are correct will be not less than α_0 "in the long run," regardless of what the true values of the parameters happened to be in the situations encountered. The user of the Cramér "confidence intervals" has no such assurance: It becomes obvious that in a sequence of confidence statements *all* may be wrong, by thinking of a sequence of experiments in which θ is fixed and outside the interval (a, b). Another criticism, which may be of a controversial nature, is that the book shows insufficient concern with the question whether data generated in a given way may safely be assumed to be results of trials on the same random variable, or in Shewhart's language, whether the underlying chance cause system is constant. This manifests itself in several ways: (1) Among the illustrations of "random experiments" are some, such as commodity prices, or quality characteristics of factory output, whose "randomness" is highly questionable. (2) In the first description given of statistical tests, the order of the observations is disregarded, that is, it is assumed that the critical region of the test is always a part of the sample space completely symmetrical in all coordinates. (3) No tests of randomness are mentioned. Clearly an oversight is the statement that in using the analysis of variance to test the hypothesis of equality of a set of unkown means the appropriate critical region of Fisher's statistic z is $|z| > z_p$, and that the z-tables are calculated for such a two-tailed test. The number of misprints is so amazingly low as to deserve comment. Here are some suggestions to the author for additions to a future edition of this fine work, or to teachers for supplementing the present edition: (1) It would be useful in view of the recent development of sequential analysis to have some material on measure and integration in the space of infinite sequences $(x_1, x_2, \cdots)$. (2) It would be enlightening to relate the estimation and testing problems arising in the analysis of variance, the analysis of covariance, and linear regression, as examples of a single theory for "linear hypotheses." (3) Even though the treatment of statistical inference is not intended to be extensive, a brief mention at the end of the book of Wald's formulation of the general problem of statistical inference and his concept of statistical decision function might be justified. (4) The value of the book to most users would be increased by augmenting the 39 problems.

Biometrika 34:374 D '47. F. N. David. This book....is a definitive exposition of the theory of mathematical statistics as it existed in 1940 (about) * The theory of sets and of such Lebesgue measure as is necessary for the understanding of the second part is developed first of all. Such a development will be useful for the student of mathematical statistics coming fresh to the theory of measure in that he receives guidance as to what are the elements essential for him to understand. * Possibly Chapter 10 on Fourier Integrals would have fitted more naturally into Part II but this is a matter of taste. Part II begins with a formal development of the theory of probability as given by the French and Russian schools of probability, and which Prof. Cramér has already given in his Cambridge tract "Random Variables and Probability Distributions." The treatment here seems simpler, however, than in his earlier tract and there is a more practical flavour to his exposition. This part while still purely mathematical begins to introduce distributions and ideas which are familiar to the statistician. The title of the third part is "Statistical Inference" and the main outline is that of small sample theory developed during the past twenty-five years. * The treatment is not exhaustive but the student who has assimilated this part will have little difficulty in extending his knowledge by further reading. As a textbook of mathematical statistics this book will remain unrivalled for many years to come. The mathematical exposition is clear, the development of ideas logical throughout, and the theorems are presented in a very general way. Any student of mathematics who wishes to get a picture of what statistical theory is about will be led inevitably to a study of this book. To those who wish to become statisticians it will be necessary to supplement the reading by a practical course in which the mathematical tools are tried out on numerical examples. This aspect of statistical work the book does not cover, but it is obvious that this would be the case from the title. It only remains to say to the student "This is a good book, buy it."

J Am Stat Assn 42:174–6 Mr '47. Paul G. Hoel. This excellent book will be welcomed by mathematicians who wish to become acquainted with statistical methods and, even more so, by statisticians who desire a reference book for

proofs of many of the fundamental theorems of statistical theory. The large amount of material that it contains, which ordinarily is found only in more advanced books and journals, will particularly enhance its reference value. Although the principal appeal of this book will be for reference use because of the level at which it is written, nevertheless it is carefully organized and presents a systematic development of mathematical statistics. * many of the proofs will be found to require a background of at least advanced calculus or real variable theory for their understanding * Part I will be particularly valuable to the statistician who has not had graduate courses in mathematics because it brings together much unrelated mathematics that is needed for an understanding of later proofs. * Part II begins with an interesting discussion of statistical stability and its relation to the author's choice of axioms of probability. * the t and z distributions were not derived as generally as might have been done. The feature of part II that particularly appealed to the reviewer was the extensive treatment of convergence theorems. Topics on convergence include Bernoulli's, DeMoivre's, and Khintchine's theorems; a central limit theorem for equal components and one for unequal components. This is the only one of the three parts for which exercises are available; most of the exercises are quite mathematical in nature. Although part III contains many excellent sections on statistical inference, a number of important topics are not included. Many readers undoubtedly would have preferred less emphasis on part I and more on statistical inference; however, this is a matter of taste and would not as satisfactorily have accomplished the author's objective of presenting a rigorous, systematic, mathematical treatment of statistical theory. * The section on estimation is one of the particularly interesting and useful sections. It contains uncommon theorems on the efficiency of estimates. Here efficiency is treated by means of variance inequalities for finite samples as well as from the customary asymptotic variance point of view. In his treatment of confidence regions, the author combines the traditional approach with an extended interpretation of confidence coefficients that hardly seems justified because his extension does not possess a frequency interpretation similar to that for traditional confidence coefficients. The only other books available at about this level are those by Wilks and Kendall; however, Kendall's first volume lacks so many topics common to the other two books that it is hardly comparable. Cramér's book requires more mathematical maturity in many parts than does Wilks' book; however, in return it gives proofs of many theorems that are only stated in Wilks' book. Cramér does not cover as wide a range of topics of modern methods as does Wilks, and other topics such as the analysis of variance and normal regression theory are treated less completely. On the other hand, the discussions and illustrative examples of Cramér's book are much more complete. The exposition is clear, and there are surprisingly few misprints. Every serious student of the mathematical theory of statistics will want this book in his library.

J Am Stat Assn 42:176–9 Mr '47. J. Wolfowitz. This book by the distinguished Swedish statistician is a superb addition to the literature of statistics. It is indispensable in the library of every statistician, and its author deserves well of the statistical world. * The discussion and topics covered [in Part II] are more elementary than the author's *Random Variables and Probability Distributions* (Cambridge University Press, 1937). For example, the central limit theorem is proved under conditions no more general than Liapounoff's on the third absolute moments. * [The] last chapters, while delightful, are all too brief. In the preface, Professor Cramér mentions that the need to keep the volume of the book "within reasonable limits" caused omission of topics which he had originally intended to treat, such as the theory of stochastic processes, time series, and periodograms. Professor Cramér should be assured that "reasonable limits" for books as excellent as his are much greater than he modestly considers them to be, and we hope that the enthusiastic reception accorded the present book will induce the author to give us another book on the subjects thus unfortunately omitted. However, if anything had to be omitted, the present reviewer would have preferred that it not be in part III, which is unique of its kind. The material of part I, on the other hand, is already well covered in many books. Omission of part I, however, would have made the book less self-contained than it now is. * the author's style.... is lucid and pleasant, without being either terse or verbose. The scope of the material covered is very large, references are numerous and excellent, and a good bibliography is appended.

The war cut Professor Cramér off from contact with American statistics, with the result that hardly any papers published in the *Annals of Mathematical Statistics* during the war years (with perhaps two or three exceptions) are either discussed or cited in the bibliography. Neyman is well represented by his foreign publications, Wilks is represented by three papers, Hotelling by one, and Wald by none. Comparison will inevitably be invited between Cramér's book and Wilks' *Mathematical Statistics,* which this reviewer esteems highly and has used as a textbook in his courses. However, a direct comparison would be unfair, because Wilks' book is a set of lecture notes of his courses. It covers a very wide range of topics in a small compass and is therefore very terse. However, it covers many topics not discussed or discussed only briefly by Cramér. In the reviewer's opinion the two books are complementary and not competitive. It should be a source of gratification to the Princeton University Press that both books bear its imprint. * A conscientious regard for his duties compels the reviewer to make the following observations on three points * (*a*) On pages 519 and following, the author describes a procedure for assigning a confidence coefficient to the estimation of the mean of a normal distribution whose mean and variance are both unknown, by means of an interval given *in advance of the drawing of the observations.* What the procedure is we shall not describe here. It comes after a description of the Neyman theory of estimation, but the author says, "At this point, we possibly exceed the conceptual limits of the theory as given by Neyman." Now the essence of the Neyman theory is that the method of estimation is associated with a prescribed frequency (probability) of correct decisions. No such frequency can be associated with any method of estimation by a fixed interval. As an illustration, consider an infinite sequence of samples of n on the same normal population. Professor Cramér's procedure assigns to a fixed interval an infinite sequence of corresponding confidence coefficients. Let k be any number between zero and one. We may separate the last sequence into two subsequences according as the confidence coefficient is $\leqq k$ or not. Yet the frequency of correct decisions is equal in both sequences and is either zero or one. When the parameter to be estimated is considered an unknown constant and not a chance variable, it is difficult to see what nontrivial operational statistical content can be given to Professor Cramér's procedure. (*b*) On pages 422 and 423 and elsewhere in the book, Professor Cramér performs repeated tests of significance on the same data. Such a procedure simply enlarges the critical region and vitiates the meaning of the level of significance. It is, however, common in statistical literature. (*c*) On pages 457 and following, the author tests a conjecture on the data which suggested it. This procedure, to the reviewer's mind, is not in accord with the logic of induction. The hypothesis conjectured is that a certain quantity is positive. The author tests statistically the hypothesis that this quantity is zero and gets a nonsignificant result. He then concludes (p. 460) "that the conjecture suggested....is not supported by further analysis." What has happened here is that the data did not contradict (*i.e.,* did not give a statistically significant result) another hypothesis incompatible with the conjectured one. Is it fair to conclude that the data do not support the conjectured hypothesis? Actually the best estimate of the quantity in question is of course not zero, although it does not differ significantly from zero. It seems to the reviewer that the author's conclusion is justified only if the *a priori* evidence for the quantity's being zero is so strong that our belief in this latter hypothesis will be shaken only if the data contradict it (in a statistical sense, *i.e.,* a significant deviation appears). However, the procedure described is widely advocated in statistical literature. The points raised above are minor. Even if the criticism is correct, it merely illustrates the fact that it is impossible to keep a book of any size free of slips. No amount of discussion of details should be allowed to obscure the fact that Professor Cramér has given us a very valuable and excellent book.

J Bus 20:117 Ap '47. L. J. Savage. * The book will be referred to by the practicing statistician when he has occasion to go deeper than other statistical textbooks will carry him into the foundations of certain statistical topics * The book shows much evidence of careful and competent workmanship. It is well arranged both for consecutive reading and for occasional reference. There is good selection of examples and exercises. The writing is logically complete and generally clear, but it is necessarily rather condensed, sometimes at the sacrifice of orienting and motivating remarks. Thus, al-

though the reader need have little specific mathematical knowledge, some passages call for considerable mathematical sophistication. The typography, apparently executed in Sweden, is exceptionally attractive and convenient. * The rather elaborate theory of complex integration is occasionally applied to statistical problems, but Cramér, without noticeable restriction on the range of his topics, is able to avoid this theory. Combinatories, the mathematics of the classical urn and ball and of card-dealing problems, is almost completely omitted. Correspondingly, little is said about order statistics and nonparametric problems. Readers of this *Journal* especially will regret that, for want of space, Cramér felt himself compelled to omit the subject of time series.

J Pol Econ 55:393–5 Ag '47. Harold Hotelling. This book meets an important and long-felt need for a really basic treatment of modern statistical theory. It brings into a mathematically satisfactory unity the diverse developments which, during the last quarter-century, have been changing the face of the statistical world. The material here at last assembled in book form must certainly be read by all who aspire to a full understanding of the logical and mathematical bases of recent developments in statistics. * a lucid account of Lebesgue and [illegible] Stieltjes integrals * The second part provides a thoroughgoing introduction to probability theory. * [The] distribution of material, the careful statements, rigorous reasoning, and high ratio of theorems to examples provide striking contrasts to other books on statistics. Readers in a hurry to find methods appropriate for dealing with particular data will not be attracted by this painstaking, exact work. But, for scholars seeking a basic understanding, it is indispensable. * Distributions are introduced and their theory developed, to a considerable extent, without at first being confined to probability or statistical distributions; this procedure illustrates the general scheme of the book in starting with the very general and gradually narrowing down to the particular, which certainly conduces to clear understanding. An intelligible and rigorous treatment of sequences of distributions and their convergence is given. Mathematical probability is presented in the manner that most students of the subject have now accepted after several false starts—namely, as an idealization of the ratios of outcomes of particular types to total trials, whose approximate stability is a matter of observation. * The concepts of singular distributions— *i.e.*, those confined to linear subspaces of the spaces of the variables—and of conditional distributions are made satisfactorily clear. * [The third part gives] a proof of a much-used but seldom proved theorem on asymptotically normal distributions of functions of moments * A notable inclusion....is a careful development of the chi test for the case in which parameters are estimated from the sample. The....three chapters, collectively entitled "Theory of Estimation," are particularly valuable in stating accurately and proving rigorously a set of theorems relating to estimates of minimum variance, maximum likelihood estimates, efficient, sufficient, and asymptotically efficient statistics, and the like. The author's ingenious formulation is a substantial advance in this important theory, which was due originally to R. A. Fisher. Chapter xxxiv gives an excellent account of confidence regions, with applications to problems regarding means of normal distributions, including the Behrens-Fisher problem. * Kendall's two large volumes cover more subjects than the book here reviewed, with far more in the way of exercises and illustrations, and meet more adequately the practical needs of the working statistician. Cramér concentrates on the elegant combination and smoothing-out of his materials to make a beautifully simple mathematical theory, with only occasional illustrations drawn from observations. Possibly it would have been appropriate to interchange the two titles, since the proportion of theory to methods is higher in Cramér's than in Kendall's book. Cramér appends an excellent bibliography, including references to many European works unfamiliar to mathematical statisticians in this country but, like the text, omitting references to the literature of some important topics in statistical theory and methodology. He provides four short statistical tables; it would seem appropriate either to have omitted these or to have provided the additional tables (*e.g.*, of the variance ratio distribution) ordinarily needed in practical statistics. Among the topics omitted from the book are time series, sampling distributions of roots of determinantal equations, and the whole work of the Calcutta school. The Princeton publication of this book represents a very satisfactory use of an offset process to reproduce the original published in Sweden. Typography and paper are excellent, and the boldface nota-

tions of chapter and section at the top of each page are of immense help in tracing back references. In this connection the American reader will be spared trouble if he bears in mind that, as used by the author, "paragraph" means "numbered section." One mechanical fault should be remedied by the American publishers at the earliest opportunity by arranging for the kind of binding that causes pages to lie flat. The labor of mastering the mathematical material at present is augmented by the irritating physical task of holding the book open. This is a book to be commended especially to teachers of statistics and to all who need a clear understanding of fundamentals.

Math R 8:39–40 Ja '47. M. Kac. The present book is, remarkably enough, both a treatise and a textbook. The presentation is such that the theory of probability is the all important background, whereas statistical techniques and theories emerge as applications. In fact, mathematical statistics is presented as a part of general probability theory. However, in presenting the fundamental ideas and results of modern statistics the author never loses sight of the motivation behind them. He does not choose the easy way of presenting statistics as a sort of an appendix to probability theory (had he done that the result might have looked somewhat like treating mechanics as an appendix to the theory of differential equations) but he makes it stand up as the "applied" counterpart of the "pure" theory. Thus while making it clear that the mathematical methods and techniques of statistics are but a part of the mathematical apparatus of probability theory, he emphasizes with equal clarity that the problems and motivations of statistics are peculiarly its own. * a short....but lucid chapter on characteristic functions * The normal distribution is discussed with particular thoroughness in view of its fundamental importance in statistics. There is a short but adequate discussion of Gram-Charlier and Edgeworth series. In proving various theorems (for example, the multidimensional central limit theorem) the author does not strive to obtain ultimate generality. He prefers to prove them under conditions most often met in practice and to refer the interested reader to original memoirs on the subject. The third and largest....part of the book is devoted to modern statistical theories. The ideas of sampling and sampling distributions are introduced with great clarity. Tests of significance, general theory of testing statistical hypotheses and theories of estimation are treated systematically and rigorously. There is an excellent discussion of such classical topics as goodness of fit, Sheppard's correction, unbiased estimates, method of maximum likelihood, *etc.* A chapter on analysis of variance, though short ....is quite satisfactory. The same can be said about the last chapter of the book, which deals with regression problems. Numerous well chosen and interesting exercises and problems add greatly to the value of the book. Historical notes and references to the literature are also quite helpful. The book is remarkably free of misprints. * the amount of space devoted to the theory of measure and integration (about one sixth of the book) is somewhat out of balance with the rest of the book. The importance of the theory of measure as a basis for probability theory could be appreciated more fully if "strong" theorems like the strong law of large numbers or the law of the iterated logarithm were considered. The book leaves these topics out, however. For the actual purposes of the book a much more rudimentary survey of measure and integration would prove quite sufficient. On the other hand, by including this extensive and readable account of the theories of measure and integration the author makes them easily available and this will undoubtedly prove beneficial. The reviewer also feels that the author's approach to the notion of a random variable through a system of axioms is somewhat unnatural. It might have been simpler to define random variables as measurable functions on spaces on which a Lebesgue measure has been established (the measure of the whole space being 1). With this approach "convergence in probability" would become "convergence in measure" (sometimes called asymptotic convergence) and "convergence with probability 1" (not treated in this book) convergence almost everywhere. The above criticism is, however, not very serious and it does not detract from the great value of the work. The reviewer is certain that this book will become a standard reference and a standard text for many years to come.

Nature 159:826 Je 21 '47. Godfrey Thomson. * Cramér's book....is very definitely for the mathematician * The first twelve chapters are a purely mathematical introduction * The author advises the reader to jump to Chapter 13 after reading the first three chapters and a few other

paragraphs, and thereafter to use this earlier part only as needed. The advice is good, and for my part I would say jump to Chapter 13 at once. Many who ought to read the book would be highly discouraged by the apparent irrelevance of those first three chapters, yet might turn to them without dismay later after seeing their use and necessity. * On p. 520 Cramér begins a three-page discussion of the problem which leads to the Behrens test, namely, the problem of determining, from two independent samples, whether the means of two populations differ significantly, their standard deviations being also unknown and not necessarily equal. This is described, in Kendall's [*Advanced Theory of Statistics*]....as a crucial problem for the rival theories of fiducial probability and confidence intervals. I speak with great diffidence, for the matter is difficult; but there does not appear to be any recognition of this in Cramér's book.

Plant Breeding Abstracts 18:175–6 Ja 1 '48. N. T. J. Bailey. There has in the past tended to be a certain hiatus between the work of the students of probability theory on the one hand and the exponents of modern statistical techniques on the other. The former, especially the French and Russian mathematicians, have been engaged in placing the classical calculus of probability on a sound theoretical basis and have constructed self-consistent systems, whose theorems have been rigorously deduced from certain fundamental axioms. In contrast to these rather abstract studies, the British and American statisticians have been occupied with essentially practical problems such as tests of significance and the design of experiments. They have often developed their methods, by no means unsuccessfully, along somewhat intuitive lines without a very critical analysis of their fundamental assumptions, and have not always made clear the distinction between the subject matter of their investigations and the statistical principles involved. The disadvantage here is that, as the subject increases in complexity, divergent opinions are harder to reconcile, and the techniques themselves are less able to meet adverse criticism because of the lack of clarity of their logical presuppositions. This confusion makes further progress difficult and uncertain. In the present book, H. Cramér.... shows how these two divergent lines of development, the abstract and the practical, may be brought together. He presents a unified treatment of mathematical statistics, in which the calculus of probability forms the theoretical foundation, while statistical techniques are exhibited as applications. In this way the assumptions of the latter are made explicit, and, now assured of mutual consistence, can be confidently used as a basis for further development and are more easily susceptible of general application. It would be idle to suggest that all the difficulties have been resolved, but it is true to say that considerable progress has been made in the process of clarification. * contains numerous interesting examples, historical notes and references to the literature * the author regrets having to exclude certain important subjects such as the theory of random processes, statistical time series and periodogram analysis. In view of the excellent treatment accorded to the subjects actually dealt with it seems a pity not to have made part three more complete by the inclusion of these other subjects. The amount of space devoted to Lebesgue measure and integration seems somewhat disproportionate, and it would perhaps have been better to have curtailed part one so as to enable subjects such as stochastic processes to have found a place in part three. While this book is clearly not intended for the experimenter who merely requires to be acquainted with a number of practical statistical techniques, it will be welcomed by the mathematical statistician who aims at a deeper understanding of the theoretical foundations of his subject. Although Professor Cramér in his book does not cover so wide a range of modern statistical methods as Wilks does, for instance, in his "Mathematical Statistics," his treatment throughout is clear and lucid, and this excellent book will undoubtedly become a standard work of reference.

Sci 104:450 N 8 '46. J. L. Doob. * Cramér's book is doubly welcome in that it contains both a remarkably complete treatment of the mathematical background to statistics and a treatment of statistical methodology itself, a combination not previously available. * The second part gives the basic knowledge of probability required for statistics. The author's general point of view makes this part a study of random variables; games, permutations, combinations, *etc.*, so dear to the hearts of probability textbook writers, are omitted, except as implicit in the binomial distribution. The development is carried through the central limit theorem (on the approximation to normality of the sum of a

large number of independent random variables) and the law of large numbers. The problem of measure in infinitely many dimensions is avoided; probably for this reason the concept of convergence with probability 1 is omitted, and the function theoretic significance of the concept of convergence in probability (convergence in measure) is not explained. The third part of the book, comprising somewhat less than half, is devoted to statistical inference, subdivided into sampling distributions, tests of significance, and the theory of estimation. Periodogram analysis and the related theoretical problems of random processes are not treated because of lack of space. The text presupposes a knowledge of calculus and familiarity with limiting processes. The writing, although almost always mathematically rigorous, does not sacrifice space to rigor. It is frankly a mathematics text, however, in spite of the numerous statistical examples, and as such is not for casual reading by outsiders. The full bibliography simplifies more extended study. Both probability and statistics have been completely revolutionized in the 20th Century. The first has been put on a firm mathematical foundation, as rigorous as any other branch of analysis; the second, basing itself on probability, has been enabled to develop the delicate and elaborate techniques which give it its present importance. The author has succeeded admirably in his stated purpose of writing an exposition of the two fields, in their interrelations, from the modern point of view.

[76]

★CROXTON, FREDERICK E. **Workbook in Applied General Statistics, Revised Edition.** New York: Prentice-Hall, Inc., 1941. Pp. vii, 181, plus 57 leaves of graph paper. Paper, looseleaf for insertion in ring binder. * For latest edition, see 77.

[77]

★CROXTON, FREDERICK E. **Workbook in Applied General Statistics, Third Edition.** New York: Prentice-Hall, Inc., 1950. Pp. viii, 181, plus 62 leaves of graph paper. Paper, looseleaf for insertion in ring binder. Text edition, $2.85; trade edition, $3.80. *

[78]

CROXTON, FREDERICK E., AND COWDEN, DUDLEY J. **Applied General Statistics.** New York: Prentice-Hall, Inc., 1939. Pp. xix, 944, xiii. Text edition, $4.75; trade edition, $6.35. * (London: Sir Isaac Pitman & Sons, Ltd., 1940. *27s.*)

Math Gazette 26:194–6 O '42. Frank Sandon. * an exhaustive volume—shall we say an enlarged and American Bowley? * although covering very fully most of the traditional course, exhibits distinctly the authors' main interests. Of 25 chapters (referred to indiscriminately by Roman or Arabic notation) time series, index numbers, forecasting and allied topics take up almost one-third. But even this leaves us with over 600 pages of text and 18 appendices, these latter taking up alone more than 100 pages and including a number of useful tables. It was, perhaps, hardly necessary to include a table of sines and cosines of 0° (1°) 90°. Appendix O is apparently printed from a worn plate. But on the whole the book is extremely well and carefully printed. The reproduction of the U.S.A. Census of Population Schedule on p. 20 is in excessively small type, conflicting with the rule laid down explicitly on p. 65. There are a very few misprints. The volume should prove very useful as a reliable text and reference book, primarily for teachers in economic statistics, though it should answer many statistical questions for other workers. The educationalist will note the omission of factor analysis, reliability and attenuation, and the agriculturalist of factorial analysis and of Latin Square, whilst even the economist will find that modern methods of market research are not dealt with. The indications given casually (pp. 634, 642, 644) of free statistical services in the U.S.A. are rather surprising to a foreigner. The authors are obviously very experienced teachers and their expositions are good and clear and their approach sound and useful. It is, however, a bit awkward to find in the chapters on trend and index-numbers that correlation, though needed, is not dealt with till later. There are very full references to the sources of tabulated material and of formulae, though it is hardly going to the fount of information to quote (p. 511) as authority for dates of Easter a publication of the *New York World Telegram*. The treatment is said to be at an elementary level: our comment on this must be that everything that is at an elementary level is here, so that the book at twenty shillings is very good value. The references are practically all American, though frequent reference is made to the standard books of R. A. Fisher, Yule and Kendall, and Tippett, and to the work of Karl and Egon Pearson. There is even something about Gram-Charlier, Tchebycheff and Camp-Meidell. It is strange to find Stamp given (p. 161) as authority for the story of Randolph Churchill's damned dots. There are full proofs of a number of formulae and full expositions of a number of calculations, often

by alternative methods, so that they throw much light for the student on the meaning of the analysis. The mathematics is not of the highest standard of rigour: thus we have the binomial theorem stated (p. 922) in a form appropriate when m is a positive integer, without the limitation being stated. Numerical constants are given to a certain number of figures with no indication that the value is not exact. The setting-out of the proof on p. 223 would be heavily penalised by any member of the M.A. "Obviously"—as [illegible] (p. 208) a step of dubious validity. The statement about rounding (p. 150) is incorrect. No distinction is drawn between rates and ratios. I do not think that 4.5! is an accepted notation for $4.5 \times 3.5 \times 2.5 \times 1.5 \times 0.5 \times \sqrt{\pi}$ (p. 326). There are vague, loose or inaccurate phrases in a number of places (for example, pp. 173, 188, 218, 221, 222, 230, 293, 310, 363, 440, 461, 498, 580, 590, 742, 858). One turns with interest to the full and useful glossary at the end (Appendix Q). The entry of "infinity" is a neat solution of a difficulty; we find simply the entry ∞ (p. 926). The section on graphs is very full and careful. It is unfortunate that the student is explicitly told (p 85) that the plotted points need not be shown (even on p. 442 where they are said to be shown by large dots they seem to have been lost in the reproduction of the figure), whilst he is not told whether to draw the curve smooth among the points or spiky through the points. The chief criticism is, however, that although there are over 250 graphs, numbered serially, yet there is no index: the page references are not usually given, so that it is a tedious task to read sections where the charts are much used, for example in chapters 4, 5, and 6. The section on sampling is not altogether satisfactory: no distinction is drawn between unbiassed and random sampling, whilst the method of random sampling (p. 307) given by the authors suggests that random sampling numbers are unknown. Representative sampling is undefined (p. 584), but apparently it is stratified (p. 586). There is an appendix (C) on calculating machines: the slide rule appears here, but the authors are optimistic in thinking that 3- or 4-figure accuracy can be obtained with a 10-inch rule (p. 870; the illustration on the very next page gives this the lie), whilst they choose to use logarithmic paper (p. 121) instead of a slide rule to get easily a logarithmic scale of any stretch. In addition to the calculating machines some other apparatus is referred to: the mechanical device on p. 268 for obtaining a binomial distribution is very neat. So is the use of a bread knife for drawing a serrated line (p. 82). There is no reference to the cope-chat (paramount) cards—the Findex (p. 44; not, I believe, on the English market) does not seem such a good idea. There is no indication that there is a mechanical sorter-tabulator as well as an electrical one (p. 41). It will be seen, therefore, from the criticisms above, that the book has ranged over an immense field, but that the faults, from the point of view of the average student, are only of a relatively minor character. The book can whole-heartedly be recommended as an encyclopaedic and reliable outline of modern statistical practice and of most aspects of its elementary theory.

Psychiatry 4 479–80 Ag '41. M. F. Ashley Montagu. * probably the best general introduction to the accomplishment of a working knowledge of statistical methods * The book is admirably illustrated, and there is very little in it which any person who has had the usual high-school instruction in numbers will have any difficulty in understanding. The book is very highly recommended.

Sci 93:498 My 23 '41. S. S. Wilks. * perhaps the most comprehensive text-book on elementary applied statistics that has ever appeared. It falls primarily in the category of "descriptive statistics," that is, it deals mainly with the practical problem of collecting, analyzing and presenting statistical data, touching very lightly and incompletely on probability theory and its application to the problem of drawing inferences from the data. The plan of the authors, followed throughout the book, is to introduce the student to the various known elementary descriptive statistical procedures and illustrate them thoroughly with applications, appealing largely to the intuition and common sense of the reader in justifying the techniques rather than undertaking a systematic logical and mathematical discussion of the assumptions and principles underlying them. * many well-chosen examples taken from economics, business, sociology and industry * The fundamental concepts and mathematics involved....have not....received adequate attention from the authors, although derivations of some of the simpler formulas have been given in an appendix. * The authors have been rather com-

plete in their coverage of elementary descriptive statistical methods commonly used in economics, business and sociology. Teachers of introductory statistics courses in these fields who have to handle students with sketchy mathematical background should find this book well suited to their needs. Many of the research investigators in these fields should find the book useful in increasing the objectivity of their own work.

Sociol R 35:53–4 Ja-Ap '43. E. Grebenik. * differs from other contemporary textbooks on the subject in its comprehensiveness. There is no paper shortage as yet in the United States, and the two authors can therefore adopt a leisurely approach and treat in great detail the various problems that crop up. Elementary points, such as the collection and tabulation of data, are discussed very thoroughly, and the reader is then introduced to the simpler measures of central tendency, dispersion, and skewness. More than one-quarter of the book is devoted to these topics. * Some readers may find the transition from the simple calculation of averages to rather complicated sampling concepts a little abrupt and difficult. The authors might also have stressed rather more than they do the necessity for caution in the application of the more refined statistical tests to social statistics. There follows a fairly exhaustive treatment of the elementary theory of time series, including the measurement of trends, seasonal movements, and cyclical fluctuations. Index-numbers are also treated here, though the authors nowhere mention the work that has been done on the economic theory of price index numbers, but content themselves with a merely statistical approach. The discussion of examples of index-numbers will be of interest mainly to American students. * there is a large number of tables of the various statistical functions, and of five-figure logarithms, which is not the least useful part of the book. The work will be of interest to the economist and sociologist who is interested in the modern development of statistical methods, but who feels that most of the modern works have been addressed to the agricultural experimenter or the biologist. The examples given in this book are largely drawn from economics and sociology, and the reader who perseveres to the end will probably find that he has a fairly good idea of what modern statistics is about. There are, however, some omissions. Little is said about statistics of population, and no mention is made of interpolation. Both these subjects are of interest to workers in the social sciences, and short sections dealing with these matters might be added to any future editions of this work, at the cost, perhaps, of some of the unnecessarily detailed discussion of index-numbers.

For additional reviews, see 2:74

[79]

★CROXTON, FREDERICK E., AND COWDEN, DUDLEY J. **Practical Business Statistics, Second Edition.** New York. Prentice-Hall, Inc, 1948 Pp xix, 550 Text edition, $4.75; trade edition, $6.35 *

For reviews of the first edition, see 38 B584 and 2 75.

[80]

★CRUM, W. L., AND SCHUMPETER, JOSEPH A. **Rudimentary Mathematics for Economists and Statisticians.** A revision of Supplement to *Quarterly Journal of Economics*, Vol. 52, May 1938 New York: McGraw-Hill Book Co, Inc, 1946. Pp. xi, 183. $2.75. (London: McGraw-Hill Publishing Co, Ltd 12s. 6d.) *

Am Econ R 36 925–7 D '46. R. T. Bowman. * an excellent presentation * The total cost of production of an individual producer turning out a single and uniform commodity is used in Chapters I and II to illustrate certain basic ideas of mathematical functions. The analysis is largely [illegible] but with an excellent presentation of the relationships between the graphs and their equations. * Probably the most important notion for economists—perhaps for anyone—is the mathematical concept of "limits." The economist's use of marginal analysis has little rigor or elegance without some understanding of the limit idea in mathematics and of the elementary uses of the idea in the differential and integral calculus. Chapters III, IV, and V deal respectively with Limits, Rates and Derivatives, and Maxima and Minima, and should be mastered by every student of economics who has not had the benefit of training in the calculus. * In Chapter IV the elementary methods of the differential calculus are very clearly presented. * The last two chapters.... deal with Differential Equations and Determinants. These chapters are much more difficult than the earlier ones, but if mastered as to meaning even if not as to technique, they should help the non-mathematical student to read and understand many current writings in mathematical economics. The volume under review, along with *Mathematical Analysis for Economists* by R. G. D. Allen, does much to fill a pressing need of economists for help in under-

standing mathematical ideas useful to them. To be really beneficial, however, these aids must actually be used in the teaching of economics. *

Economica 14:310–13 N '47. W. J. Baumol. "Mathematics for Economists." * the book is in complementary rather than competitive relation with the other standard works in the field * considerably less ambitious than the others. In outline, roughly the same ground is covered here as in Allen's *Mathematical Analysis for Economists,* but with calculated omissions, *e.g.,* the calculus of variations, as well as omissions of detail throughout. As a result the book is not at first likely to prove terrifying to the neophite. The very fact that it is quite small is important in this respect, for it may impress the reader with the idea that the magnitude of his task is not beyond reason. The book is smoothly written, and there is a commendable emphasis on fundamentals and first things first. * if.... those who peruse this literature may be divided into two classes—those who intend ultimately to master the mathematical technique and those who seek merely an indication of the meaning of such basic concepts as the derivative, the integral and the determinant—then it may well be that those who belong to the latter category will find the work in question to be entirely adequate and just about the easiest possible source. Certainly all advanced students of economic theory who do not plan to enter a serious study of mathematics will find that failure to peruse at least this book is a luxury they can ill afford. * The book should also prove invaluable for review purposes to those who have already done some work in the subjects discussed, but who have subsequently forgotten much of it. For those desiring to learn more than this minimum, the advantage to the beginner—the likelihood that it will prove the most readily palatable—becomes its weakness. Its limited size forces much of the treatment in the latter sections to be extremely sketchy. Much of the material is presented on the author's word and some stated almost without elaboration. Where this is true, the simplicity of the book tends to be deceptive, for the uninitiated reader is likely to be confused ultimately by the list of ideas and techniques which are hinted at and not elaborated upon. After finishing the book he is apt to be discouraged by the implied magnitude of the task before him. Therefore this type of reader may find a work like that of Professor Allen considerably more suitable to his needs. Moreover, the amount of preparation which the neophite can obtain from Professors Crum and Schumpeter's book is distinctly limited. I do not believe, for example, that a person whose mathematical armoury comes from this book alone will be able to follow much of the material in an average issue of *Econometrica.* There is indeed little question that this is clearly recognised by the authors. In fact, I doubt whether there is possibly a single volume which will entirely satisfy this criterion. There are two minor points of criticism which I should like to add. The first is that I believe the omission of exercises is somewhat unfortunate, since I think there is no substitute for "doing the thing yourself" as one of the requisites of mathematical education. Secondly, while the bias towards economic examples is definitely welcome, it is unfortunate that some of these examples tend to have an aura of artificiality which might perhaps induce distrust on the part of the reader. * [See original article for related comments not excerpted.]

J Am Stat Assn 41:606–7 D '46. J. E. Morton. * the most outstanding feature of the book is the pedagogical skill with which the student is introduced to and led through the field of calculus. The ease of exposition, and the smooth and well-integrated development of the idea of rates of change and their systematic treatment, result in a volume which places all teachers considerably in the debt of the authors. * The less satisfactory aspects....are the absence of bibliographical material and the absence of problems and examples, which some instructors or readers may deplore. The book addresses itself primarily to the future economist rather than to the statistician. There is no doubt in the mind of the present reviewer that the book will be sincerely welcomed not only by teachers but also by those students in economics who do not feel quite up to the task of working their way through, say, Allen's *Mathematical Analysis for Economists.* * Is there need for a book of the nature of [this book]? * If....used as collateral reading or for purposes of self-study, the answer....is an unreserved "Yes." *

J Am Stat Assn 41:607–9 D '46. Gerhard Tintner. * The authors ought to be congratulated for having achieved almost a miracle of condensation. A great number of difficult subjects are discussed in a very small space. This could only be achieved by presenting many

mathematical theorems without proof. This lack of proof may, however, be confusing to the reader. * On the whole, the needs of the student of statistics are somewhat neglected; the only statistical subject used as an example comes from the theory of simple regression. * This book certainly fulfills a very useful purpose as an introduction to calculus for the somewhat mathematically inclined and interested economist. It is particularly recommended because it is free from the preoccupation with physics and especially classical mechanics which characterizes almost all introductory calculus books. A knowledge of these subjects is of no great importance to the economist. He will save himself time and unnecessary trouble if he uses this introduction to calculus which utilizes exclusively examples from economic theory and mathematical statistics. If we compare the present book with other available introductions to mathematics for economists, it appears that it is somewhat inferior to R. G. D. Allen's *Mathematical Analysis for Economists* * Another book, *Elements of Mathematics for Students of Economics and Statistics,* by D. C. Jones and G. W. Daniels....is also somewhat preferable. But both of these books are written for English students who are able to approach college economics with a better high school education in mathematics. Hence, it seems that they are not as suitable for teaching purposes as the present book. All the examples included are artificially constructed. One may wonder why the authors have not used some of the results of recent empirical econometric research. These would provide excellent examples for an introduction to mathematical and statistical methods. *

J Pol Econ 55:392–3 Ag '47. Lawrence R. Klein. * of the various ways of teaching elementary principles of mathematical economics, this volume....is one of the less desirable. It is very difficult to see for whom the book is intended. If a student is seriously interested in becoming an accomplished mathematical economist, he will not derive much benefit from it. The only satisfactory solution for such a student is to get a good mathematical education at the hands of professional mathematicians and a good economics education at the hands of professional economists. A good student will easily discover the problems to which mathematical methods can be applied in economics, and others will get their synthesis from journal articles. Presumably, the authors have in mind other types of students, say, students who desire only to understand writings in mathematical economics without becoming mathematical economists. While this alternative is probably not possible, it can be considered for the sake of argument. This student will certainly be confused by the treatment of this book. Several mathematical notions are introduced in the text and then defined in footnotes or by references to books on mathematics. An entire semester of integral and differential calculus is condensed into a few scattered pages. * A student who goes to this "rudimentary" treatise will be lost. The order in which subjects are presented is very unusual and confusing. Often ideas are introduced which depend on other ideas introduced only in a later chapter. The analysis is unsystematic, especially unsuited for its objective of teaching elementary students. In the section on maxima and minima of functions of more than one variable subject to constraint, the authors should realise that they are bound to run into systems of equations from which the Lagrange multipliers must be eliminated, yet they casually refer to the elimination of the parameter without ever having introduced the student to the methods of dealing with systems of simultaneous equations and of eliminating variables from such systems. In fact, their confused order of treatment leads them to make an incorrect statement. On page 131 they say that a function of two variables (x and y) will be a minimum if the second order partial derivatives with respect to x and with respect to y are each positive. The correct condition involves a more complicated expression which is the whole determinant of second derivatives, including cross-derivatives between x and y as well as the others. However, since the theory of determinants comes later, it would not have been possible to present the correct condition as early as page 131. The volume is to be criticized for what it does not say as well as for what it does say. There is no treatment of difference equations, an inexcusable omission in a book on elementary mathematical economics. The examples of economic problems are hardly inspiring. Most of the modern problems that mathematical economists are attacking are conspicuously absent from the book, although some very simple examples could be constructed for use in an elementary text. The title indicates that the book is intended for statisticians as well as economists, but one looks in vain for treat-

ment of statistical problems or the sort of mathematics that a statistician needs. There is one example of a regression problem but, for training statisticians, this example probably does more harm than good A statistician needs to be trained for work in probability theory, sampling, estimation, testing of hypotheses, *etc.* The mathematics for this type of work extends far beyond the limits of this book. A basic textbook for Econometrics and mathematical economics still remains to be written.

J Royal Stat Soc 100 297 pt 3 '46 R. G. D. A(llen). * The additions are largely due to Professor Schumpeter; they include the introduction of such useful methods as the Lagrange multiplier, an extension of the section on differential equations to higher order and partial equations and a new chapter on determinants. * The economist with no mathematical equipment is at a disadvantage in reading modern economic theory. The book is designed to supply such a student with the simplest ideas of mathematical reasoning, arranged in the form most comprehensible to him as an economist. It is not a substitute for a serious study of mathematics which is, in fact, recommended to all who can reach the last page of this introduction without flinching. The content is very simply ordered to proceed from curves and limits, through derivatives to problems of maxima and minima, with a final dip into differential equations and determinants. Some non-mathematical economists, however, may find that the final dip leads to complete immersion. * the title of the volume addresses itself to the statistician as well as to the economist. In fact, apart from the derivation of lines of regression by least squares as an example of extreme values, there is very little indeed in the text of interest or assitance to the statistician as such.

Rural Sociol 11:390 D '46. Edgar Z. Palmer. It was hardly necessary to have engaged two such eminent economists to produce this little book. It purports to be a self-teacher for economists in the basic concepts of mathematics from analytic geometry to differential equations. The addition of "statisticians" to the title is deceptive, since nothing of especial interest to statisticians appears except four pages on the line of regression. * The progress of the subject matter is parabolic, in that it starts with an easy gradient, becoming ever steeper as it proceeds. Eventually the climb becomes so steep that the economic illustrations are omitted for pages at a time. No exercises or problems are suggested * The chief usefulness of the book is probably as a refresher for economists who have had the mathematics courses involved.

For reviews of the first edition, see 38 B585 and 2·76.

[81]

DAHLBERG, GUNNAR. **Mathematical Methods for Population Genetics.** Basle, Switzerland: S Karger, 1947 Pp viii, 182 sFr 25 (London: Interscience Publishers Ltd, 1948. 42*s*.) (New York Interscience Publishers, Inc., 1948. $4 50.) *

Ann Eug 14·348 Je '48. C. A. B. Smith * a very useful book for the human geneticist * The discussion is for the most part theoretical, but the mathematics used is little more than simple algebra. Where the equations used are too difficult to solve algebraically, numerical calculations are given. It follows that the more complicated mathematical population theory of Haldane, Sewall Wright and Fisher is not to be found in this book, but there is a bibliography with references to their papers. There are a number of statements in this book which are not very clear, or seem misleading to the reviewer. For example, it is repeatedly stated (see pp. 67 and 111) that linkage would lead to a correlation between characters, whereas it is known that in a random mating population there would be no correlation in the population as a whole, owing to the equal frequency of coupling and repulsion. On pp. 29 and 30 no account is taken of the more refined methods, due to Stevens and Fisher, of estimating the frequencies of blood-group genes and checking their agreement with observation. The term "epistatic" on p. 32 has not been previously defined. On p. 59 Dahlberg says that "there is hardly reason to suppose that cousins marry one another to any appreciably greater or lesser extent than any other persons in the population, who are not related." This may in fact be so, but some justification should be given for making such an important assumption. On pp. 117–18 the method of expression of racial differences might be improved by using a discriminant function technique. On p. 168 it seems a little difficult to believe that the breaking up of isolates could make so considerable a difference to the stature of the Swedish population. As the author himself emphasizes, the mathematical theory is based on somewhat arbitrary assumptions, especially with regard to assortative mating, and until further observational evidence is

at hand, it is not clear to what extent it can be validly applied to actually existing populations. On the whole, however, the book is very clearly written, and it is well printed and attractively set out. There are surprisingly few misprints or lapses from perfect English, and most of these are of a relatively trivial character.

J Am Med Assn 141:570 O 22 '49. * Although some will disagree with some of the ideas expressed in the book and consider many of the mathematic expressions or terms unfortunate choices, the book is a valuable one. It may well serve as a starting point in a study of the genetics of human populations and also serve as a stimulus to those who already are working in this new field. The book should be of value to the clinician who is interested in populational aspects of inherited human variations.

J Am Stat Assn 44 447–8 S '49. Howard Levene. * This book is a translation, with minor changes, of the author's "Mathematische Erblichkeitsanalyse von Populationen," *Acta Medica Scandinavica*, Suppl. 148, 1943. The author has deliberately omitted all discussion of the work by the Fisher school and others on estimation of mode of inheritance, linkage relationships and gene frequencies for particular characters; and has made little use of the investigations of Wright, Fisher, Haldane and others on evolution in natural populations. Within the author's chosen field, the book suffers from the defects to be expected of a book written on an essentially mathematical subject by a non-mathematician. Most of the proofs involve verbal reasoning and are consequently hard to follow and check. Furthermore, the precise mathematical model involved is not always clearly evident. In particular, the reviewer has felt for some time that geneticists use the term random breeding to cover a number of different processes that may lead to different results in finite populations, and the author's discussion seems to have this same fault. The author also fails to distinguish between the actual values of gene frequencies and their expected values, although at other times he makes effective use of the concept of random fluctuations in small "isolates." Furthermore, the modern theory of statistical inference is virtually ignored. In the section "Isolates and Racial Differences" a type of discriminant analysis is introduced which is in general inefficient in comparison with that of Fisher. The above criticism should not be taken to imply that this is not a valuable book. For biologists and men of affairs it discusses clearly the problems of heredity in human populations, and shows the importance of further research along these lines. The final chapter in particular should serve as a valuable antidote to the more rabid eugenists and racists. (The author states that the first edition was intended in part for the postwar edification of the German people.) The wealth of tables and graphs interpreting the various formulas should be particularly welcome to the less mathematical reader, and the conclusions drawn from them are likely to be at least qualitatively correct. For the mathematical statistician and the biometrician, this book will be primarily valuable as an introduction to a new discipline of great practical importance which furnishes some problems of no mean mathematical difficulty. The reinvestigation and extension of the author's results, using the theory of stochastic processes and modern methods of statistical inference, provides a wealth of problems at many different levels of difficulty. All things considered, it is a book which will well reward reading by those with any curiosity toward this subject.

Math R 10:556 S '49. W. Feller. * The numerical analysis is emphasized. In the preface the author states that "in order for the reader to accustom himself in successive steps to the methods of calculation used here, the presentation has been given a very elementary form, especially in the first part of the book which to mathematically trained readers must seem irritating and tedious." This describes the purpose of the book, but does not do justice to the elegance of presentation.

[82]

DAHLBERG, GUNNAR. **Statistical Methods for Medical and Biological Students.** London: George Allen & Unwin Ltd, 1940. Pp. 232. 15*s*. (New York: Interscience Publishers, Inc. $4.00.) *

J Royal Stat Soc 104.65–6 pt 1 '41. H. O. H(artley). * It is a pity that the author has attempted to compromise between the "demands of the mathematical statistician" and the "mathematical limitations of the medical and biological student." He has tried to "explain the (theoretical) reasoning in words." We should have rather liked to have the author's expert view on the *applications* of statistical methods to the medical sciences. Conventional lines of books on theoretical statistics are followed. The theory of probability and of permu-

tations and combinations is given first, and is followed by an outline of the binomial theorem and the normal curve. The experimenter who wants to learn why and how mathematical conceptions enter into his sphere will find but little satisfaction. However, in Chapter IV an instructive example is given. Human growth is considered as being conditioned by five factors, each of which is a simple alternative, such as "good nutrition" or "bad nutrition." It is shown by simple logic that with independent factors a binomial distribution of human heights will result from the simple theory. Treatment of averages and measures of variation also follows conventional lines, but much of the subject-matter given is out of date. Moreover simplicity is sometimes achieved at the expense of accuracy. On p. 94 the formula for the standard deviation of a product is obviously not valid for factors with zero mean, and such essential limitations should be mentioned. The discussion of Sheppard's correction ignores the conditions under which it is valid, although group intervals of the order of the standard deviation are considered. Elementary cases of an analysis of variance are given in terms of problems in medical research, and the comparative importance of individual variation, inter-individual variation, environmental and hereditary factors is discussed. There is, however, a conspicuous lack of modern methods. An interesting source of variation enters through the uncertainty of a single diagnosis or determination of an experimental quantity. Repetition of the determination with variation in technique are therefore necessary. The resulting discrepancies are comparable to the sampling error in field experimentation. The book will be of interest to professional statisticians and give them an idea of the difficulties encountered in medical research; it will also be of some help to the medical student.

Sci 93:497–8 My 23 '41. S. S. Wilks. * a book which is very elementary and limited in scope and not very well written from the point of view of statistics. The mathematical and statistical argument is rather amateurish throughout the book. Many of the modern statistical techniques such as Student's ratio, regression methods, analysis of variance and statistical estimation, used by some medical men, are not even mentioned. The distinguishing feature of the book lies in well-chosen examples and a thorough discussion of them in relation to the statistical methods actually considered in the book. The book should perhaps be useful as an introduction to statistics for those medical and biological students who have only a secondary school mathematical background and who know nothing about statistics.

For additional reviews, see 2:80.

[83]

★DAVID, F. N. **Probability Theory for Statistical Methods.** London and New York: Cambridge University Press, 1949. Pp. ix, 230. 15*s.*; $3.50. *

Ann Eug 15:93–4 O '49. J. B. S. Haldane. * David tends to go back to Laplace for some of her theory, revising it along the lines developed by Neyman and Pearson. That is to say, she tries to base every argument on the conception of a set of equally probable arrangements. This approach is particularly well suited for the treatment of elementary genetics, though if she ever tries to tackle linkage estimation she will find it a rather narrow foundation. The treatment is rigorous, except that, as the author does not use point set theory, most of her theorems are only completely proved for discontinuous probability distributions. It leads inevitably to the "unbiased estimate" as the idea to be aimed at. I think that some readers will be genuinely startled to find that the usual estimate of a standard deviation from a sample is appreciably biased, and, indeed, that no exact unbiased estimate of it is possible. The book contains many results, both of the British Biometric school, and of authors such as Markoff, Lexis and Uspensky, which are not sufficiently widely known in Britain. In particular, Markoff's method can be used with great advantage in the highly practical problem of "stratified sampling," that is to say, the taking of samples from different strata of a heterogeneous population. A chapter is devoted to "simple genetical applications"; the rigorous method used can be unreservedly welcomed. Nevertheless, I believe that the author has made a mistake in the calculations of pp. 96 and 97, as she certainly has in describing colour blindness as a recessive defect in the sense in which she uses the word. I believe that such problems are much more easily solved on the basis of *Kollektiv* or large population theory than of probability theory, even if its logical basis is weaker; simply because it allows a shorter symbolism. If Dr. David doubts this, let her try to solve the problem of pp. 85–9 when recessives of one sex only (*e.g.* horned bulls) are eliminated. Perhaps genetics are

never quite as simple as she believes. In the last two chapters characteristic functions and cumulants are introduced. My own belief is that this can usefully be done at an earlier stage, because thanks to the development of radio, so many students have at least a rough idea of the Fourier transform that they will find it an easier tool than, for example, the difference quotients of zero. They may even take more kindly to $e^{-\frac{1}{2}x^2}$ when they learn that it has the unique property of being its own Fourier transform. Similarly, it might have been desirable to introduce maximum likelihood as a method of estimation, if only to show that it does not in general give an unbiased estimate. However, Dr. David's approach is of her own choice, and her book will certainly be of value to all students of biological and other statistics who are interested in the logical foundations of their subject. It will also suggest methods which in some cases will be more accurate than those generally used. We all have our favourite statistical tools, and even if we do not accept all Dr. David's collection, we shall be unlucky if we do not find something in it which will help us.

Biometrika 36:469–70 D '49. Cedric A. B. Smith. * intended primarily for students who have reached intermediate standard in mathematics, but it will be found useful by all who are interested in statistical methods, as it gathers together a number of useful results which otherwise are very much scattered throughout the literature. * [the author's definition of probability] is adequate for the purposes of the book (except that strictly speaking in the form given it applies only to *rational* probabilities, whereas when the normal distribution is being considered we shall need irrational ones too) * a chapter on simple genetical applications of the theory, largely replacing the usual sequence of problems on drawing black and white balls from urns, throwing dice, *etc.*,....seems a very welcome development, provided that it is accompanied by a sympathetic understanding of at least the elements of genetics, and genes are not going to be regarded in future simply as objects conveniently provided by nature for the construction of new types of examination questions. Incidentally, Dr. David is over-cautious in her discussion of random mating, saying that it is "rarely met with in practice," whereas in fact with genes such as the blood-group genes it can be shown to hold with considerable accuracy. * The style of the book is simple, straightforward, and lucid—refreshingly so; and there are few errors, mostly trivial ones. The only two places where the exposition is not quite up to the standard of the rest of the book seem to be the "problem of points," p. 26, where the condition $r < t$ might be brought in earlier, and the calculation on pp. 96–7, where the sentence "we may assume therefore that A_1 = **Rr**" gives rise to what seem at first sight rather doubtful calculations of the probabilities of various genotypes for A_2; if, however, we say instead "let A_1 be the parent who passed on the **r** gene to B_2" then these calculations are completely justified. Incidentally the phrase "for example, colour-blindness" which occurs in the examination question quoted here seems to be singularly unfortunate, as colour-blindness is not inherited in this manner, nor has it a gene frequency as low as 0.001. Other omissions which may cause some difficulty occur on pp. 15–16, where the product law is used before it has been proved; in chapter XV, where the fact that two different distributions cannot have the same characteristic function is frequently used but nowhere stated; and on p. 214, where the independence of the grouping error is tacitly assumed. It is a pity that means and moments are not defined on p. 31, and their simpler relations proved, since apart from this omission the book is self-contained. Small errors occur * The use of $(q + p)^n$ instead of (say) $(q + tp)^n$ as a generating function (as on p. 30) does not seem very happy, since obviously $(q + p)^n = 1$. The consistent use of "standard error" for "standard deviation" seems also a little odd. The usual practice for geneticists now is to concentrate attention on gene frequencies, rather than the genotype frequencies considered in chapter VIII; although this would probably simplify the calculations, the point is not very important in the context. The French spelling "Tchebycheff," though in common use, is irritating, but can perhaps be blamed on the man himself, although he was really "Chebyshof." And finally, the notation $\Gamma(x + 1)$ for $x!$, often used when x is not integral, seems merely designed to make the formulae unnecessarily complicated. Summing up, we may say that the book would be a most useful addition to the library of any statistician or student of statistics.

J Am Stat Assn 44:567–8 D '49. John W. Tukey. * this book is based on a carefully organized set of lectures. The imprints of Karl Pearson and Jerzy Neyman are plain to see.

* Noteworthy are (*i*) a 17-page chapter on simple genetical applications, (*ii*) the elementary derivation of sampling moments for sample moments from finite populations, (*iii*) an account of differences of zero and their simplest uses, (*iv*) an emphasis on mathematical precision and the use of elementary methods, and (*v*) a clear-headed middle-of-the-road attitude toward the relation of probability theory to the real world. While it is hard to name courses in the United States where such a book would be an appropriate text, it should be helpful supplementary reading for both students and teachers. (The reader is supposed to be familiar with the notation for third and fourth moments [p. 31].) As is inevitable and appropriate, there are places where the author and the reviewer hold different views, but in only two places were definite errors detected. One is in the statement of the boundedness hypothesis for the Central Limit Theorem on page 217, where $0 \leqq m_2$ should read $0 < m_2$. The second is the derivation of Sheppard's corrections on page 214, where the cumulants of G are expressed in terms of those for E and x as if E and x were independent, when in fact E determines x completely. The reviewer is unable to be sure of the meaning of "The fundamental probability set, written F.P.S. for short, will be just that set of individuals or units from which the probabilities are calculated" (p. 12) in view of the discussion on page 58. The only other place which seems likely to confuse the student is in the discussion of the "elementary probability law" of a continuous random variable, where a careless reader could conclude that $p(x')$ was "the probability that x takes the value x'." The author is definite on such points as replacing the binomial distribution by a continuous distribution with stepped densities, "Such an assumption is, of course, wholly fallacious, since the binomial probabilities are a discrete set of points, but it is a useful aid to memory if not pursued too tenaciously" (p. 53—more tenacity would have replaced npq by $npq + (1/2)$ with better approximation), the uselessness of the negative binomial, "It would appear wrong therefore to carry out calculations in which p and n are given negative values" (p. 65) and division by n or $n - 1$, "If a measure of the scatter in the sample is required then—(dividing by n)—must be calculated. If it is desired to estimate the population standard deviation then the expression—(dividing by $n - 1$)—may be calculated because in the long run it will be equal to σ" (p. 126). Two points need to be made in the last connection. First, if "in the long run" were well defined, the last statement would be wrong. Second, the reviewer, and, he believes, an increasing number of other statisticians, feel the time is coming soon to loosen the thrall of moments of inertia, and *always* divide by $n - 1$. References to further reading are given after each chapter. These could be slightly improved by giving dates (only 4 are given, including one on page 81) and by giving volume numbers in Arabic rather than in Roman numerals (after all, statisticians no longer do arithmetic in Roman Numerals). After mentioning a few of the things he likes, and all of those he doesn't, it behooves the reviewer to point out what he failed to find. To fill the two prominent gaps in a reasonable manner, Miss David would have had to recast her order of presentation and bring in cumulants (semi-invariants) long before the next-to-last-chapter. If this had been done, and k-statistics had been added, then Irwin and Kendall's (*Ann. Eug.* 12:138–142, 1944) powerful and simple methods of deriving sampling moments of sample moments from finite populations could have been used with a great gain in simplicity of presentation and in power of tools. (The experience of the early workers with heavy algebra and consequent errors points up the need for keen and powerful tools.) Second, the early introduction of cumulants would have made it possible to extend the present discussion of Lexis theory, which seems ineffective, into a presentation of the essentials of the analysis of variance *without normality assumptions* as developed by Pitman and Welch (*cf. Biometrika,* Vol. 29). This would have been a most important addition.

J Franklin Institute 248:183 Ag '49. F. R. Innes. * While it is quite plain that the justification of procedures used in statistical analysis must be based upon some conception of probability, very often this background is difficult to find or to determine. This book makes a valuable attempt to set down in a small space the ideas necessary to such a justification. * a number of informal but extremely lucid discussions of the fundamentals of probability * a valuable chapter on genetical application * physical applications are not mentioned. In the main, the author has confined himself to the traditional subject matter of the theory, without venturing into mathematical physics. The book

is noteworthy for the clarity and simplicity of its style. It might serve as an illuminating introduction to the study of the theory of probability.

Math R 10:613 O '49. J. Wolfowitz. * in spite of its name, this is a book on probability and statistics. The distinction between the theory of probability and the statistical theory of estimation is not made, and the general effect is such as to heighten the confusion in the mind of the reader. For example, on page 71 the author gives the proof of a perfectly innocuous result, usually known as Bayes' theorem, about whose validity there is no argument. She precedes this proof by the warning that "the modern point of view is that, strictly speaking, the theorem is wholly fallacious except under very restricted conditions." The reference here is obviously to statistical applications of the theorem. Again on page 72 she states that "unless....the prior probability of the event E_t is known, the formula cannot be valid (*sic*)." The validity of a formula can hardly depend upon knowledge of the particular values of the quantities which enter into it. The author is obviously very enthusiastic and devoted to her task. The examples are many, frequently original, lively, and interesting.

[84]

★DAVIES, GEORGE R., AND YODER, DALE. **Business Statistics, Second Edition.** New York: John Wiley & Sons, Inc., 1941. Pp. ix, 616. $4.50. (London: Chapman & Hall, Ltd. 36*s*.) *

For reviews of the first edition, see 38:B595 and 2:86.

[85]

★DAVIES, OWEN L., EDITOR. **Statistical Methods in Research and Production: With Special Reference to the Chemical Industry.** Published for the Imperial Chemical Industries, Ltd. Edinburgh, Scotland: Oliver & Boyd, Ltd., 1947. Pp. xi, 292. * For latest edition, see 86.

Analyst 73:53 Ja '48. Eric C. Wood. * excellent book * Lord McGowan has written a foreword which refers to the present work as the first of a series to be published by I.C.I. "with the aim of making generally available the important body of information accumulated as a result of the Company's manufacturing experience and research." (The whole of this foreword, by the way, deserves careful consideration and wide publicity; as a statement of a wise policy and an enlightened outlook it is, shall we say, highly significant.) Should the I.C.I. be as fortunate in the authors of subsequent publications as they have been in this one, a heavy debt of gratitude will be owing to them from both industrial and general members of the chemical profession. * The computations are very clearly set out, and the authors have recognised the importance of discussing the circumstances in which each method is or is not applicable and the interpretation of the results obtained. There is a very readable glossary, a list of symbols and their meanings, some of the more commonly required tables and an adequate index. The whole book is eminently practical and workmanlike and is almost free from printers' errors. The authors, in inviting criticisms and suggestions, foreshadow the writing of a sequel on the Planning of Experiments; the present book hardly refers at all to the value of the statistician *before* an experiment is begun. The more fundamental part of the chapter on Sampling could well be expanded, the concepts of "randomness" and "representative sampling" being developed from a wider viewpoint, and inserted before Chapter 4. Conclusions are all too often drawn from differences between the means of samples which differ in other respects besides the factor the effect of changes in which is being examined. Something should be said, perhaps in Chapter 6, about transformations of variates and the reasons for using them. An instance occurs on p. 193; ranking data can be normalised by the transformation given in Table XX of Fisher and Yates's well-known book, and are best so treated. There is room for mention, at or about p. 93, of the occasional necessity for testing the main fractions in an analysis of variance against appropriate interactions rather than against the error variance itself. But the fact remains that this is a book that ought certainly to be acquired by all whose work involves the drawing of conclusions from numerical data—and probably by many others as well.

Brit Med J 4572:389 Ag 21 '48. A. Bradford Hill. * the company hopes that these publications will be of particular help to industrialists and technicians in industry, this book should certainly be more widely useful than that * many research workers with other interests will undoubtedly find it of assistance in learning and applying statistical techniques to any type of data, particularly, it would be fair to add, those who either already have some grounding in statistical theory and methodology or are not perturbed by algebraical symbols. The arith-

metician will be aided by the numerous examples that are fully worked out (and upon which—an essential step—he can practise), but much of the discussion and the approach to the arithmetical processes are centered around mathematical expressions. * the authors have taken great pains over the setting of their text, arithmetical examples, and algebra, and in these austere days it is a pleasure to handle a book so beautifully produced.

Chem & Eng News 26:126 Ja 12 '48. James R. West. * The treatment is that of a handbook, but the statistical concepts are presented so clearly that little or no previous knowledge of the subject is needed in order to make use of the contents. The "practical" mathematical background predominates. * The term "moment" with applications has been ignored and there seems to be no definition of probability. The reviewer feels that quality control and control charts and their use are covered inadequately. The knotty problems which arise in the actual industrial use of production and process control are given scant recognition. The book is well written and is worth-while reading for the technical person with no formal training in statistical methods. * The table of nomenclature and a discussion of the typesetting of mathematical expressions are....of value. The editor should be commended for his careful selection and presentation of unambiguous nomenclature.

Endeavour 8:148 Jl '49. D. J. Finney. * an important addition to....elementary statistical texts * The classification of types of regression equation does not seem entirely satisfactory, and the discussion of their errors may increase rather than decrease confusion. An excellent chapter on sampling is marred by description of both stratified random and systematic sampling as *representative sampling,* so obscuring important distinctions in error estimation. These are minor blemishes, however, on a work notable for systematic development, clarity of exposition, and detail of instruction.

J Am Stat Assn 43:318–20 Je '48. D. B. DeLury and A. E. R. Westman. * much careful and thoughtful explanation accompanies each example * Each chapter starts with a general description of the questions with which it deals, followed by examples based on data (usually drawn from the chemical industry) which are intended to illustrate the type of situation with which the chapter deals. The discussion of the examples is not obscured by arithmetical details; systematic methods of computation are dealt with in chapter appendices. This plan is, no doubt, effective, but starting as it does with the data rather than with the *gathering* of the data it tends to cover up the importance of statistical considerations in the planning of the experiment. Perhaps each chapter should include an example in which statistical techniques can extract no worth-while information from the data! Those who are interested chiefly in practical applications will find much useful information gathered together in this handbook. On the whole it is clearly presented and illustrated by good examples. The reader who has a knowledge of theoretical statistics will doubtless find many points on which he does not agree with the authors and others may find some of the discussions confusing. Certainly the quality of the book is uneven with respect to both clarity of exposition and accuracy of statement. While many of the discussions and explanations are excellent, others are obscure, sometimes inaccurate and occasionally meaningless. * Owing, perhaps, to reluctance of the authors to expand the book to greater length, some topics are treated too briefly. Only one model for the analysis of variance is explained, that in which differences among cell averages are regarded as arising entirely from random sources. The case of "fixed effects" is not discussed, although these methods are used to exhibit, for example, differences among three "gaugers," who could hardly be considered a randomly chosen sample from a population of gaugers, in a test of the compressive strength of Portland cement (Example 5.5), and the difference between two operators who carried out simultaneous determinations of the percentage of ammonia in a plant gas (Appendix 4B). The chapter on regression suffers considerably from the failure to discuss the underlying statistical model. The conditional nature of the regression problem never emerges. Instead, there is created a hierarchy of regression problems, the two extremes of which are, apparently, (*i*) the case in which the quantities observed are inherently variable, in a statistical sense; (*ii*) the case in which the quantities observed are not statistical variables; the only random variation in this case comes from errors of measurement. This is described as the case in which the variables are related by an exact mathematical formula. The choice of examples to typify these two extremes is unfortunate. Case (*i*) is discussed in terms of the

relationship between hardness and abrasion loss in rubber. The observations on these two variables are made on samples of rubber in which the amounts and types of ingredients are deliberately changed from one sample to another, a situation which would seem to require the use of multiple regression methods. Case (*ii*) is illustrated by the dependence on concentration of the response to a penicillin solution. It may be granted that the concentrations are known without appreciable error, but the variations in response represent genuine biological variation and it is difficult to envisage an "exact" relationship between response and concentration. In any case, the differences between these two cases largely disappear when the true nature of regression is recognized. The distinction between these types is maintained throughout, culminating in two different formulae for the standard error of a prediction based on a regression equation (Formulae 6.3 and 6.31). It is not clear what is being predicted, a mean value or the value of a future observation, but whichever is intended, the same formula (6.3 *or* 6.31) should apply in both case (*i*) and case (*ii*). More serious is the failure to bring together regression methods and the analysis of variance, so as to present the elements of the analysis of covariance, a technique second in importance only to the analysis of variance in all fields of experimentation. Inevitably a few slips must creep into every book. The following may be noted. (1) The F test is introduced in a comparison of variance estimates from two independent samples, a situation in which a two-tail test usually is indicated. However, the test employed is one-tailed (Example 4.51). (2) Throughout the discussion of the errors of prediction which result from the errors of the regression coefficients (p. 130), a should be replaced by $\bar{y}$. Readers interested in control chart techniques will find a clearly written chapter on the subject based on British Standard practice. However, only the charts for average and range are discussed in detail and the unfortunate impression is given by some parts of the discussion and by the numerical example that a subgroup of four or five is necessarily "rational." In the chapters concerned with other techniques, not much attention is paid to the quality control approach to industrial problems and readers familiar with developments in America will consider the following statement on page 4 of the Introduction to be overcautious: "Its application in the wider field of the chemical industry is still a matter of some doubt, but in view of its striking success in other fields, it is felt that the possibility of its application to chemical plants should receive careful consideration." The book, as it stands, should be most useful to the industrial investigator. The intention of the authors, stated in the preface, to keep the handbook up to date, will furnish an opportunity for the critical editorial overhauling which is needed to bring this work to a uniformly high level of excellence. A sequel on the planning of experiments is contemplated. The typography is exceptionally good. Misprints are rare and unimportant.

J Am Stat Assn 43:320–1 Je '48. E. L. Lehmann. Authors of any book such as the present manual who, without assuming any previous statistical knowledge on the part of their readers, want to give an introduction to intelligent use of statistical methods are concerned with three different aspects of statistics. (*a*) They must explain the basic concepts such as probability, expectation, statistical hypothesis, power of a test, confidence intervals, *etc.* (*b*) They must describe the most important statistical procedures, state the conditions under which these procedures are known to be valid, and discuss some of the computational problems that arise. (*c*) They must illustrate the methods with representative examples from the field of application with which they are concerned. In the present volume, as in most other books of this kind, (*b*) and (*c*) are emphasized at the expense of (*a*) and even in the discussion of particular procedures the underlying assumptions are frequently indicated only rather vaguely. This seems regrettable since, as Professor Wolfowitz pointed out in a recent review in this *Journal* (41:127–8 Mr '46), "misapplication of statistical methods is more likely to be serious than the use of inefficient computing techniques." In the discussion of hypothesis testing, for example, no mention is made of possible alternatives or, therefore, of power. As a result the assumptions underlying a test are never quite clear. For instance, when the authors explain their recommendation of a two-tailed F-test in analysis of variance, the class of alternatives which they have in mind seems to change during the discussion. * There is a somewhat incomplete glossary of statistical terms and an unusually comprehensive collection of tables * A nice feature of the book is that the methods are illustrated throughout with

many interesting examples from the chemical industry. * It would perhaps be useful also to include some nonparametric methods [in a later edition].

J Inst Actuaries 74:163–4 pt 1 '48. N. L. J(ohnson). * the authors have surmounted most of their difficulties with considerable skill * the result of their work should prove of much value to those whom it is intended to aid * Preciseness of statement is not to be expected, nor indeed is it always desirable, in a book such as this. There are, however, occasions where lack of precision in wording can be misleading, and a few such cases do occur in the work under review. We may instance the statement on p. 28 that $V \Sigma(x - \bar{x})^2/(N - 1)$ gives the best estimate of the universe variance from the data available. It is unfortunate, also, that the old confusion in the definition of the F-ratio should appear once again. On p. 60, F is defined as the ratio of the *greater to the smaller* variance (authors' italics): on p. 179 it is stated that, if the degrees of freedom in F are ϕ_1 and ∞, then F is χ^2 (with ϕ_1 degrees of freedom) divided by ϕ_1. According to the definition on p. 60, F cannot be less than unity, yet χ^2/ϕ_1 clearly can take values less than unity. The paradox is resolved when it is realized that the F-distribution on which the tables are based applies to the ratio of two variances, without condition as to which is the greater. Some alteration of either the definition of F or the description of its use should lead to a clearer appreciation of the position. Certain praiseworthy features of the book must be mentioned. The first is the care with which the effect of departures from normality is described, a distinction being made between cases where such departure is critical and where it has but a minor importance. Closely allied to this is the authors' advocacy of the use of the Camp-Meidell and similar inequalities to draw conclusions which would apply over a wide variety of shapes of distribution. It is not clearly brought out, however, that these inequalities do not apply to one-sided deviations from the mean so effectively as they do to deviations without regard to sign. The chapter on sampling is an admirable treatment of the subject. It is, of course, strongly biased towards sampling problems arising in the chemical industry. Finally, the authors have made a most interesting, and, in the opinion of the reviewer, largely successful, attempt to construct a systematic notation for statistical theory. Actuaries have long been aware of the value of a rational, universally accepted notation, and in their international notation they have an instrument to be envied. It is to be hoped that the present book may be a first step to a similar happy state of affairs in statistical theory. It is especially pleasing that the notation, summarized at the end of the book, is in general harmony with statistical tradition. Only the use of ϕ for degrees of freedom and gothic type for the binomial "p" and "q" can be regarded as innovations.

J Inst Actuaries Students' Soc 7:255–8 Ap '48. L. S(olomon). * one need not be a chemist to appreciate and profit from this very useful handbook * As a handbook the work is described, and a handbook it undoubtedly is, with all the solid merits and some of the defects of those merits, of this form of literature. It is concise; in the main clear; in tone didactic and authoritarian. The alterations in style, the occasional repetition, and the still more occasional mild contradiction merely exemplify the usual risks inherent in a work of joint authorship by seven writers, and are unlikely to worry the student. The captious might, however, grumble at the lack of explanation and proof of fundamentals. Some basic matters are discussed, and discussed well. Mathematical justification is provided here and there; but, some might feel, this occurs only with a frequency necessary to lull the critical faculty when it was about to become restive. But this—one admits it willingly—is less of a criticism of the particular work under review than a comment on the *genus* "handbook." * two chapters deal with.... Frequency Distributions, and Averages and Measures of Dispersion * Certain of the concepts which arise from these topics are not rigorously defined, and there is accordingly a danger that a reader new to the subject will accept them in their everyday, rather than in their technical, sense. A "best" estimate, and statistical independence, are among these concepts. The interest quickens in Chapter 4, which deals with Tests of Significance, and which contains an admirable introduction thereto. The t-criterion, which serves as a test of the "significance of a mean," and the F-criterion which tests whether two independent estimates of the variance of a normal population are mutually compatible, are described and exemplified. Unfortunately, if inevitably in such a handbook,

the reader is instructed—no nonsense about convincing him—that these are the correct instruments to use in given circumstances. The questions whether other tests might be invoked and in what sense those described are the best, are not touched upon; nor is the derivation of their sampling distributions even broached. The next chapter, on the Analysis of Variance, continues the theme of tests of significance. It deals clearly and fully with the technique of the analysis of variance of data with one and with two criteria of classification. The corresponding analysis of data with three such criteria is also discussed, more summarily. Next, in Chapter 6, the subject of Regression and Correlation is taken up, with a commendable account of the errors involved when a regression equation is used for purposes of prediction. Frequency data and Contingency Tables form the subject-matter of Chapter 7. The use of the χ^2-test, as a measure of the divergence between a set of observed frequencies and a corresponding set of expected frequencies, is explained; but the precise relation between χ^2, the sum of the squares of a number of observations from a normal distribution with zero mean and unit variance, and χ^2, the measure of disparity between observed and expected frequencies in a contingency table, may well elude the beginner who reads this chapter. In compensation, perhaps, for this weakness, and for some similar instances of lack of clarity, the treatment of the 2×2 contingency table and of the "exact" test of independence associated therewith, is particularly good. The remaining three chapters, unlike those preceding which deal with general statistical methods, are much more intimately concerned with essentially chemical or engineering problems. They are concerned respectively with Sampling—the means whereby a random or a representative sample can be drawn from a solid, liquid, or gas, and the estimation of the size of sample required to assess statistically whether some general conclusions regarding the universe may be drawn; with Control Charts, and the use of quality control in manufacturing processes; and, briefly, with Prediction and Specification. These chapters provide a commentary, rather than a full discussion, on the subjects in question. This feature, combined with the mixture of theoretical argument with practical "wrinkle" in the text, might perhaps recall to some actuarial readers the "Lessons" of the Actuarial Tuition Service. * the Central Limit Theorem, in view of its major importance is introduced much too casually. Again, the reader is in Chapter 3 rightly given to understand that this theorem is theoretically valid; yet farther on, on page 55, he will read that it rests merely on experimental evidence. Skew distributions, we are told in passing, should be normalized by a suitable transformation of the variate. Good—but why not give an example of a skew distribution, an explanation of how an appropriate transformation would be found in practice, and an illustration of the amenability to such treatment of some actual data? Furthermore, is it true that an exact transformation exists which would normalize *any* distribution? On the analysis of variance, we read, on page 90, that if no independent estimate of the random error is available, "it is usual *and valid* to use the interaction variance as error variance." Such a practice may be usual in chemical work. Its validity is another question, and would hold only if there were good—non-statistical—grounds for assuming the absence of interaction effects. Again, the example on accident rates in Chapter 7, though sound, may not read clearly, because of the somewhat obscure logical connexion between its mode of solution and the ideas developed in the immediately preceding pages. And why, the reader may well wonder, should the binomial distribution approximate to the normal? He is told that this is so, but as elsewhere throughout this book, the justification of the statement is omitted. Such flaws diminish the value of the work, but none of them is major. Let that serve as a measure of the general merit of *Statistical Methods in Research and Production*. This book, one conjectures, will be used by many chemists, engineers and physicists who wish to increase their statistical knowledge. *

J Royal Stat Soc 110:266–7 pt 3 '47. S(tefan) V(ajda). * workers in other lines [than chemistry] will also benefit from a study of this book. It can be recommended to those wanting to become acquainted with statistical methods, without spending much time on the mathematics which justify any particular technique. * On the whole....the line has been drawn with sound judgment. The following extreme examples are meant as illustration rather than as criticism of the presentation. The method of least squares in connection with straight line regression is explained (App. 6A, pp. 146 *seq.*) in such detail that the most pedantic reader will

be satisfied. On the other hand, App. 5L (pp. 116 *seq.*) dealing with the estimation of a missing value gives, quite correctly, Yates's formulae, but without a hint as to their reason. We do not understand why, in the case of more missing values, there should be "no 'exact' formula for estimating them" (p. 117), but we agree that in such cases "a statistician should be consulted," which phrase appears in other places as well and circumscribes the scope of the book. The Analysis of Variance with proportionate frequencies in subclasses is again dealt with by rule of thumb, and it is impossible that a reader should guess that there are some subtle points of interpretation involved. * [the] introductory chapter....[refers] rather frequently to later pages (which is, perhaps, unavoidable in a book of this origin) * A chapter on Tests of Significance precedes the treatment of Analysis of Variance (using examples from chemistry, not from agriculture) and of Regression and Correlation. The reviewer, at any rate, fully agrees with the readable account of their respective merits, and he does not regret the omission of correlation indices. * The next chapter is on Frequency Data and Contingency Tables, followed by chapters on Sampling and on Control Charts. They may be necessary, but they could be improved....with less traces of haste left. * (Credit for the so-called "Camp-Meidell"-inequality should, incidentally, be given to C. F. Gauss). An account of the logic of statistical inference, in particular that of estimation, might usefully be added. Even in normal times this book would be called well produced. * Where appropriate the tables are followed by neat graphs showing clearly which areas are given in the respective tables. Other graphs are printed in the main text, but are not entirely satisfactory. * At the end of chapters, References are given. * There exist accounts of the Analysis of Variance with disproportionate subclass numbers which are more readily available in this country than Snedecor and Cox's Iowa Research Bulletin (p. 96), and it is surprising that Snedecor is not mentioned elsewhere. Neyman is only mentioned once, as the co-author of the (unexplained) L_1-test, to which "the Bartlett test is to be preferred." The Behrens test is mentioned without a hint as to the niceties of its interpretation, let alone the doubts about its legitimacy. * Barnard's paper in the *Suppl. J.R.S.S.* on Sequential Analysis is, justly, mentioned, but Wald's work on the same subject seems to have been unknown to the authors. * We do not doubt that the present publication will contribute to spreading sound statistical knowledge and contribute to its taking its place among other useful arts.

J Scientific Instruments 25:61 F '48. * Students of statistics will find the book an invaluable complement to their theoretical studies because it is based on actual problems met with in industry. *

Math Gazette 33:69–70 F '49. F. Sandon. * If the rest of the series maintains the standard of this handbook the I.C.I. will considerably, as Lord McGowan says, "comunicate to our partners in the nation's industry some of the results of our past study and experience." * The treatment is clear and sound, the references, development and examples admirable: only occasionally is there a slight obscurity in the text. Although in some places the writers suggest that for guidance in particularly difficult problems a statistician should be consulted, yet many a statistician will find that he can learn quite a lot from this handbook. There are some interesting original examples. Thus, there is a cubic regression to fit neatly data from a test of paper pulp, a Poisson distribution on the number of particles seen in a flashlit limited field of dusty gas, and a good example on rubber abrasion wherein hardness accounts for 54 per cent. of the abrasion loss, tensile strength for 9 per cent. of the loss, but hardness and tensile strength together for 84 per cent. Our criticisms are few. The book is intended for scientists who will know all about Petri dishes, tensile strength and piston-ring failures in compressors. But for others who have forgotten their chemistry it would have been a help to have had given the derivation of the equation for the oxidation efficiency at the bottom of p. 44, whilst non-physicists would no doubt welcome the justification for the transition from abrasion loss in c.c. per h.p. hour of the graph on p. 118, to the abrasion loss in grams per h.p. hour of the table on p. 119. The chapters on quality control are, perhaps, not so good as the others (though there is a suggestion on p. 215 that this procedure has not, in the chemical industry, as many applications as it has elsewhere), whilst the Glossary is not very well arranged: cross-references, in particular, are weak. On the other hand, the treatment of degrees of freedom, the assumptions about Null Hypothesis, the worked examples for Analysis

of Variance ("probably the most powerful test in statistics"—p. 72), and the explanations on random, representative and systematic sampling, are particularly good. The book....includes a Nomogram for Probability Levels that has not, to our knowledge, appeared elsewhere. There is a good six-page index. Altogether the I.C.I. must be thanked for this book and the contributors congratulated: it is a valuable handbook not merely for chemical engineers but also for many others.

Philos Mag 38:608 Ag '47. J. H. A(wbery). This most interesting book....lies comfortably between the text-book....and the formulary * It gives less demonstration of the truth of its assertions than the former, and a great deal more by way of example and explanation than the latter. In so doing, it meets very successfully indeed the need which is often felt by technical men in industry and elsewhere for an explanation of how they can apply statistical treatment to their everyday problems, and it does something more—it warns them quite explicitly of many of the more complicated matters on which they would be wiser to consult a professional statistician. * The reader may place full reliance on all this material, coming as it does from qualified men who have themselves served industry for some years. The subject of quality control receives its due measure of attention, and a reasoned appraisal of its value, but in fact its use calls for little special equipment or knowledge, so that it occupies here less space than might have been expected from its prominence in general literature in recent years. *

Plant Breeding Abstracts 18:393–4 Ap 1 '48. N. T. J. B(ailey). * While elaborate theoretical considerations would certainly be out of place in a book of this type it is important that false ideas should not be allowed to establish themselves in the mind of the experimenter by the unqualified assertion of general theorems which are not in fact universally valid. For instance, on page 25 we have: "The arithmetic mean as defined in equation (3.1) is the arithmetic mean of a sample of N, but if these N observations constitute all the information available, $\bar{x}$ is also the best estimate of μ, the Universe mean, assuming the sample is a random one. As N increases, $\bar{x}$ becomes a more and more precise estimate of μ." And on page 35 we find: "A further result of importance in connection with the sampling distribution of the mean is that, whatever the nature of the parent Universe, the distribution of sample means tends rapidly to the Normal form as the sample size increases." Although the three statements in these two passages are often true in practice, it would be dangerous to assume that this is always so, and in the case of the Cauchy distribution, for instance, all three are false. The treatment of significance tests is by no means lucid. For example, section (*b*) at the bottom of page 52 describes, quite correctly, how one calculates the probability that a statistic will have the observed or more extreme values. But in the following paragraph (*c*) the true logical situation is confused * It is important to realize that, as correctly stated in (*b*), we calculate the probability that the statistic will have the observed *or more extreme values,* and not merely the observed value. * A serious omission is the failure to provide an adequate discussion of the problem of estimation. Indeed the efficiency of estimation is referred to only in the glossary, and the method of maximum likelihood is not mentioned at all. It is most important, in all fields of research, for the practical statistician not only to be familiar with methods of estimation but to realize that the use of "inefficient" methods can be positively misleading. It is to be hoped that subsequent editions will make good this deficiency.

Sci 107:657–8 Je 18 '48. John Mandel. * Many chemists who, through the particular nature of their work, have felt, at one time or another, the advisability of becoming acquainted with statistical methods may have been repulsed by the inadequacy, from their viewpoint, of the available books in this field. This certainly is regrettable, inasmuch as statistical thinking and the use of statistical methods should contribute materially to rendering more objective and efficient the experiments of those engaged in chemical research and production. The present book, at last, is a readable presentation, from the chemist's point of view, of the fundamental principles and methods required for the successful application of statistics to the chemical field. In fact, any person with a background in any quantitative phase of science and with only high school mathematics is likely to have his interest in statistics aroused by the reading of this book. Unlike many books on statistics, it does not contain a series of antiquated, erroneous, or useless concepts and introduces only such definitions and explanations as are used and illustrated in later chapters. Computational

methods are duly emphasized and amply illustrated by means of numerical examples worked out in detail. * the outstanding chapters are those on "Analysis of Variance" and "Regression and Correlation"—especially the latter, in which linear regression is treated in a modern and practical fashion. Two types of regression are covered in detail. Perhaps the choice of the titles "Rubber Testing Type Regression" and "Penicillin Type Regression" to denote these two types is not a fortunate one. It seems reasonable to expect that such fundamental concepts not be made dependent on casual applications. This chapter has, as another laudable feature, a clear exposition of the treatment of regression by means of the methods of variance analysis. The statistically trained reader may find that many of the topics mentioned in this book are treated in a somewhat sketchy manner. One could not expect, however, that all statistical methods useful to the chemist or the engineer would be exhaustively covered in less than 300 pages of text. Nevertheless, this reviewer believes that the inclusion of an introductory chapter on the principles of statistical design would have enhanced the value of the book, inasmuch as it would have shown the chemical reader the intimate relationship between the statistical design of an experiment and the statistical interpretation of its outcome. One therefore looks hopefully forward to the appearance of the second volume announced by the editor.

Sci Progress 36:185–6 Ja '48. L. H. C. Tippett). [Not excerpted because of copyright restrictions.]

Times Ed Sup 1691:510 S 27 '47. * It is.... gratifying that Imperial Chemical Industries, Limited, have decided to publish for the benefit of all who can profit by it a reference book on *Statistical Methods in Research and Production* which was prepared primarily for the use of servants of the company. * The sections on Degrees of Freedom and Levels of Significance are particularly helpful. While it is disappointing to find that consideration of newer techniques, such as sequential sampling, is deferred until a later edition, the notes on the sampling of liquids, gases, solids, magmas and continuous flow processes should arouse a more general statistical interest in the special problems of the chemical industry. * Since this is one of the few books on applied statistics which deals with a field not related to biology or economics it will be welcomed by teachers as a fresh source of examples and ideas. The student of statistical method will find it a useful companion to any general textbook. The appearance of this book is evidence of the growing importance of statistical methods in industry; those who advocate that room should be found for statistics in school and university science curricula here find additional material for their arguments.

Trans Faraday Soc 44:438–9 Je '48. D. M. N. * The authors have performed their task with judgement and discretion. * The book is well planned and the examples are carefully chosen from a wide range of practical problems. * The treatment, on the whole, is clear and concise and, in particular, the chapters on Sampling and on Control Charts are of outstanding interest. * The mechanical technique of sampling is not dealt with, but the examples chosen to illustrate the various methods also serve to emphasize some of the precautions which have to be observed to avoid systematic errors. * Although....[the use of control charts] has been widely used in light engineering work, its application to chemical processes is relatively new; it has, nevertheless, already proved of value in a number of investigations in bringing to light significant variations, which would normally be overlooked An instructive example is worked out in detail, in Appendix 9A, and illustrates the use of the charts in a research investigation, the setting and hardening properties of a plaster. * We cannot conclude without a word of appreciation of the enlightened policy, which has placed at the disposal of scientists generally the unique experience of a large organisation in the field of chemical technology.

[86]

★DAVIES, OWEN L., EDITOR. **Statistical Methods in Research and Production: With Special Reference to the Chemical Industry, Second Edition.** Published for the Imperial Chemical Industries, Ltd. Edinburgh 1, Scotland: Oliver & Boyd, Ltd., 1949. Pp. xii, 292. 28*s*. * (New York: Hafner Publishing Co. $6.50) [Pagination same as in first edition. "Important changes....include rewriting §§4.5 and 4.51 (Variance Ratio), the latter part of Appendix 5L (Missing Values), and the last paragraph of §8.61 (Random [illegible] and the insertion of a new Appendix ([illegible] and Double-Tailed Tests). Minor changes include attention to printers' errors, occasional improvements in wording, and additions to the lists of references. The tables at the end of the volume have been independently checked * "—Preface to the Second Edition.]

Chem & Eng News 27:2502 Ag 29 '49. Henry Eyring. * An excellent glossary of terms followed by a large collection of mathematical

tables make the book easy to use. * This book with its numerous worked examples should be invaluable to the beginner. *

For reviews of the first edition, see 85.

[87]

★DAVIS, HAROLD T. **The Analysis of Economic Time Series.** Bloomington, Ind.. Principia Press, Inc., 1941. Pp. xv, 620. $5.00 (London: Williams & Norgate, Ltd. 32*s.* 6*d.*) *

Am Econ R 33:399–401 Je '43. Leonid Hurwicz. Recent progress in economics has been largely due to the recognition of the importance of two factors hitherto ignored or underrated. First, *time* did not become a variable in the economic model until rather recently when the "dynamic" approach gained popularity and influence. Second, the role played by *uncertainty and random factors* which gave rise to what is often called "stochastic" economics is recognized; earlier, the existence of those factors, while not denied, was not regarded as affecting theory or empirical work to any important extent. By now it is commonly realized that economics will not achieve its objectives until most of it has been put on a stochastic and dynamic basis. For among these objectives are to be found: the explanation of business cycles and dynamic phenomena in which the random disturbances (innovations, discoveries) are said to play a crucial part; prediction of the cyclical fluctuations; extrapolation of trends; estimation of future (or hypothetical) tax yields, *etc.* Unfortunately, the methods of empirical investigation of these problems have scarcely been developed. The ordinary statistical techniques which were created primarily for use of scientists in other applied fields usually require a theoretical model which is totally unacceptable to the modern economist. Therefore, a paradoxical situation arises: after the majority of economists have been convinced that they must analyze and interpret reality on a dynamic and stochastic basis, they are told that the customary statistical techniques are not applicable to time series and that there are no good substitutes available. Of course, economic time series have been analyzed repeatedly. The periodogram methods, as applied by Crum and others, have often served as a basis for "proving" and "refuting" the existence of various cycles. Other more modest attempts were made merely to try out certain techniques (*e.g.,* correllogram), as in Wold's *Study in the Analysis of Stationary Time Series,* but there have always been doubts with regard to the validity of these procedures. While scattered papers and discussions of specific problems were not lacking, there was no source from which the proper perspective in economic time series problems could be gained. Not only beginners but even experienced scientists were unaware of progress made in various fields. Professor Davis's book would have been a great contribution to our knowledge if it had merely given a systematic treatment of the available literature and techniques. However, *The Analysis of Economic Time Series* does more than that. It puts emphasis on the most essential aspects of the theory of time series; it opens new perspectives in the field of significance tests (chap. 5, "Degrees of Freedom in Economic Time Series"); it also contains a wealth of applications, especially in the chapter on periodogram analysis. * Undoubtedly many of Professor Davis's views would be contested by a number of economists; in particular, the rôle attributed to Pareto's law of income distribution may be regarded as somewhat exaggerated. Of importance, however, is the logical structure of the author's argument. He sets up a certain hypothesis (that Pareto's law holds) on the basis of explicitly stated theoretical assumptions (see p. 412, "Theoretical Derivation of the Distribution Function"). The section on "Statistical Verification" is then directly based on that hypothesis. Whether one will actually agree with the conclusion that the empirical data verify the hypothesis is of secondary importance, but it is to be regarded as a great step forward that the statistical work should be directly related to the stochastic model on which it is based, as is the case here. The ideal situation, of course, would be if the hypothesis could be tested by means of one of the modern techniques initiated by Neyman and Pearson. This, however, might present considerable difficulties. The section on business cycles is perhaps of greatest interest. It comes at a time when a decade of discussion has yielded a fairly satisfactory theoretical approach to the problem of explaining the "why" of the business cycle. Even though there is a tremendous amount of statistical data concerning the cyclical fluctuations, no systematic attempt has ever been made to examine these data in the light of recent developments in the statistical techniques and theory, so as to corroborate or refute alternative explanations of the business cycle phenomena. Thus, only

theories which can be shown to be internally inconsistent can be seriously rejected at the present moment. Davis's work is one of the major steps forward in the direction of relating empirical evidence to existing theories. His restraint in stating the conclusions concerning theoretical evidence for the existence of various cycles (p. 384) is very praiseworthy. Later on, however, in analyzing the empirical data (chap. 12, "Interpretation and Critique") Professor Davis resorts to methods which the reviewer feels deserve a certain amount of skepticism. For instance, the evidence for the 40-month cycle is mostly derived from the periodogram analysis, though the distribution of the length of the cycle is also considered. The periodogram method is not likely to give correct results in series which are subject to irregular phase shifts as is the case in business cycles. The correllogram method and the method of "harmonic dial" (developed by Bartels) would seem to be more appropriate. A word of comment might not be out of place on Professor Davis's discussion of the 50-year war cycle. It would appear rather risky to state that "the intensity of a war may be measured by this increase in prices" (p. 553). One wonders whether it is not premature to attempt a statistical analysis of a phenomenon where the "random disturbances" are so powerful as to overshadow the "systematic component." *The Analysis of Economic Time Series* is not merely a textbook and therefore contains a number of controversial statements and theories, but in the reviewer's opinion, it can be used as a textbook and a very stimulating one at that, provided a certain level of scientific maturity can be assumed on the part of the students.

Ann Am Acad Pol & Social Sci 221:219–21 My '42. Harold Hotelling. In addition to the problems of statistics in general, time series present many special questions. To meet the peculiar problems of observations ordered in time, whether these be of economic, biological, astronomical, or meteorological character, a great variety of statistical methods have been devised, chiefly by persons who knew little about the general theory of statistics but were faced by a burning desire to draw inferences from observations of some particular kind. These varied methods, some good, some bad, have been described in articles scattered through journals dealing with all sorts of subjects, and several distinct literatures have grown up, largely independent of one another, without the benefit of mutual criticism and articulation with more fundamental considerations common to all of them. It is therefore a distinct service to have brought together in one volume a great part of the statistical methods that have been applied to time series. The impressive volume by Professor Davis does this, and much more. It is concerned not only with the technique of analysis but also with the results of actual analyses of many historical series, and further, with the construction of an economic-historical-political cosmogony based on the statistical findings. This is an argument of almost Miltonian dimensions, soaring far above the Aonian mount on the multi-cylinder engine of harmonic analysis while it pursues a synthesis of history and economics by a combination of higher mathematics, historical references, and imaginative speculation unattempted hitherto by gods or men. * The first chapter provides an excellent introduction to problems of economic time series. In the succeeding methodological chapters there is special emphasis on periodogram analysis, with a very convenient condensed account of the contributions of Schuster, Walker, R. A. Fisher, Wiener, and others in this field. A much-needed table of the Fisher periodogram probability, as well as of the Walker function, covers forty pages. It may be appropriate to mention here the work of Daisy Starkey published in Vol. X of the *Annals of Mathematical Statistics,* no doubt after these chapters were written. There is an illuminating and substantial discussion of serial correlation analysis, a most important subject. The accumulation of random shocks and the sinusoidal limit law are highly interesting. Occasionally bad methods are included with good ones without sufficient discrimination. Nowhere do we find any statistical method explicitly condemned, though the quality of much current practice is such that charity is here out of place. Thus the link relative method for seasonal variation, and formulae for correlating deviations from trends of different orders, are presented at some length without the appropriate caution that they ought never under any circumstances to be used. Seasonal variation might well be treated by a variant of the harmonic analysis used for other purposes so effectively in this book. Excellent results in the study of cycles are reached through regression equations for the second differences in terms of the variate

itself. A really amazing feat is the explanation of the series of 40-month cycles following 1914, the stock market boom, and the collapse of 1929, all by means of one simple differential equation of second order. The fundamental idea here is resonance arising from the interaction of an impressed period of 41 months with a natural period of 48 months. The mathematical methods expounded in the first part of the book are applied in later chapters to numerous economic series and to some others, such as those concerning sunspots, which have been thought to have a bearing on economic fluctuations. The search for cycles and their explanation is the chief motif. There are, however, several others. Among these are some to which many readers will take strong exception. In this class is at least one matter which, because of its current importance for international politics, cannot be passed over. A good many observations are quoted from Pareto, or obtained elsewhere, to show that always and everywhere there is a tendency for the distribution of wealth to have a certain exponential form which makes the curve appear as a straight line on doubly logarithmic paper. This Pareto law does not fit at all well the upper and lower parts of the curve, and the significance of its fit near the middle may be questioned. However, it receives a certain support based on the distribution of abilities as measured by scores at billiards, numbers of papers published by chemists, and salaries of General Motors executives. On this basis the fatalistic position is taken that the Pareto law is one of those inviolable fundamentals with which men must not meddle. It is pointed out that deviations from it have been followed by the most catastrophic upheavals, such as the French and Russian Revolutions. The Spanish Civil War and the fall of France are ascribed to the meddling of socialistically inclined governments which sought to equalize wealth in violation of Pareto's law. The German conquest of the Maginot line is laid to lack of unity in the French Government and inefficiency in French industry, resulting from equalitarian deviations from the sacred Pareto law. Another mathematical statistician, considering the same facts, might take quite a different view. Lack of unity in France, as in this country, arose because a democratic people tolerated men of antidemocratic sympathies in high places. The tragedy of Spain resulted from the apathy of democratic countries with undemocratically inclined governments, in contrast with the military aggressiveness of fascist invaders who used as a spearhead the reactionaries whom the tolerant Spanish Republic had allowed to retain places of military, economic, and ecclesiastical power. The world must be saved from ruin, not by blindly allowing the wealthy to retain the position of pre-eminence which they have enjoyed in many times and places in the past, even if a particular kind of distribution curve should be found to describe this pre-eminence better than the Pareto curve fits the actual facts, but by ejecting from places of military, economic, and political power the fascist-minded, antidemocratic reactionaries who have so often been found at these key points. President Conant of Harvard has called for the development of "roving scholars" whose competence and activities should not be confined by traditional departmental limits. Mathematical statisticians perhaps approximate more closely than anyone else the ideal roving scholar who dips into all sorts of things hitherto considered separate and distinct. This remarkable book deserves attention for many reasons, of which one is the fact that it displays the work of a brilliant scholar whose roving has carried him into more fields than even H. G. Wells ever reached, but who has managed to establish connections among these many diverse territories.

B Am Math Soc 48:338–42 My '42. Gerhard Tintner. * The whole mathematical profession and especially its statistical branch is indebted to Professor H. T. Davis, who has in this monumental volume assembled and lucidly interpreted a great number of the recent developments in the interesting, if somewhat puzzling, field of the study and analysis of economic time series. It also contains many of his own very important contributions. I feel certain that this book is destined to exert a deep influence upon the future development of the field. It also will stimulate the thinking of many who have been working on entirely different problems and who may find some of their difficulties related to the questions discussed in Professor Davis' book. The first chapter deals with the history of the analysis of time series and gives a very valuable account of the most important writings in the field. It also affords an excellent introduction to the other parts of the book. The mathematical reader may not feel he can even glance through the whole 600 pages of the book. But he will be able to gain a rapid survey of the field and to

select the material most valuable to himself by reading carefully the 60 pages of the first chapter. The second chapter deals with the technique of harmonic analysis; this is the representation of empirical data by Fourier series. It does not on the whole add very much to the classical treatment of the problems. The last section relates the technique of harmonic analysis and more generally the method of decomposing empirical series by orthogonal function to the theory of multiple correlation. It contains some very valuable and original ideas. There are also, as in all other chapters, applications to economic data, which will be of great interest to economists. The third chapter treats serial correlation. * This chapter presents the best exposition of these extremely interesting and difficult problems which have given so much headache to the statistician. A great deal of the work originally done by Norbert Wiener is reproduced but important theorems are added. There are also new calculation techniques. * The fourth chapter brings an extensive discussion of the important problem of the theory of random series, which naturally is of great interest not only to professional statisticians but also to workers outside the field of economic statistics. * Chapter 5 deals with the difficult and puzzling problem of degrees of freedom in economic time series, which has troubled statisticians for a long time. * Dissatisfied with previous results he finally proposes a very ingenious method which he calls the method of elementary energies. Chapter 6 deals with the analysis of trends. * The discussion adds some new formulae for the correlation of residuals from polynomial trends. * A very interesting section deals with the fitting of the logistic, which is a somewhat difficult problem because of the nature of the curve. * Chapter 7....is a clear and valuable presentation of the technique of periodogram analysis. Chapter 8 deals with the evidence and explanation of economic cycles. * He....goes into some problems on statistical hysteresis which are very interesting from a purely mathematical point of view. * Davis....tries to give [in Chap. 9] a new and very interesting general distribution function which seems to fit the empirical income distribution better than Pareto's function or variants proposed by other writers * Chapter 10 is entitled, "The dynamic trends from the point of view of the equation of exchange," and will not be of very great interest to non-economists. Chapter 11 takes up very courageously the difficult problem of forecasting economic time series, especially as applied to stock prices. It reviews the classical work of Henry Schultz, *The standard error of a forecast from a curve.* Then it presents Professor Davis' own contribution which essentially assumes that it is not possible to forecast in the future beyond a range equivalent to the range of the available data. There are some interesting ideas about moving periodogram analysis and the method of probable error bands. The last chapter finally deals with interpretation and critique of the material presented, especially from the point of view of business cycles. It also gives a new "economic" interpretation of history and presents some interesting analogies between mathematics and economics. This book should prove very useful to the statistician as a handbook. He will find a great deal of stimulation and valuable material and procedures even if he is not professionally concerned with economic problems. The pure mathematician can gain a survey of the field. He may be interested especially in some of the unsolved problems of serial correlation and periodogram analysis which evidently require very powerful tools of analysis. One has to be extremely grateful to the author for having accumulated so much material and presented it in such a readable and interesting form.

Economica 10·80–1 F '43. C. E. V. Leser.

* The author is the first to give in one volume an account of the more advanced work done on this subject and mostly scattered in original publications. The large number of references shows what a formidable task this has been. * Chapter I gives a historical introduction into the economic problems associated with time series, the statistical problems arising out of them and the methods devised for their solution. It gives a very clear account of the subject matter and, being easy to read, it may be very useful to readers for whom some of the arguments set out in the following chapters are rather too technical. * The economic part of the book is to some extent open to criticism. For example, the distribution of income, which forms the subject of Chapter IX, seems rather far-fetched in the framework of this book, and the significance of magnitudes like the concentration ratio of income or wealth is exaggerated; the suggestion that the value of this ratio has to lie between certain limits, if political disturbances are to be avoided, is clearly untenable.

Similarly, the practical value of the equation of exchange, on which Chapter X is based, and consequently that of the quantity theory of money, is overestimated. The eighth and the main part of the twelfth chapter deal with theories of and evidence for business cycles; in the former chapter, the study of the relations of interest rates as well as building activity to other economic variables deserves attention. The most interesting chapter in this part, however, seems to be the eleventh, dealing with forecasts of stock prices. After having balanced successes and failures of actual forecasts, the author develops an original theory of the standard error of forecast, showing the difficulties encountered in practice and the weaknesses of theories on the behaviour of the stock market. It is not easy to find one's way through this work, which is not a systematic textbook. To the serious student of the more advanced methods in economic statistics, however, it will prove an invaluable aid. In order to become familiar with the essence of one or the other method, a study of the numerous examples set out in the text will prove particularly helpful.

J Am Stat Assn 37:294 Je '42. Louis J. Paradiso. The difficult problem of analyzing and interpreting economic time series has received its greatest attention during the past decade. Professor Davis, therefore, has rendered a distinct service in setting forth in this volume the present status of research in this field. * important aspects of the subject are inadequately covered. Problems of discovering and interpreting relationships among time series and the associated problems of significance play but a minor and unsatisfactory part in the analysis. * The treatment of the material ....is elegant and those familiar with this field should find the book stimulating and thought provoking. The first chapter of the book presents a concise history of the problem and serves as a splendid introduction to the treatment given in detail in the chapters that follow. * A major interest in these techniques lies in their utility in forecasting economic variables, a problem considered in the closing chapters of the book. The discussion at this point is inadequate since it throws no light on the problems that must be solved in forecasting economic time series. Variations in the movement of such series are usually dependent on many factors some of which are measurable and others non-measurable. Criteria for the selection of the factors, the form of relationship among the variables, and tests of the reliability of the forecasts are essential in predicting the future of economic variables. This phase of the problem is not touched upon in this volume. Despite these shortcomings, Professor Davis has made a distinct contribution in making available to the student a brilliant presentation of powerful techniques of analysis which promise much for the future development of economics as a science.

J Pol Econ 51:275–6 Je '43. Paul A. Samuelson. No reader can claim that he has not had his money's worth from this volume in terms of paper and ink, charts, references, and ideas. But it is not the systematic treatise to which the author refers in the Preface. There is no essential unity to the subject matter dealt with, and the treatment is very spotty. However, there is little or no overlapping between this and any other available work, not written by Professor Davis. The first seven chapters are concerned with statistical methods, while the next five consist of diverse economic applications: analysis of the distribution of income, the quantity equation of exchange, stock-market forecasting, and explanation of cycles. Of these applications the reviewer was most impressed with chapter viii dealing with the last-named subject, and least impressed with chapter x, "The Dynamics of Trends from the Point of View of the Equation of Exchange." The universality of Professor Davis' thought and interests is reflected in the final chapter, wherein an "economic time series" theory of history is expounded. * Not the least valuable feature of the chapter on the distribution of income is the extensive Bibliography. Because of his preoccupation with Pareto curves, Professor Davis holds the usual belief that inequality for the distribution as a whole moves in the same way as that of the tail. Empirical work of Mendershausen, Peckman, and Lintner shows the reverse to be the case; and common sense would suggest that the Lorenz curve should be given a "twist" by prosperity, the increased inequality at the tail being more than compensated by the increasing equality of income incident upon the abolition of unemployment. On the technical side there appears to be at least one mathematical error in Davis' derivation of the "new general distribution function." This function has the advantage of being like a Pareto curve at its extremity, at the same time that it possesses a

mode. As might be expected of a professional mathematician, Professor Davis' comparative advantage lies in the field of statistics rather than economics, and it is to the first seven chapters that we must turn with the greatest interest. Chapter i gives a good brief historical summary, which should not be too technical for most readers. Chapter ii provides an introduction to harmonic analysis, the periodogram, and orthogonal functions, which should prove useful in intermediate courses. Chapter iii, in the reviewer's opinion the best in the book, provides a useful introduction to the generalized harmonic analysis of Norbert Wiener, to the concepts of serial correlation, and to the concept of a stochastical difference equation, as first conceived by Yule. In many parts of chapter iv, dealing with random series, the author makes grateful acknowledgment to the work of Herbert E. Jones. As a measure of randomness the author discusses Goutereau's constant; this seems definitely inferior to the ratio of the mean square successive difference to the variance studied by Young, Williams, von Neumann, and others. Not only has the exact distribution of this ratio been worked out for normal populations, but complete moment relationships for any population have been derived. Unlike Goutereau's constant, its expected value is independent of the form of the universe specified, provided that the series is random. The discussion of the introduction of harmonic components by repeated summation is not related to the work of Slutsky, although a citation to the latter is included elsewhere. The section on sequences and reversals should be compared by the reader with the work of Wallis and Moore ("National Bureau of Economic Research," Occasional Paper 1). In chapter v the author introduces a novel concept of the degrees of freedom of a sequence of numbers which is highly questionable. Accepting its definition literally, every sequence including a "random" one has only a single degree of freedom, because there always exists a family of orthogonal sequences of which only one term is necessary in order to duplicate the series perfectly. The author's method of trend-fitting described in chapter vi has been found, in the reviewer's experience, to be definitely inferior in practice to the well-known method described by R. A. Fisher and to the less well-known method of A. C. Aitken. To facilitate tests of significance of harmonic elements devised by Fisher and Walker, Davis has presented useful tables. He does not discuss the efficiency of these tests. Indeed, nowhere in the book is there a discussion of the modern theories of estimation and distribution associated with Fisher and Neyman. The reviewer has dwelt upon shortcomings of the book because economic statisticians do not always have the necessary technical equipment to ferret out points of difficulty. But he would like to conclude with an affirmation of the many solid contributions of the work and the assertion that this is a book which should be in the library of every statistical economist.

Math R 3:176 Je '42. W. Feller. * One of the most pleasant features of the book (besides its wide range) is the clear recognition that the employment of a specific mathematical tool in itself implies an economic assumption. Thus the final conclusions will depend on the tools employed and on the postulates which underlie these tools. This recognition necessitates a careful mathematical analysis. It is needless to point out, however, that the book is not written for mathematicians; hence no complete mathematical theory could be given and the book has necessarily become, in part at least, descriptive in character. Occasionally the conditions of validity of a formula or its approximative character are not made quite clear. This, however, will not affect the value of the book for economists and for statisticians in general.

Nature 150:335 S 19 '42. A. L. Bowley. * The author devotes an interesting chapter to the study of random series, with reference also to the possibility of forecasting movements when there is autocorrelation. But perhaps the main importance of s_v is as a measurement of the magnitude of the variation that may be expected from unassignable causes. * Space does not permit even allusion to all of the many topics discussed, or criticism of the less mathematical chapters on wealth and other economic subjects, which are less guarded than the purely analytical studies. Parts of the book are very difficult reading, and only possible to a qualified mathematician, who should be prepared to refer to the originals of studies where results are only summarized. The whole is a very valuable account of the work that has already been done in this important region, while at the same time many indications are given of promising lines of approach towards the basing of some parts of economic theory on a quantitative basis.

R Econ Stat 24:191–2 N '42. E. B. Wilson. In the list of monographs of the Cowles Commission,....the book is described in these words: "This work surveys the problem of analyzing economic time series beginning with historical origins and ending with a critical appraisal of what has been accomplished by modern statistical methods. Numerous examples illuminate the text. Many tables and 169 charts illustrate the contents of the book." A fair statement in a few words; the book is worth its price; it is difficult to see how it could be listed so low. One subject is omitted, namely, the actuarial method of graduation used by Macaulay in his discussion of the interest rate. This is a statistical study of an economic time series and the method and the topic are worthy of note; but it may be that Davis does not think the method sufficiently important in the *analysis* of time series to incorporate it in a book already long and extremely full in respect to methods. The study of Macaulay and many studies on economic time series may be regarded as studies in the preparation of economic indices rather than in their analysis in the mathematical sense. From the point of view of the economist interested in a just portrayal of some economic movement through an index, the analysis of the economic and statistical elements which must be made in order to construct a satisfactory index may be the most important step there is in the analysis of economic time series. Davis is not ignorant of the importance of this type of analysis. He chooses to begin where that leaves off; otherwise he would have had to write two volumes instead of one. * Except for the first and last chapters and occasional interludes, the work is essentially mathematical and should not be attempted by one who does not have a good working knowledge of advanced calculus. It is dangerous for those less trained to put in their thumb and pull out a plum from some particular chapter; they may quite misconstrue the author's intent. Indeed, the detail of his intent is not always clear even to those who are highly trained applied mathematicians in the statistical and economic and physical fields; the detail cannot be clear when so much is compressed into the space. Furthermore, I do not find the author particularly gifted with clarity and precision of expression, and I should not expect it in a person who does and prints so much useful work in a difficult field: Davis's productivity is prodigious. Moreover, the range of the present book is so great that some important subjects are touched so briefly that the student cannot expect to understand the text except through consulting some of the many references to the literature. As an illustration of the preceding statement I may cite Chapter 5, Section 7, entitled Factor Analysis, where in six pages (192–97) Davis sketches the methods of Spearman, Thurstone, Frisch, and others. Economists have not been much concerned with the methods developed by the psychologists, but Frisch's bunch-map analysis has attracted their curiosity and perhaps their attention. All these methods are extremely laborious. In my opinion, it has not yet been demonstrated that, in the fields to which they have been applied, they reveal scientific realities of value commensurate with the labor involved, and I am not sure but that the methods may be abandoned. Still, at the moment, high as the cost may be, they must be understood and applied by some others than their chief proponents if they are either to be accepted as scientifically valid or dropped as certainly not worth-while, or both. I am not wholly unfamiliar with these methods and yet I find great difficulty in getting anything out of the author's brief discussion which seems to use unfamiliar and undefined terms, which states that X_i and X_j are two normalized variables and yet writes down explicitly some X's which patently are not normalized, and which altogether seems to create difficulties to be cleared up only by reference to Frisch's original. I presume there are places in my *Advanced Calculus* of which much the same can be said; coverage and clarity are hard to combine. Furthermore, the general topic of Chapter 5 is Degrees of Freedom in Economic Time Series, and it seems to me far from certain that factor or confluence analysis do contribute definitely to that topic, or that any method has yet become established which does; the term degrees of freedom is itself a bit hazy, and one may have for some time to leave it as indicative of something we are trying to learn how to define in a useful manner. Let us turn to another statistical analysis. The author (pp. 227–36) gives a considerable treatment of four time-series: X_1 = The Dow-Jones Industrial Stock Price Averages, X_2 = Pig-Iron Production, X_9 = Stock Sales on the New York Stock Exchange, X_{14} = The Cowles Commission-Standard Statistics Index of Industrial Stock Prices. He gives the correlation table for these

variables as

	X_1	X_2	X_9	X_{14}
X_1.....	....	0.7697	0.3961	0.9516
X_2.....	0.7697	....	0.1167	0.8152
X_9.....	0 3061	0.1167	....	0.3128
X_{14}.....	0.9516	0.8152	0.3128	....

and the similar table between the residuals after the trends and some harmonic elements have been removed, namely,

	X_1	X_2	X_9	X_{14}
X_1.....	....	0.0778	0.4057	0.7092
X_2.....	0 0778	....	0.2575	0.0608
X_9.....	0.4057	0.2575	....	0.2654
X_{14}.....	0.7092	0.0608	0.2654	....

He notes that the initial high correlation of 0.7697 between X_1 and X_2 has been reduced to the insignificant value 0.0778. The correlation between X_{14} and X_2 starts at a slightly higher value 0.8152 and comes out at the even lower value 0.0608. Thus the inference from stock prices, whether Dow-Jones or Cowles-Standard, is the same. The correlation, however, between the two indices has come down from 0.9156 to only 0.7092, of which the author remarks: "While this is not to be regarded as a large change, it is certainly sufficiently great to excite attention." I wish he had given it a little more explanatory attention, particularly in view of his referring to the final residual X's as the erratic elements of the original X's. Why should erratic elements correlate at 0.7092 when something like 200 observations are involved? Why should the erratic elements of X_1 and X_9 correlate at 0.4057, and even why those of X_2 and X_9 at 0.2575 and of X_9 and X_{14} at 0.2654? It may be all perfectly obvious but was not to me or to my class of very superior students with whom I used the book as a text last Spring. In discussion of economic interpretation of statistical findings, as in the attempt to supply the meaning to the results of other statistical work, one has to bear in mind the criteria of significance, which are of three very different kinds: First, there are the criteria of internal consistency which come out of mathematical theories of probability and which may be called criteria of *probable* significance; second, there are the criteria which come out of the consistency of results obtained by different competent statisticians working independently upon the same scientific problem, and which may be called criteria of *statistical* significance; and, third, are the criteria which are based upon the way the results fit into the accepted body of factual and theoretical knowledge and which may be called criteria of *logical* significance. We often have only one of these types of significance at our command in passing a judgment; we are very fortunate if we have all three with mutually consistent suggestions. It is the different weights which different investigators assign to such evidences of significance as they find, dependent partly upon the various considerations which they have in mind (and in which in complicated situations they rarely can be completely in accord) that account for such differences as the author finds between the interpretation which he and I put upon some results of periodogram analysis. In his final chapter he seems to be toying hesitantly with the sunspot theory of the "10-year cycle"; the trouble is that a stronger component in the periodogram seems to be at around 9 years, and that the sunspot cycle is not 10 years but something over 11. There is, however, a real difficulty in the possibility of displacements of periodogram peaks by interference; and it is doubtful if the periodogram indications for complex cyclic (but not strictly periodic) phenomena are yet adequately understood. A. E. Douglass, for his extensive investigations of tree rings, has developed an optical apparatus that makes some kind of cycle analysis with dispatch; there are persons who are skeptical of his method and results, but it is a pity that his apparatus is not available widely enough to enable many analyses to be made of a great variety of phenomena, so that we may know better what dependence to put upon that general type of cycle analysis. Many economists will be convinced that Davis's economics is too simplicist; some may believe that all econometrics has to be too simplicist to be of great utility in so human a subject as economics, but for that matter any pure economic theory is liable to suffer from similar limitations. The author's final paragraph (p. 580) indicates that he may well agree with them; but he probably believes, as they do, that one must keep on trying, each in his own way, with adequate awareness of the efforts of others in their ways. Students of economic time series will be thankful to the author for the diligence with which he has brought together in his book so vast a literature, much of it rather recent; though none may use the whole of it, scarcely one will fail to find in it something that is of aid to him in his own work.

Sankhyā 8:83–4 N '46. M. Mukherjee. The Analysis of Economic Time Series together with its sister volume *Econometrics* gives a more complete picture of the recent analytical tools in the field of econometrics than perhaps any other similar group of publications. * Davis has surely done a significant service to the science of econometrics. * Treatment....is abstract and formal. But a few well chosen examples help the reader to follow the argument easily. Compared to the treatment of harmonic analysis, the discussion on serial correlation is more interesting. Strangely enough, similar ideas have been used in the Indian Statistical Institute without any reference to the time series. Auto-correlation of adjacent quods of a random field can be exactly likened to that of a random series. And though it seems paradoxical, one is led to the conclusion that so far as mathematical tools are concerned, the time aspect is not the really relevant aspect in the study of time series. The chapter on random series has given within a short compass all that is relevant in this yet undeveloped subject. Of particular interest is the chapter on "the degrees of freedom in economic time series" which is a very lucid extension of the idea so common in physical and astronomical sciences and recently given such importance in statistics through the writings of "Student" and Fisher. The chapter surveys the status of the problem of tests of significance in economic time series with the author's valuable contribution to it. Chapters 6 and 7 describe respectively the usual methods of the analysis of the trend and the periodogram analysis. The next chapter is too small to bear the ambitious name "the evidence and explanation of cycles"; any one reading about cycles only from this chapter will have an incomplete view of the picture. The chapter on the nature of wealth and income is not different from the chapter on this topic in the "Econometrics" and hence need not be discussed. The next two chapters discuss the dynamics of the trend from the point of view of Fisher's exchange equation of the monetary theory $PT = MV + M'V'$ and the very interesting practical problem of forecasting respectively and no new ground is covered in the last chapter which is a critical winding up of the problem and the solutions. There is no doubt that the book is a masterly presentation of the more advanced mathematical and statistical tools as employed in the analysis of the time series. But one is sometimes led to feel that the author is more interested in the tools than in the facts which he wants to shape by the tools. With all praise for mathematics, is it not too much to expect that every possible datum will be amenable to exact mathematical treatment? Excessive practice of tools often makes us slaves to the tools, and as a result reality often eludes our grasp. Perhaps one day a perfectly mathematical science of aesthetics will be built up, but it may not stand nearer to facts than present aesthetics. Econometrists should bear this in their mind that the creation of a mathematical reality-image is not justifiable *a priori,* it is justified only by its results. At the present stage of our knowledge of business cycles, and other allied time series problems, a less mathematical language would have perhaps given a picture of something which is nearer to reality. And to be pragmatic, a fuller treatment of the economic principles involved, would have made the book more attractive to students of economics, who unfortunately are usually not well-up in advanced mathematical analysis. I do not say this in criticism of Davis's book in particular. If I had, Davis could easily have refuted the charge by simply recalling the universe of discourse of econometrics. This is more a criticism of a general tendency in recent economic writings. Schrodinger, writing on biology, has openly affirmed that the subject is too complex for the application of mathematics. Economists and econometricians can learn something from this humility.

Social Forces 21.119 O '42. Margaret Jarman Hagood. It is doubtful if many sociologists will read *The Analysis of Economic Time Series* in its entirety, for its second chapter, The Technique of Harmonic Analysis, will stop most. And until sociologists have more data available on at least an annual basis, they probably will not have occasion to apply many of the methods described. However, this book may be profitably sampled and with pleasure, for the author displays a wide range of familiarity with economic history, treats carefully the logic of scientific research, and enlivens his presentation with quotations from Lewis Carroll. Sections especially recommended for sociologists are Chapter 1, History of the Problem (of time series analysis); sections on The Logistic Trend and The Growth of Population (pp. 247–264), which give detailed examples of fitting logistic curves by a modification of Hotelling's

"method of the rate of increase"; Chapter 9, The Nature of Wealth and Income, which includes a section on The Pareto Distribution and another on the Application of the Pareto Distribution of Income to Political Events; and finally the last chapter, Interpretation and Critique. In the last there is a chart of political changes as interpreted by time series (p. 575) for the United States, 1790–1940, with an interesting discussion. Also, there is a summary of the sun spot theory of Jevons, which affords an excellent example of the testing of a hypothesis by time series analysis.

South Econ J 9:164–5 O '42. Dudley J. Cowden. * important book * A complete array of statistical methods applicable to time series is not offered. Seasonal variation in particular is skimped, and the only methods discussed are the link relative method and the method of harmonic analysis. In trend fitting the logistic curve is emphasized, and a method of fitting is explained that is a modification of a method by Hotelling. Harmonic analysis in its various aspects is thoroughly covered. Two noteworthy chapters are devoted to testing the randomness of observations with respect to time, and to degrees of freedom in economic time series. * Index number construction is barely touched upon, but the author seems to favor Fisher's "ideal" index number. * If the non-mathematical reader will detour the parts of the book that he can't negotiate, and will concentrate on the economic discussion, he will find many interesting conclusions, presented with varying degrees of confidence. * The reader of this review will undoubtedly form an underestimate of the content of the book, especially as to the statistical techniques presented. A rich storehouse of sharp tools is contained between the covers of the treatise, and a careful reading of the exposition of statistical methods will amply repay the mathematically competent economic statistician. The reviewer is not quite so confident as to some of the economic conclusions. He is of the opinion that there are sharp differences between dynamic economics and physics as sciences, and he doubts that economic time series are as permanent in their structure as the author appears to presume. Rather, he believes that both the technical basis and the institutions of economic society are continually changing, and that generalizations from economic time series must be limited in their scope.

[88]

★DAVIS, HAROLD T. **The Theory of Econometrics.** Bloomington, Ind.: Principia Press, Inc., 1941. Pp. xv, 482. $4.00. (London: Williams & Norgate Ltd. 28s.) *

Am Econ R 31:602–7 S '41. A. Smithies. It is both significant and appropriate that the decennial year of the life of the Econometric Society should see the publication of a book which could appropriately have been called *The Principles of Econometrics.* The development of econometrics during this decennium is well demonstrated by comparing the contents and the bibliography of Professor Davis' book with those of Evans' classic work (*Mathematical Introduction to Economics,* New York, 1930). In addition to many valuable re-formulations and improvements of the neoclassical system, the last ten years have witnessed the growth of dynamic economics from infancy at least to adolescence. In 1930 Professor Evans and his fellow pioneers were concerned with bringing new horizons within the vision of the economist. In 1941 Professor Davis is able to report a very substantial record of exploration. * The chapters on interest and investment and on insurance are welcome inclusions in the Dynamic section of the book, since they emphasize the fact that the problems of an uncertain future are germane to realistic economics, whereas they are assumed away by a rigorously static approach. However, the reader should be warned against the impression that economic uncertainties are insurable risks. It is doubtful whether uncertainty is susceptible to mathematical treatment, and it would have been instructive had Professor Davis expressed his opinion on this question. A review of a book which is as important a landmark as this should not merely consist of a summary of its contents accompanied by conventional words of praise, nor should it concern itself with debates over minutiae of analysis. The general methods should be carefully evaluated. This seems particularly desirable since the author brings to economics the fruits of a distinguished career in the application of mathematics to the physical sciences. What follows will be frankly critical, and may perhaps be legitimately construed as the perverse reactions of one trained in economics alone to the impact of a broader vision. * The division of a work on economics into Part I: Statics, and Part II: Dynamics, unfortunately has many modern precedents. The theory of general equilibrium is presented in

Part I and is then forgotten when the attempted realistic treatment in Part II begins. This is the procedure, for instance, of J. R. Hicks, who concludes his book (*Value and Capital,* Oxford, 1939) with engaging candor, as follows: "We began our study of dynamic economics by rejecting the concept of a stationary state as an analytical tool. We rejected it then because it seemed to be no more than a special case which offered no facility for generalization. We have come in the end to doubt whether it is even conceivable as a special case." Professor Davis also makes no use of the general equilibrium analysis in his realistic treatment. I think Professor Davis has fallen into the bad habit of the economist because of the attractive analogy offered by the physical sciences. But in mechanics, for instance, positions of stable equilibrium are known empirical facts, and there is every justification for determining the conditions for those equilibria without reference to any dynamic system. In economics, on the other hand, general equilibrium is an unproved hypothesis, and Professor Hicks seems to think that it is not a useful hypothesis at that. Why, then, encumber a textbook on modern economics with the subject at all? To honor the great names of Walras and Pareto is not in itself sufficient justification for burdening the minds of our students with useless impedimenta. I think the answer is that, although equilibrium never characterizes an actual situation, the equilibrium concept can be used realistically if, and only if, it is considered in its relation to the dynamic model from which it is derived. To be more specific, dynamic models of the economy in general have particular solutions where the variables take on values that are unchanging over time. These are the values about which cyclical fluctuations of the variables takes place and toward which their values converge if the system is damped. These values are therefore entitled to be described as the equilibrium values of the variables, and are of importance, even though they may never in fact be attained. This equilibrium value of, say, national income will be the average level of income over a sufficiently long period provided the conditions of the problem remain unchanged. Thus equilibrium analysis is immediately necessary in considering the average effects of permanent changes in the economy—the effect of the Social Security act is an example that comes readily to mind. However, as was implied above, our analysis must not rest with the determination of the equilibrium value of income; we must also determine the effects of changes in data on fluctuations about the equilibrium value. As an instance, a measure which will decrease the propensity of the economy to save and leave all other things unchanged will increase the equilibrium level of income; but when we consider the dynamic problem, it may be shown that such a change will make the cycles about the equilibrium position less damped. Clearly both those questions must be examined in evaluating any given policy. If equilibrium is interpreted in the way I have suggested, it can be given a realistic and significant rôle in economic analysis. On the other hand, if it is merely inserted as a historical curiosum in Part I: Statics, it is of very little use to the practical economist. The most satisfactory division of a general work on economics seems to be between partial analysis and total analysis. Partial analysis applies neo-Marshallian methods to the solution of problems where demand and supply conditions can be assumed to be independent of each other, while total analysis must be used where this condition is not satisfied. My second criticism of Professor Davis' methods concerns his approach to the analysis of economic problems and to his conception of the rôle that empirical evidence should play. Although this is an ancient field of controversy, the matter is still unsettled and I feel that no apology is needed for raising it here. Professor Davis' point of view is well summarized by the following quotation. "It would be interesting, indeed, if it were possible to do so to formulate the dynamics of economic time series in terms of a variation principle as has been done so effectively in the dynamics of physical variables * *There are many ways to formulate such a principle and probably, in the present state of economic theory, one way is as good as another, provided the resulting equations describe statistically the observed variation in the time series*" (p. 404). (Italics mine.) This presumably means that the important thing is to derive laws which are empirically verified, and once they are verified what went on in the mind of the theorist in developing his theory is irrelevant. This would be true in cases where a theory could be proved or disproved by a conclusive experiment and the expectation of changes in the data was zero. These conditions are not fulfilled in economics; even if the data did remain unchanging for a sufficiently long

period for experiments to be made, the economist must always face the possibility of disturbances upsetting his calculations. Nevertheless, Professor Davis does freely apply his principle to economic analysis. The most striking instances are his acceptance of the Paretian law of the distribution of income (of which more later) and the logistic law of industrial growth, on the basis of empirical evidence alone. The same tendencies are exhibited in his analysis of time series, where chief emphasis is placed on developing periodograms and serial autocorrelations of particular time series rather than investigating the interrelations of all the relevant time series of the economy. The latter type of problem plays but a minor and unsatisfactory part in Professor Davis' analysis. The more fruitful point of view is that the final formula, far from being the end of economic investigation, is merely a device for testing economic theory. For an economic theory to be valid, it must fit the facts and here the final formula is of use; but it does not follow that if the theory fits the known facts it is a good theory, and the economist can not afford, on empirical grounds alone, to accept such a theory until it is proved to be wrong. The trouble is that economics is not an exact science. In support of this statement I quote Professor Davis himself: "So also in economics the observation of real cyclical phenomena in time series should lead to the same forecasting power which distinguishes an inexact science from an exact one. Unfortunately....the proportion of total variance which can be attributed to pure harmonic terms in economic data is small even in the most regular of the series" (p. 42). This being so, the basis for economic prediction and economic analysis must be wide economic understanding based on sound theory and exhaustive empirical knowledge, rather than reliance on imperfect statistical prediction. In acquiring such understanding, the techniques used by Professor Davis, and the mathematical method in general, are invaluable. My criticism is not of Professor Davis' technical methods but of the use he makes of his results. My third criticism concerns Professor Davis' general economic point of view; or rather not so much his point of view as the grounds he has for holding it. Here Pareto's law is of central importance, since his belief in its validity dominates Professor Davis' whole economic outlook. His statement of the law is as follows: "In all places and at all times the distribution of incomes in a stable economy where the origin of measurement is at a sufficiently high income level, will be given approximately by the formula $y = ax^{-v}$, where y is the number of people having an income x or greater, and v is approximately 1.5" (p. 23). This statement is elucidated by the following footnote: "The phrase in a stable economy has been interpolated by the present writer and should not be ascribed to Pareto. By a stable economy is meant one that is not verging on revolution or civil war as measured by political disturbances, civil riots and the like. The consequences of this interpolation will be examined later." Before commenting on the basis for Professor Davis' acceptance of this law, let us illustrate his applications of it. (1) In chapter 19, he establishes a direct correlation between the concentration of income and business prosperity, and states (p. 201): "It is not unreasonable to suppose that disturbances in the concentration ratio may be accompanied by economic and political abstractions." To be specific, significance is attached to the fact that the concentration ratio was abnormally high in 1928 and 1929, and abnormally low in 1920, 1921, 1931 and 1932. (2) The Paretian law is held to be the criterion for the degree of progressiveness of the income tax (p. 200). (3) It is tentatively suggested that the collapse of France may be attributed to a sub-Paretian income distribution (p. 203). (4) A low interest rate policy is condemned because as a result of it "the concentration ratio will be lowered and with it will come all the attendant ills of this disturbance of the Pareto pattern" (p. 289). (5) An inference of fundamental importance can be drawn from the logistic law of industrial growth in conjunction with the Pareto law. On the basis of his study of growth Professor Davis concludes that we are near the upper symptote of industrial production. This leads to the conclusion that the rate of net private investment is approaching zero as a limit. On the other hand, the requirements of a "stable economy" preclude any attempts by the state to reduce to zero the propensity of the economy to save at a high level of income, which is necessary if maturity is to be accompanied by prosperity. The obvious inference is that a mature economy must either be kept alive by public investment or must fulfill the predictions of Marxian theory. I do not propose to debate these conclusions in this review, but it does seem to be the

duty of a reviewer to examine the basis of the author's acceptance of a law which he uses to draw inferences of such fundamental importance. With this end in view I shall set out my criticisms of Professor Davis' derivation and use of the "generalized law of inequality" in summary fashion as follows: (1) Results obtained from graduating only the supra-modal part of a frequency distribution must be used with extreme caution, and very possibly with greater caution than Professor Davis has exercised. (2) The great importance Professor Davis attaches to the Pareto law from the point of view of "a stable economy" derives from his theory that the Paretian distribution of income corresponds to the distribution of ability in the economy. This correspondence he establishes by investigation of the distributions of the ability of the faculty of the University of Indiana to play billiards and the abilities of given populations to write articles on mathematics and chemistry, respectively. Again the statistical results themselves are questionable; but, more important, even accepting those results, far from proving that it is necessary for stability, that abilities should be rewarded by corresponding incomes, these examples suggest, if anything, exactly the reverse conclusions. For I take it that the Indiana faculty does not play billiards professionally, and I imagine Professor Davis himself could testify to the fact that the pecuniary rewards for writing articles on mathematics do not provide the chief motivation of the writer. (3) In view of the last paragraph, it is hard to see how Professor Davis' conclusions can be applied as a criterion for income-taxation. Moreover, if we accepted the argument fully, a proportional tax, however high, on all incomes, the proceeds to be used to pay a subsidy to Mexico, would leave the Pareto distribution unaffected and therefore be irrelevant to the working of the economy of the United States. (4) The nearest approach to an economic theory justifying Professor Davis' conclusions is the following: "The *a priori* reason for these deductions" [*e.g.*, as to the fall] of France is to be found in the general assumption that a concentration of wealth and income of approximately the Pareto concentration is essential in supplying the necessary capital to provide employment for the optimum number of workers" (p. 203). We are apparently expected to accept without question a natural law that the Pareto distribution yields the optimum propensity to save. I have dwelt at some length on the discussion of the Pareto law, not only because of the conclusions Professor Davis has drawn from it, but because his use of it illustrates very effectively the pitfalls of the method of analysis I have discussed in my second criticism. My criticisms have been directed to Professor Davis' book as a general work on economics. As a vehicle for bringing to the student a knowledge of the mathematical techniques that are of use in economics, it serves its purpose excellently. The mathematical arguments are presented with the precision and the elegance that one expects of a professional mathematician, and the techniques employed are the simplest that are consistent with the difficulty of the subject matter. Its merits will make the book of great service to the economist, while its imperfections will reassure him that his subject is more than a branch of applied mathematics.

Econ J 52:350–2 D '42. *J. R. Hicks.* What do we mean by econometrics? The present reviewer, searching in his own mind for a new meaning whose need for christening might justify the new word, would suggest the following: "the use of statistical methods for estimating the functional relations between economic magnitudes." That would cover the characteristic work of those whom we regard as the leading econometrists—Schultz, Frisch, Tinbergen, Kalecki, Roos, to name no others. Econometrics in this sense starts from the statistical demand curve, and reaches up to the cloud-capped structures of Professor Tinbergen. It is a new and distinctive branch of economics, which deserves a name of its own. It is different (*a*) from mathematical economics, which merely states essentially *a priori* or hypothetical reasoning in mathematical form; it is different (*b*) from the ordinary so-called economic statistics, which is nothing else but Social Accounting, being concerned with the balance-sheets of a whole community, just as accounting is concerned with the balance-sheets of the individual firm. It is also different (*c*) from the genuinely statistical, but not genuinely economic, analysis of economic data, which consists in applying to economic material the methods of *classification* developed by general mathematical statistics. A good example of this last is the harmonic analysis of time-series; on the definition here suggested that also is *not* econometrics. Whether or not this

suggested demarcation is wholly satisfactory, some such demarcation will surely have to be made before it is possible to write a coherent work on the theory of econometrics. Professor Davis offers us no such demarcation. He uses the term "econometrics" to imply that "the phenomena of economics are to be investigated through their statistics, and such patterns as may be observed are to be described in mathematical terms and by means of mathematical equations." Econometrics in the narrow sense thus becomes confounded with both (*a*) and (*c*); if (*b*) is largely left out, the reason apparently is that it is not sufficiently mathematical. The book which results is in fact nothing else but a text-book on economics, written for what we in England should regard as a rather peculiar type of student. This student is one who comes to economics after completing his training in mathematics; he has acquired purely mathematical habits of thought, and he expects to be able to treat economics as a branch of applied mathematics. The English teacher of economics, on the rare occasions when he is confronted with such a student, feels that the first thing to be done is to broaden the man's mind; when that has been done, perhaps his mathematics will come in useful after all. The Americans have evidently decided that he has to be accepted, and given the sort of economics he wants; in the American environment that is possibly inevitable. But the results are not altogether reassuring. Professor Davis provides us with useful abstracts of most of the more important work done within recent years in mathematical economics and econometrics; no doubt it is a convenience to have these papers summarised in volume form, since this kind of literature is not conveniently read in libraries. Now and again the English reader will probably pick up something which had not reached him previously; Professor Yntema's econometric study of the costs of the U.S. Steel Corporation, prepared for the Temporary National Economic Committee in 1939–40, sounds particularly intriguing. All this is useful; but the book is too often marred by a singular carelessness towards all those parts of economics which are not narrowly mathematical. How can the student learn any proper sense of proportion in the handling of economic data, if he is presented with a chart like that on p. 13, showing an index-number of industrial equities, and is not told that the apparently increasing fluctuations are largely illusory, because the chart has not been drawn on a logarithmic scale? Does it make for clear thinking to be told (p. 340) that when a price-series has an upward trend "we say that the market is bullish?" or to be given formulae for depreciation without one word being breathed about the question of uncertainty, or even any suggestion being made that there is any difference between past and future at all? The clue to this state of mind is probably to be found in a statement in the preface. "In earlier days, when economists were scarcely aware of the power of the mathematical method, Alfred Marshall found it the better policy to place his equations in a small appendix towards the end of his treatise on economics. In recent times this appendix has come to be regarded by many as his most valuable contribution to the subject." Hardly, we must surely reply, by those who know their Marshall. This statement is [a] mathematician's wishful thinking. Our mathematician will not have become an economist until he has learned that there are vital things in economics which are not applied mathematics; and that there is much else which could be stated mathematically but which anyone with a sense of mathematical elegance would prefer to state in prose.

J Am Stat Assn 37:149–50 Mr '42. Wassily W. Leontief. The contents....are encyclopedic. One finds in it a description of depreciation formulae and of various methods of computing life insurance premiums; the author discusses the concept of utility and presents a detailed theory of international exchange; he devotes considerable space to the problems of taxation and makes passing observations concerning the interrelation between interest rates and the outcome of presidential elections. In his endeavor to present a complete, up to date picture of the application of quantitative methods of analysis in economics Professor Davis refers to the works of more than three hundred different authors. Numerous bibliographical footnotes are implemented by summaries of selected literature attached to each of the eighteen chapters. Of the two principal approaches through which quantitative analysis enters the field of economics—pure theory and statistics—both are given equal attention. No attempt, however, is made by Professor Davis to integrate either one in a unified system. Although essentially a compendium, the book contains here and there original contributions. As many an econometri-

cian with a background of mathematics and physics, the author shows great weakness for analogies between familiar definitions of theoretical physics and some basic concepts of pure economics ("isomorphism between money utility on the one hand and entrophy on the other" p. 171 *etc.*). If his more cautious colleagues should object to Professor Davis' readiness to develop an elegant deductive argument on the basis of a few bald factual and theoretical assumptions, he will be able to point out that some of the best known authorities in the field of business cycles theory reach far bolder conclusions on the basis of much more dubious assumptions—and they get away with it. The appearance of this volume raises again the question whether "Econometrics" as defined by Professor Davis should and could be usefully treated as a distinct, separate part of economics. * It can be hoped that a working knowledge of the fundamentals of mathematical analysis will soon be as much required from an advanced student of economics as the knowledge of foreign languages. But precisely for this reason a "Theory of Econometrics" can not be more usefully established as a separate field of advanced studies than for example a "Theory of Economics treated with the help of foreign languages." The use of economic problems in teaching mathematics to economists is of course highly advisable, but so is the use of Barone and Böhm Bawerk in teaching them Italian or German. However, before Econometrics have found their natural place in the general body of Economics a great pedagogical task has to be performed. Professor Davis' book will be of invaluable help to those engaged in teaching mathematics to economists and economics to mathematicians.

J Pol Econ 51:182–3 Ap '43. Gerhard Tintner. * the first textbook in the relatively new subject of econometrics * Davis' book is divided into two parts—economic statics and economic dynamics. Statics is defined as the part of econometrics which does not involve time explicitly, whereas dynamics deals with problems involving time. This seems to be a very satisfactory definition from the point of view of the mathematician and comes very near to the usual distinction between statics and dynamics made, for instance, in Hick's *Value and Capital* (Oxford, 1939). The first ten chapters of the book, which relate to economic statics, deal with the following subjects: income distribution, utility theory, supply and demand, exchange, monopoly and similar problems, production, budgets, the theory of equilibrium, and taxation. All these subjects are presented competently and extremely well from a didactic point of view. Many examples and problems are given and also extensive bibliographies, which make the book very valuable for self-study or teaching. There are not many original contributions except on the subject of the personal distribution of income. The author tries to give a generalization of the well-known Pareto distribution function, which, in his opinion, graduates the entire distribution, including the part with low incomes. The derivation is very ingenious and certainly an important contribution to this much disputed subject. The remaining ten chapters are devoted to the study of economic dynamics and discuss the following subjects: population, equation of exchange, interest, insurance, index numbers, time series and their dynamics, business cycles, and international exchange. It is here that the main interest of the author lies. He presents some of his own original contributions * This is particularly true for the sections which deal with time series and which bring up, very courageously, many problems generally shunned in economic statistics, like serial correlation and forecasting. Serial correlation consists in the lack of independence between the consecutive items of a time series. * In chapter xviii the author presents his own business-cycle theory, which he calls the "resonance theory of crises." These contributions, as well as the treatment of business cycles and related subjects, are extremely interesting and stimulating. Considering the value of the book for teaching purposes, it should be said that in the writer's experience it can very easily be used as a text for students in economics who are somewhat familiar with calculus. The problems are in general not too difficult; and a student who has mastered the book can certainly be trusted to have a very excellent knowledge of econometrics, that is to say, the mathematical theory of economics and statistical methods as applied to economics. Professor Davis ought to be congratulated upon his pioneering effort, for which both economists and mathematicians should be extremely grateful.

Math R 3:11 Ja '42. A. Wald. Econometrics is a relatively young science which has been greatly developed in the last few decades. Its subject is a quantitative formulation of eco-

nomic theories together with the problem of their statistical verifications. Many of the modern findings are scattered over a great number of periodicals and there has been a need for a comprehensive presentation of the theory. The present book, with its extensive bibliographical references, certainly contributes towards that end. * The book was apparently written to be used as a text. This purpose is served also by the large number of problems in each chapter designed as exercises for students. Mathematical tools are extensively used in the book, although not on a very advanced level, so that a knowledge of calculus is sufficient for the understanding of most of the book. Since the book was written as a text, and not as a treatise, the treatment of the topics is somewhat elementary and not as complete or profound as it could have been in a treatise. In several cases the reader is referred to another larger work of the author [*The Analysis of Economic Time Series*] for a more extensive analysis. Mathematical economists will find interesting the discussions of numerous modern theoretical results and the extensive statistical data with which the theory is confronted. Teachers of mathematical economics will find the book helpful in their class work.

[89]

★DAVIS, J. F.; BATEN, W. D.; AND COOK, R. L. **The Effect of Time of Application and Levels of Nitrogen, Phosphorus and Potash on the Growth of Sugar Beets With a Detailed Statistical Procedure of Confounding in a 3×3×3 Design.** Michigan State College, Agricultural Experiment Station, Technical Bulletin 203. East Lansing, Mich.: the Station, June 1946. Pp. 40. Gratis. *

[90]

★DAYTON, SCOTT. **A Manual of Problems in Statistics.** New York: Henry Holt and Co., Inc, 1941. Pp. iv, 163. Paper. $1.45. *

Am Math Mo 49:393–4 Je–Jl '42. Kenneth J. Arrow. This work has been designed as a companion volume of problems to the customary undergraduate text in economic statistics (such as "Statistical Methods," by Frederick C. Mills). In this purpose, it has succeeded admirably. There is a wealth of problems which illustrate clearly the computational elements involved in virtually all the statistical methods in common use. The wide variety of topics handled include algebraic exercises, graphs, description of the frequency distribution, index numbers of prices and physical volume, analysis of time series (secular, seasonal and cyclical variation), simple correlation (grouped and ungrouped data and time series), multiple correlation, the normal curve of error, the Chi-square test, measures of reliability, small samples and analysis of variance. Two appendices give tables of problem data and the chief statistical tables. The data used in the problems are drawn from significant economic material and are presented in tables which are models of good construction. A few more detailed remarks may be made on these technical aspects. Problem 2c in Section A involves the solution of three simultaneous linear equations; these equations are linearly dependent, which may confuse the student. The section on graphs, though covering a wide range, omits the Lorenz chart which has become prominent in recent years in connection with studies of income distribution. On the other hand, inclusion of the logarithmic standard deviation in describing frequency distributions and of the analysis of variance test for seasonal variation means treatment of two topics of importance which are frequently neglected. However, some caveats may be entered on a more fundamental level. These may be illustrated by the problems given for describing frequency distributions, which involve calculation of several measures each of central tendency, dispersion and skewness. This disregards the logic of the mathematical theory of statistics (as developed by R. A. Fisher, H. Hotelling, J. Neyman and A. Wald), according to which these measures are used as estimates of parameters of the underlying probability distribution. There can, of course, be only one best estimate in each case. This same disregard of the mathematical assumptions underlying statistical techniques appears in the section on cyclical variation in time series. The essence of the proposed method (which is the standard one in statistics texts) is to divide the observed values by the product of the trend value and the seasonal index. However, the fitting of a trend by least squares involves the assumption that there is no cyclical variation. It might be objected that since there are no mathematically valid methods of dealing with cyclical variation, the suggested technique is at least a good approximation. Prima facie, this is a good argument; but it puts the matter up to practical experience. E. L. Frickey (see "The Problem of Secular Trend," Review of Economic Statistics, 1934) has shown that the average duration of a cycle as determined by standard methods

from different trends fitted to pig iron production may range from 3.6 to 45 years (depending on the trend fitted). This would seem to suggest the unreliability of the method. Some attention might be paid to the simpler methods used by the National Bureau of Economic Research (see W. C. Mitchell and A. F. Burns, "The National Bureau's Measures of Cyclical Behavior," Bulletin 57 of the Bureau), which seem to have definite advantages over the standard method suggested by Mr. Dayton. Two minor points may be disposed of before closing. In discussing correlation, use of the standard error of the correlation coefficient is suggested (Section J, problem 4), although the size of the sample is only 18; further, in using the formula to test the significance, the calculated value is substituted for r, instead of the theoretical value. In discussing the analysis of variance, the method is introduced (as is customary) by a comparison of two variances. The method of treating this problem (making the larger variance always the numerator in the variance ratio) amounts to using a 10 percent level of significance instead of the 5 percent level which is intended. These remarks must not be interpreted to deny the great contribution this manual can make to the instruction of a statistics class. Most of the observations made on the relation of the material to the fundamental mathematical assumption are directed more against possible abuses by instructors than against the work itself. As a matter of fact, the sections dealing with measures of reliability, small samples and analysis of variance pay close attention to the underlying statistical theory; and many recent developments have been incorporated in these sections. In fine, Mr. Dayton's work can be recommended as an invaluable aid in the teaching of elementary economic statistics.

[91]

★DEMING, W. EDWARDS. **The Gamma and Beta Functions: Notes and Problems Designed for Use in Mathematical Statistics and Mathematical Physics.** Washington, D C.: Graduate School, Department of Agriculture, 1944. Pp. ii, 37. Paper. $1.00. *

J Am Stat Assn 40:527–9 D '45. T. A. Bancroft. * Deming has gathered in one place valuable material from mathematical and statistical literature. The booklet warrants a place in the statistician's library, and should constitute a handy reference. The material is presented in a lucid style with full explanations, and is suitable as a supplement or reference for lectures or textbook in mathematical statistics. The teacher of mathematical statistics should welcome the 46 exercises as a source of problem assignments. The teaching of mathematical statistics, despite the recent appearance of several valuable textbooks, continues to suffer from the paucity of pertinent problem material. Some minor mistakes and typographical errors make their inevitable appearance. * There are also several minor points of presentation in which we disagree with the author. [See original review for critical comments not excerpted.] *

R Scientific Instruments 16:291–2 O '45. Mina Rees. * presents in a simple and interesting form many of the properties of the gamma- and beta-functions which are of particular interest to students of statistics, and of some interest to students of physics * the point of view seems to assume no mathematical training beyond elementary calculus; and indeed no great use of the concepts of the calculus is made. Graphs are effectively used to give a vivid appreciation of the relationship of the incomplete to the complete functions. A graph of the Γ-function is also included which indicates the discontinuities of the function at zero and at the negative integral values of the argument. But the non-existence of the Γ-function at these points is handled in the text with less rigor than is pleasing to the mathematical reader. This casualness about rigor is reflected also in the omission of clear indications of the range of the variables at the time of defining new functions, such as the Γ- and β-functions themselves; and in some other details. Clearly, the author is attempting to give the student a sense of the quality and usefulness of these functions, and prefers not to confuse him by taking him down the many bypaths where lurk the torments of limits, continuity, and precise statement. He must be permitted his own solution of this familiar pedagogical problem. * Seventeen of the thirty-seven pages of this pamphlet are devoted to exercises, some of which are fully solved. These are well selected to develop further an appreciation of the usefulness of the Γ- and β-functions in pure theory, in physics, and particularly in statistics. A competent understanding of these problems should give the student some facility in the subject. This book ....should prove useful in courses in other institutions. * there are some fairly obvious typographical errors.

[92]

★DEMING, WILLIAM EDWARDS. **Some Theory of Sampling.** New York: John Wiley & Sons, Inc., 1950. Pp. xvii, 602. $9.00. (London: Chapman & Hall, Ltd. *72s.*)

[93]

★DEMING, W. EDWARDS. **Statistical Adjustment of Data.** New York John Wiley & Sons, Inc., 1943 Pp. x, 261. $4.00. (London. Chapman & Hall, Ltd., 1944 *21s*) *

Am J Sociol 50:163 S '44. Thomas C. McCormick. * An interesting feature is that curve-fitting, as usually understood, and the "adjustment" of [illegible] errors and of errors in geometric measurements are treated together as different aspects of a single problem. For the first time, a solution is given for the case where both x and y coordinates are subject to error. * The book is scholarly, up to date, and stimulating. The mathematics is not very advanced; but, combined with an elliptical style, it makes substantial demands of the reader. Social statisticians will want to know of such developments in mathematical statistics as those outlined by Deming, because they include some useful ideas and techniques. It is worth remembering, however, that it cannot be shown that mathematical functions fitted by the complicated and laborious method of least squares actually describe the underlying relationships of sociological data any better than freehand curves. The emphasis on the former is due rather to a preference for their neatness and apparent precision and to the prestige of mathematics. One may also object that so much more effort is being expended in the mathematical reduction of random errors than in the correction of biased errors of enumeration, measurement, and observation. This is not a well-balanced situation but mathematicians should not be blamed for what others do not do.

Am Sociol R 10:114-5 F '45. Louis Guttman. * a practical discussion....which can be followed by a reader who has some familiarity with statistical concepts. Sociologists will find this book undoubtedly the best available with which to make or deepen an acquaintance with an increasingly important prediction technique. Abundant numerical examples and exercises are given throughout the book to illustrate selected varieties of problems. Of special interest to social scientists will be the chapter on adjusting sample frequencies to known marginals, and the example of a sample survey borrowed from Hansen and Hurwitz. On the more technical side, for those interested in some theory, a chapter is devoted to a general formulation of the problem of least squares, and another to the propagation of error. Thus a general set of normal equations is derived of which all the examples in the book are special cases. This enables a uniform routine for numerical solutions to be maintained throughout. This reviewer believes it should be pointed out that the theoretical formulation here is for what are called "large samples." The weighted squares of residuals that are minimized refer to the past observations, but it is the future residuals that need minimizing. If the past observations form a large enough sample, then the adjustments that minimize their squared errors will tend also to minimize squared errors in the future. This may be far from the case, however, for relatively small samples. There remains much work to be done on the problem of how best to predict from a past sample to a future one in the sense of least squares. There remains also the basic question to which the author alludes briefly in his opening chapter: when is least squares a best method of adjustment, when is some other method best? An extended answer is beyond the scope of the book, but mature readers would undoubtedly prefer more orientation here. There is some danger that the short answer given will not be adequately appreciated since no indication is given of how to prove it nor of what proofs are available. Many of the profound developments of the past two decades in the theory of estimation and of the testing of hypotheses bear closely on this matter, and a large number of fundamental problems remain to be solved. Least squares, as the author indicates, is versatile in that it often yields a workable approximation in situations where a theoretically best answer is difficult to compute—or is even unknown as yet analytically. Of course, in some simple situations, informal adjustments—like drawing free hand curves—may be just as adequate, depending on the action to be taken. In some situations, especially if the errors are normally distributed, least squares is actually a theoretically best solution as well as a practical one. As the author points out, however, it should be kept in mind that "What method of adjustment to use (least squares, free hand curves, *etc.*) is as much a matter of economics as of science, and must be decided on the basis of time, costs, and results. It is more important to insist on having a series of experiments carried out under a variety of

conditions, than to insist on using any particular method of adjustment."

J Am Stat Assn 40:380–2 S '45. John H. Smith. * Considerable emphasis is placed upon (*a*) problems containing conditions without parameters, (*b*) estimating cell frequencies when marginal totals are known, and (*c*) curve fitting when more than one variable is subject to error. Methods based on the characteristic equation of the moment matrix in units of the respective standard errors of measurement are not mentioned in connection with (*c*). The book has a number of distinctive features. The example in which random errors of known variances are added to both coordinates of selected points on a parabola (pp. 218–30) is praiseworthy because it permits the reader to compare each aspect of any given practical problem with the corresponding aspect of the example in order to assure himself that the two problems are comparable. The use of Lagrange multipliers to simplify and systematize the solutions for many types of problems popularly supposed to be insoluble illustrates the technical devices which the author has assembled and organized for adaptation to many types of problems. The saving of time and effort made possible under certain conditions by the use of approximate values of parameters is well presented. The section on conditions without parameters contains important types of problems which are rarely presented in statistics books, and the material on estimation of cell frequencies is indeed timely as the author suggests in the preface. The technical discussions are liberally supplemented with bits of good practical advice. The author has done a scholarly piece of work assembling materials bearing on the general problem of adjustment of data and adapting them for his purposes. Since original articles in this field are not readily accessible, the many well-chosen references and historical notes are especially helpful. The author's contributions to the specialized and relatively difficult problems which he emphasizes hardly justify his overoptimism with respect to the relative effectiveness of the proposed methods. Since a considerable amount of effort is still required to solve some of the problems, it is unfortunate that the author tends to conceal *relative* advantages by emphasizing conditions under which a given approximate method yields results which are good enough for purposes of action rather than those under which the method has comparative advantages. For example, consider the problem of minimizing the sum of squares of residuals of the form $y - ax^b$ based on the six observations (1, 9), (1, 11), (2, 19), (2, 21), (4, 39), and (4, 41), where the three array means (10, 20, 40) are the required adjusted values. These are approximated closely by either (10.10, 20.11, 40.03) or (9.95, 19.96, 40.01)—values obtained by weighting log y by y^2 and by the simpler unweighted method, respectively. This example illustrates the conditions stressed by the author as favorable to weighting log y by y^2; that is, the curve fits well (it fits the array means perfectly) and the residuals are small—so small that $r_{xy} = 0.997$. Nevertheless, equal weighting yields results which are superior to those obtained by the more complex proposed method *as judged by the criterion on which weighting by y^2 is based* because the weighting bias introduced by weighting by y^2 is (to two decimal places) three times as great as the similar bias in the opposite direction introduced by equal weights. Of course, there are conditions under which the weighting bias is trivial in comparison with differences in results due to other factors. In such cases, the relative advantage of weighting by y^2 over the unweighted method may be great (pp. 199–201). These conditions should be discussed in a manner designed to help the reader to recognize conditions *relatively* favorable to alternative approximate methods. For a practical research worker who chooses among alternative methods on the basis of simplicity and effectiveness, the class of problems in which log y should be weighted by y^2 is very limited. Even when the criterion is appropriate the advantage in accuracy over that of the unweighted method must be significant in order to justify the extra effort introduced by the weighting process while, at the same time, the accuracy requirements must not be so exacting as to warrant the moderate amount of additional effort necessary for estimating exact weights (p. 202). When the marginal totals of a universe are known, cell frequencies can be estimated from inflated sample frequencies by simply distributing the row adjustments among the cells in proportion to column totals and column adjustments in proportion to row totals. In this way, the proportion for any cell in a two-by-two table with equal marginal totals is estimated to be half the sample proportion in both cells on its diagonal. Hence, for this simple special case, the sampling variance of the

estimated proportion is reduced from pq/n to $2p(q-p)/(4n)$, a reduction of more than fifty per cent. When all adjustments are relatively small as in the examples in the book, results obtained by this simple method are satisfactory. The author's treatment of errors in cell frequencies is not convincing with respect to the theoretical advantages of the proposed methods even under ideal conditions. For example, he begins with the assumption that the sampling variance of the frequency of a cell containing more than 10 observations is equal to the cell frequency and shows (by methods developed for *independent* measurements) that the variance of the sum of the cell frequencies in a two-celled table is equal to n (instead of zero, the exact value) and that, by the process of adjustment, the variance of a cell proportion "is reduced from p/n to pq/n" (p. 69). Discussions which suggest that errors in cell frequencies are uncorrelated appear also in later sections. This is important because the sum of squares of standardized errors in a set of correlated cell frequencies is not, in general, distributed as chi-square. In fact, Pearson's original article is mainly devoted to a proof by which the general expression for the sum of squares of any complete set of standardized uncorrelated functions of errors in cell frequencies is shown to be exactly equal to the familiar expression for chi-square. The expected values in the denominators are not intended to be equal, or even proportional, to the sampling variances of the corresponding cell frequencies as suggested by author's discussion on page 102 in which he defends the use of observed frequencies in the denominators of the quantity (similar to chi-square) which is minimized by the proposed methods. Although it would be desirable to revise this discussion in conformity with the theory of random sampling, it is even more important to investigate the relative advantages of alternative methods with respect to certain types of bias especially when the bias is known to be most serious in certain parts of the table.

Math R 5:208 S '44. T. E. Sterne. This book is intended to be a text and a book of reference, to deal with the scattered and less generally known parts of least squares rather than the well-known parts and to supplement, rather than supplant, other books. By intention, some of the best known parts of least squares are omitted, and such familiar problems as the fitting of curves to data in which the X's are accurate and the Y's alone subject to error are slighted. The book is not introductory; a prior knowledge is presumed, for example, of the meanings of certain statistical terms like "variance" and "correlation." * A fault of the book is that it does not presume a uniform degree of prior knowledge and hence its value as a text is limited. A greater fault is the disordered manner in which some topics are presented. On pages 65 and 66, for instance, a schedule is displayed and discussed for computing the weights of functions of the adjusted angles of a triangle, although the formulae for such weights, without which the computations cannot be understood, have not been given. More complicated examples are worked out later, still without the necessary formulae, until at last, on page 90, Gauss' expressions for the weights are revealed to the reader. The book as a whole is free from errors, but there are several on page 56, where L_{hh} is said to be the weight of F^h and L_{hk} to be the reciprocal of the covariance of F^h and F^k. If parameters are present, they contribute to the variances and covariances of the F's without appearing in the L's and hence the weights and covariances of the F's involve in general the partial derivatives F_a, F_b, *etc.*, and thus are not functions of the L's alone. If parameters are absent, then L_{hh} is the reciprocal of the weight of F^h, and L_{hk} is the covariance of F^h and F^k. Despite the faults of the book, the computational procedures that it describes are excellent and chapter IV, its heart, is a connected and concise exposition of the general problem of least squares. Although the reviewer does not recommend reading through the book consecutively, it does contain information, not readily available elsewhere, that is of much value to those who deal with observational data.

Q R Biol 19:272–3 S '44. The adjustment of data presented in this book is by the method of least squares, and the book could appropriately be called "Least Squares Adjustment of Data," since no other method is developed. The basic principle of least squares is presented in a different way from the classical approach. It follows in generalized form the line of thought that is inherent in the least squares adjustment of measurements on the angles of a plane triangle to the condition that the sum of the three angles shall equal 180°. As applied to curve fitting, the equation to be fitted becomes a conditional equation to which the adjusted values of the

observations are to be subject. This approach unifies the various problems in least squares adjustment and a single general solution is given, to which the solutions of all the special problems are oriented. The author states at the outset that he is not attempting to cover all statistical methods, nor even the entire field of least squares, but is attempting to supplement other books, with emphasis on scattered portions of the subject of adjustment of data that are difficult to find elsewhere. Perhaps it is because of this effort to collect scattered matter that the book is very uneven and it is not clear to what type of audience the author addresses himself. In fact, one gets the impression that he has put together papers prepared for different groups. His use of such terms as "standard error" and "Student test" without definition, implies some familiarity on the part of his readers with statistical terminology, yet in Chapter VII he defines at some length the terms "cell" and "cell frequency" in a correlation table, which implies no [illegible] of the most elementary terms. Incidentally, he had used these terms previously without definition. Another difficulty with the style is the continual reference to a later part of the book for the definition or interpretation of the matter under discussion at the moment. Thus such a fundamental concept as the weight of an observation is used in equations and text, in the solution of a problem of equal weights and one of unequal weights before a section is reached entitled "A digression to define weights." The term residual is used in three pages of discussion before it is defined. We find in Section 8 (p. 15) the sentence: "Least squares may also be considered the minimizing of the estimate σ (ext), to be introduced in Section 13." Such frequent reference to future sections for definitions must oblige the person who is not already familiar with the subject matter to jump back and forth in his reading or else to read without understanding. More serious from the point of view of acquiring a real understanding of the method of least squares and applying it soundly is the failure to stress the assumptions underlying the method. The inquiring student might ask why least squares is preferable to least 4th powers or least absolute deviations, and what criteria must be fulfilled to justify adjustment by this method. What discussion there is of these issues is so scattered and disorderly that it would be virtually impossible for a student to get a view of the complete set of assumptions involved in the process of least squares. The author stresses that he is interested in the practical side of adjustment, that is, in results that "can be used as a basis for action." However, in the section on curve fitting he gives the student no guidance whatever on how to select the function to be fitted. Yet every person experienced in curve fitting knows that this is by far the most difficult and critical issue of the entire procedure. The book is weak, therefore, at the very point where most guidance is needed in getting results that furnish a sound basis for action.

R Scientific Instruments 17:152–3 Ap '46. J. W. Tukey. * without a doubt the best book in English on this subject * In general, it covers the methods of least squares in all their usual applications, but does not discuss at any length when and why these methods are to be used. * With the possible exception of the first chapter, all of the material suggested by....[the] part headings is present and is treated carefully and adequately from a single unified point of view. The book is practical, since it is based on Dr. Deming's many years of experience in solving his own problems and those of his colleagues. The book is theoretical, since it emphasizes the common mathematical structure underlying the problems often treated in separate ways. It is not a textbook for teaching the practice of least squares, it presents too few numerical problems for such a purpose, but it should be familiar to every teacher of the practice of least squares, who will wish to refer to it frequently. The large number of well-chosen references, from Gauss (whose works are clearly very familiar to the author) to R. A. Fisher, R. T. Birge, and their followers, are a prominent feature of this book. The individual scientist or engineer who uses least squares will find this book a helpful reference, and will probably wish to supplement it by reference to the improvements in the numerical solution of linear equations (*cf.* P. S. Dwyer, "The Square-root Method and Its Use in Correlation and Regression") and to the philosophy of least squares (to which the reviewer can give no adequate reference). The author maintains successfully that the fitting of relations like

$$y = ae^{bx}, \qquad (1)$$

$$\ln y = \ln a + bx, \qquad (2)$$

$$y = ae^{bx} + cx + d, \qquad (3)$$

(all of which are discussed in detail on pages 191–203) is not appreciably more complex than the fitting of simple relations like

$$y = a + bx + cx^2 + dx^3 + ex^4.$$

He is able to do this because he approaches all problems in two stages, first an approximate solution (the reviewer would like to emphasize the possibility of doing this graphically) and then a least squares refinement. This requires the calculation of residuals for the approximate solution, *but allows the use of many fewer significant figures in the least squares work.* Since, in addition to saving labor, this procedure enables one to detect exceptional points at an early stage in the fitting, it is to be highly recommended. He points out that the fitting of either (1) or (2) above, *with the proper weights,* yields the same results up to terms of second order in the final residuals, saying (p. 201) "but these are not usually of much consequence if the data are worth fitting." His methods and treatment, therefore, apply to the case where the term "adjustment" is proper and legitimate. Problems where the "signal-to-noise ratio" is lower will require different analysis, more specifically adapted to the individual problem. This book gives the general method for good, clean data. An important and useful feature of this treatment is its systematic coverage of (i) only the first variable subject to error, (ii) only the second variable subject to error, (iii) both variables subject to error in a known or estimated ratio. The methods presented are sound and helpful. It is somewhat unfortunate that the example (p. 231) with all variables subject to error, includes an estimate of error for the merchantable volume of a tree in board feet. Since it is difficult to cut up the same tree twice in independent ways, it is difficult to see how this standard error was determined. (The reviewer is indebted to Dr. C. P. Winsor for this comment.) The author shows (p. 186) that when x and y have the same two weights at each point, and a straight line is being fitted, that the distribution of error between x and y alters the fitted line only through the higher power of the residuals. It is interesting to compare this result with his remarks (pp. 156, 201, *etc.*) about the general unimportance of such effect, *but it is not safe to conclude that the assumed distribution of error between x and y is without practical importance.* The concentration of the book on method rather than on philosophy or principles was pointed out in the opening paragraph of this review. There are points of the latter sort, however, with which the reviewer takes issue. The first of these is the confusion of control in the sense of Shewhart, with randomness (the reviewer has recently been guilty of this himself!). The author indicates (p. 6 and footnote, p. 220) that the Shewhart control chart is a means for detecting deviations from randomness. This was not Shewhart's purpose, and it is easy to construct artificial examples where non-randomness is in control or randomness is out of control. A state of control, in Shewhart's basic sense, is reached when *it is uneconomic* to look for assignable causes, and experience has shown that the compactness of distribution associated with a good control chart implies this sort of control. It does not imply randomness! There seem to be two reasons for this common confusion between control and randomness. First, bringing a process into control almost inevitably brings it measurably nearer randomness. (And yet a random process with a Cauchy distribution will not be "in control" on a control chart.) Second, randomness is easily discussed in a simple model by a mathematical statistician, while economic control requires a complex model without (to date) any interesting or beautiful mathematics. A closely related point seems to be the confusion of randomness with randomness combined with normality of distribution. On p. 230 the author implies that randomness is sufficient for the usual distribution of x^2, while a small change in the underlying distribution may upset the distribution of x^2 very seriously. Few physicists will need the warning on p. 171 about trusting single experiments. All will agree with the statement (p. 13) "It is more important to insist on having a series of experiments carried out under a variety of conditions, than to insist on using any particular method of adjustment." But it may help many readers of the warning on pp. 215 and 230 about believing results based on small numbers of "degrees of freedom," if they realize that this empirical feeling has arisen *both* from lack of randomness in the observations *and* lack of normality of their distribution.

South Econ J 10:317–8 Ap '44. R. L. Anderson. Dr. Deming has prepared one of the best books yet written on the application of the method of least squares to the adjustment of data. Although he says in the preface that a

knowledge of differential calculus is not needed to interpret the results, it is doubtful if anyone with less mathematics than much of the calculus plus advanced matrix theory could understand the discussions. The notation is quite complicated in most cases; hence, a good foundation in higher algebra is essential. Certain definitions used by Deming are different from those with which the reviewer is familiar. He uses the word "adjustment" to apply to any method of arriving at an estimate to form a basis of action. His main theme should be emphasized by every statistician: "The object of taking data is to provide a basis for action." Much time and money has been wasted on securing data without any basis of action ever being recommended. Also, he admonishes people not to make recommendations based on few experiments; repeated experimentation is more important than the method of adjustment. The author sometimes fails to distinguish between what is to be proved later, what is being proved now and what is accepted as already proved. As an example, he takes up the problem of estimating the value of b in the regression equation $y = bx$. Then he says that the weight of b is Σwx^2. He fails to point out that this will be proved later. Most of the exercises are excellent thought-provokers; some provide only drill material. The book certainly can be used as a text; but supplementary exercises based on data known to the students are necessary. The examples used here should appeal to engineers; in fact, this seems to be the first serious attempt to present modern statistical methods so that the engineers can use them. For the social scientist, there is an excellent chapter on adjusting to marginal totals in sample census data. Since the whole adjustment problem is of such great importance in applying sample results to the entire population so that certain results agree with known facts, everyone handling such data should read Chapter VII. For those people who have trouble understanding the whole problem of weighting observations, Deming presents a rather exhaustive treatment in his first chapters. He presents a good method of considering the analysis of variance but for some reason does not mention the F-test, which is much easier to use than the z-test. The last half of the book concerns curve-fitting for more complicated cases than $y = bx$. He makes the excellent warning to beware of extrapolating beyond the realms of the data included in the adjusting process. * Of course, Dr. Deming includes several problems with both variables in error; most people in the biological and agricultural fields have disregarded the possibility of errors in x, but in economic studies, we may not be able to do this. For example, to predict future production-price relationships from present and past ones, one can hardly imagine one variable being any freer of error than another. Only in simple time-series analysis with t as the independent variate can we assume such conditions. Here we are faced with other problems, which Deming does not consider. He constantly reiterates the necessity for normal independent variates, a condition so seldom met in time-series analysis that the whole least-squares solution becomes very complicated. Dr. Deming's work certainly presents an excellent introduction to even this complicated problem.

Trans Actuarial Soc Am 45:431–4 O '44. Hugh H. Wolfenden. * an excellent first chapter on "The Meaning of Adjustment" * As early as the second chapter the reader....will discover that he will really understand the exposition only if he is already thoroughly conversant with basic mathematical-statistical theory * The next chapter on "The Propogation of Error" sets out the fundamental propositions in determining mean-square errors, with a useful numerical example of small errors. Chapter iv then presents a mathematical statement of "The General Problem in Least Squares," based on three of the author's papers in the *Phil. Mag.* —a treatment which contains the essence of the problem in a highly condensed form but which will reveal the essentially simple underlying principle of least squares only to those who have considerable previous knowledge of the subject. The two following chapters dealing with geometric conditions will not be of interest to actuaries except for the occasional historical references for which Dr. Deming's work is always notable. Chapter vii, on "Adjusting Sample Frequencies to Expected Marginal Totals," is for actuaries probably the most useful in the book. * Notwithstanding the compressed character of portions of the exposition and the inclusion of some geometrical and physical questions with which the actuary has no immediate concern, there are many clear statements....coupled with the author's unrivaled historical background, which render this book of significance to those actuaries who are concerned with mathematical-statistical theories

and their applications in census, medical and similar investigations.

[94]

★Dixon, W. J., and Massey, F. J. **Introduction to Statistical Analysis.** Eugene, Ore.: University of Oregon Cooperative Store, 1949. Pp. viii, 219, 32. $3.75. *

[95]

★Dodd, Edward L. **Lectures on Probability and Statistics.** Austin, Texas: University of Texas Press, 1945. Pp. 44. Paper. Gratis.

J Am Stat Assn 41:133 Mr '46. Thomas N. E. Greville. * three lectures....on the theory of means or averages, together with a biographical sketch of the author. The lectures.... are of a semi-popular nature, seeking to indicate the general nature of the subject and to stimulate interest. For those who desire to read further, references are given to all the important papers. Much of the discussion in the second and third lectures centers around certain highly generalized definitions of a mean or average, of which the familiar types, such as arithmetic, geometric, and harmonic means, median, mode, and midrange, are special cases. To the uninitiated this is likely to appear a highly academic study, but the author shows by several well chosen examples taken from the fields of statistics, compound interest, and actuarial science that a number of unusual or peculiar types of means or averages are in common use for certain purposes. In the third lecture, mention is made of a number of specific properties which have been used to classify the various types of means. For example, a mean of a set of numbers is said to be internal if it lies between the greatest and the smallest of the numbers, or at worst equals the maximum or minimum value; it is said to be associative if it remains unchanged when all the numbers in any subset (taken at pleasure) are replaced by the mean for that subset. In the opinion of the reviewer, these lectures admirably fulfil their purpose of popularizing and arousing interest in the subject.

[96]

★Dodge, Harold F., and Romig, Harry G. **Sampling Inspection Tables: Single and Double Sampling.** New York: John Wiley & Sons, Inc., 1944. Pp. vi, 106. $2.50. (London: Chapman & Hall, Ltd., 1945. 20s.) *

J Am Stat Assn 40:382–4 S '45. Kenneth J. Arnold. * The sampling plans seem originally to be intended for and are best suited for the case in which the *consumer* and the *producer* are parts of the same organization or where the inspection is carried out by the producer in the interests of the consumer. * while the plans proposed are initially restricted in purpose to *acceptance inspection* (*i.e.*, to control of quality of accepted lots), the authors rightly describe their use in *quality control* (*i.e.*, in the control of quality of production). Several other sampling inspection plans are now available which admit a broader class of sampling procedures while preserving a significant part of the objectives of the Dodge-Romig plans. The inadequacy of presently available comparisons of these various plans leads one to hope that someone soon will take it upon himself to systematically list objectives and restrictions on type of sampling which have been considered, to give as far as possible, operating characteristics, average sample size and some discussion of the adequacy of each plan in attaining other than the primary objectives.

J Appl Physics 16:260–1 Ap '45. Leslie E. Simon. * these tables apply only to inspection by attributes * Manifestly they are not adapted for use where testing or inspection is of a destructive nature, since the system requires that the entire lot be inspected when the sample is more defective than a tabulated value. Statistical theory has provided some additional techniques for acceptance inspection, since the papers reprinted in this book were written. Among these are sequential plans and operating characteristics, and also the minimization of combinations of cost and risk other than simply the cost of inspection. These things should not be held against this valuable piece of pioneering work; they are mentioned only by way of warning against blind following of any stereotyped procedure in this subject. "Sampling Inspection Tables" comes as close to being a safe guide for engineers not familiar with statistical theory as any book available. In time, such tables as these may become widely used in writing contracts between manufacturers and large scale purchasers, to provide each with a criterion of quality which is both economical and objective. But it may be found in the end that the greatest benefit accruing from these tables will be neither this nor their primary purpose of direct protection for the purchaser, but instead the *reaction of the sampling plan on the manufacturing process.* *

J Royal Stat Soc 109:297–8 pt 3 '46. A. W. S(wan). * The book suffers considerably from

the fact that it is a reprint of three articles. The subject of statistical sampling is so important, and Dodge and Romig's contributions to the general thought have been so well worth while, that one would suggest that the book be rewritten as a single entity, and that in the near future. When this is done there are suggestions which can be made as to improvements and additions. In the first place, although the tables are admirable in their practical lay-out, they are not completely consistent in themselves, and show signs of rather too much smoothing out. Revision of the tables from this point of view is definitely indicated. The graphs from which sample size and rejection numbers can be determined are not sufficiently simple to use, and should be entirely re-designed. Recognition should be made of the limitations of the system; and some of the practical consequences which cannot be avoided, and must be accepted by the user, should be weighed against the very great advantages. For instance, with sample-100 per cent. inspection, the number of inspection staff is bound to vary, and so must the inspection facilities (interim storage, *etc.*), and the inspection time-lag. Variations of this type will depend on the closeness with which the incoming percentage of defectives corresponds to the Process Average. The authors might well devote a section to problems of this type which are of great importance to the executive who is to use a sampling scheme of inspection. The practical notes are very good, but it is suggested that they could be amplified to include: (*a*) a comparison of the use of "screening" sampling for single lots of purchased material with quality control charts, (*b*) notes on applications in other types of businesses other than those manufacturing electrical apparatus, with information on A.O.Q.L. found acceptable in practice in different industries.

Mech Eng 67:276–7 Ap '45. Eugene L. Grant. * fills a need for available literature on the subject * should be in the library of every inspection department and should be available to all who have responsibility for planning inspection programs.

Nature 155:438–9 Ap 14 '45. M. G. Kendall. * The computation of the tables was no easy task, even with the help of various approximations. The values given are no doubt sufficiently accurate for working purposes, but it seems possible that the methods employed of arriving at them are capable of improvement and refinement. The whole subject furnishes an interesting field for research in practical mathematics; and in the meantime the Dodge-Romig tables continue to do first-class service to industry.

R Scientific Instruments 16:93–4 Ap '45. S. S. Wilks. * These tables....have served as the basic source of many of the sampling inspection plans now used [illegible] the country. The demands for the tables have been very large, and the authors have done a valuable service to production and quality control engineers in making their earlier work available in a single book. *

[97]

★Dodge, H. F.; Wilks, S. S.; Simon, Leslie E.; and Gause, G. R. **Symposium on Usefulness and Limitations of Samples.** Presented at the Fifty-First Annual Meeting, American Society for Testing Materials, Detroit, Michigan, June 22, 1948. Reprinted from Proceedings of the American Society for Testing Materials, Vol. 48. Philadelphia, Pa.: the Society, December 1948. Pp. v, 39. Paper. $1.00. *

[98]

★Dudding, B. P., and Jennett, W. J. **Quality Control Charts: Being Part 1 of a Revision of B.S. 600:1935, The Application of Statistical Methods to Industrial Standardisation and Quality Control.** B.S. 600R:1942. Reprinted with Amendments December, 1942. London: British Standards Institution, 1942. Pp. 89. Paper. 3*s.* 10*d.* * (New York: American Standards Association. $2 25.)

Gen Elec R 49:70 My '46. A. V. Feigenbaum. An as yet little developed area of quality-control practice receives some welcome attention in this study of simplified methods used by the British in the application of control-chart limits to engineering and manufacturing specifications. * Questions of detail could certainly be raised with the authors, but the excellence of their general approach is such that their book warrants attention from any quality-control advocate.

J Am Stat Assn 40:386 S '45. Harold A. Freeman. [See 99 for a joint review.]

R Scientific Instruments 17:151–2 Ap '46. Walter A. Shewhart. * this is an outgrowth of a former British Standards Association publication, 600-R:1942 on *Quality Control Charts* by the same authors. Any one interested in the "why" as well as the "how" will wish to consult this earlier publication as well as a still earlier BSI pamphlet (1935) on *The Application of Statistical Methods to Industrial Standardization and Quality Control* prepared by Professor Egon S. Pearson *

[99]

★DUDDING, B. P., AND JENNETT, W. J. **Quality Control Chart Technique When Manufacturing to a Specification: With Special Reference to Articles Machined to Dimensional Tolerances.** London: General Electric Co., Ltd., of England, 1944. Pp. iii, 74. Paper. 2*s.* 6*d.* (Highland Park, N.J.: Gryphon Press, 1945. $1.00.) *

J Am Stat Assn 40:386 S '45. Harold A. Freeman. [Also a review of *Quality Control Charts* (see 98) by the same authors.] These two publications explain to practical readers the construction and use of quality control charts. The first is Part 1 of a revision of an earlier publication by Professor Egon Pearson; the second covers about the same ground, with heavy emphasis on the relation of engineering tolerances to quality control technique. Both jobs are well done. Quality control charts for attributes and variables are described in great detail; there are many arithmetical examples, complete glossaries and much practical advice. The usual tables covering the sampling variation of commonly used statistics are included. Emphasis is on the applied side where the authors have had, obviously, considerable experience. The two publications cover about the same ground as do the American pamphlets issued by the American Society for Testing Materials and the American Standards Association. The British publications are somewhat more complete, the American a little easier to read. It is possible that this particular job has now been done well often enough. The reviewer would welcome a pamphlet on the statistical theory on which quality control rests for this is not quite as obvious and ironclad as these excellent applied publications make it out to be.

[100]

★DUDLEY, JOHN W., JR. **Examination of Industrial Measurements.** New York: McGraw-Hill Book Co., Inc., 1946. Pp. ix, 113 $2.00. (London: McGraw-Hill Publishing Co., Ltd., 1947. 10*s.*) *

Chem & Eng News 25:1695 Je 9 '47. Paul S. Olmstead. * A commendable feature....is the stress placed on the importance of order in the statistical examination of a set of observations. Unfortunately, the book is marred in many places by loose statements that are apt to lead to trouble. There is hardly a page without some statement that is not clear, is half true, or is incorrect. No topic is discussed in sufficient detail to serve as a safe guide to practice. The examples, most of which are presented in a way that suggests fictitious origin, do not show the dollar and cents importance of the application of statistics. It is doubtful that this book will be of much service to chemists.

J Am Stat Assn 42:312–3 Je '47. C. West Churchman. * the language of the little volume is designed for the engineer who wishes to be "eased" into his mathematical thinking. The development is gradual, and the points are extremely well illustrated. Since the book is designed for very widespread use among persons unfamiliar with statistical methods, it suffers considerably from loose or unqualified terminology and symbolism, apt to deceive the unwary into an illogical application of the methods. For example, it is certainly unwise to take the "betting odds" for limits recommended by A.S.T.M. and A.S.A. as "standards" (p. 6) since the odds differ so widely depending on the product. The specification for a sample size between 300 to 600 for making "reliable estimates" (p. 11) for large lots is also arbitrary. The discussion of randomness (pp. 17–18) is far too brief for any real understanding, and is better eliminated or else replaced by a more careful analysis of the meaning of the randomness presupposition relative to the application of the methods. Perhaps the greatest flaw, however, occurs in using the same symbol for sample estimates and for the true values of the parameters of a population. Thus, the empirical formulas for $\bar{X}$ and σ (pp. 23–4) are incompatible with the formula for the normal curve (p. 32), and the formulas for its areas (p. 36). So often, especially in quality control manuals, an appeal is made to "large sample theory" as an excuse for a failure to distinguish between estimates and true values, as though there were a different logic associated with large samples, from the logic we associate with small samples. The carelessness of terminology *may* be less important for large samples, but this point can scarcely be established without some rigorous analysis to begin with. And it is not difficult to discuss the nature of the true parameters of a population independent of the calculus. The failure to make the mathematical model explicit is apt to lead the layman into a very serious misconception of the underlying logic of statistical methods in quality control. In sum, the book is an adequate summary for the engineer who does not plan to apply statistical methods, but merely wants to know what is "going on" when such methods are applied; it is a very poor introduction for the engineer who wishes to

know the logical basis for the proper application of statistical methods in quality control.

J Am Stat Assn 42:313–5 Je '47. Joseph Manuele and Roscoe Byers. * the author.... succeeds in acquainting the reader with the standard source material on the various aspects of statistical techniques. The bibliography given at the end of the book is complete, and the author makes reference to the various authors throughout his book. The author neither develops any new methods in statistics nor presents completely the methods which have been perfected by others. His general method is to present a problem, show the reader the general method of solution, and then refer him to the proper text in the bibliography, where a complete discussion may be found. The author makes a strong case, and justly so, for the benefits to be derived from the application of statistical methods, but the reader had better be prepared to do a considerable amount of collateral reading if he wishes to master this subject, or even become familiar with it. * [The] subject of central tendency and extent of variation could receive more attention because of its importance. However, authors in general pass it off with a paragraph or two, leaving the reader to acquire understanding through experience. * the use of quartiles for data appreciably skewed is brought out with interest. In the discussion of the theory of sampling, neither probability nor risk is defined or mentioned in any manner. No presentation of the subject of sampling is complete without at least sounding a warning of the risks involved; the author would have done well to have mentioned them. The subject of runs is treated in an interesting manner, and a few rules-of-thumb are given which, if applied, will enable the engineer to detect and question suspiciously long runs. * Curve fitting with lines of variation for control purposes is nicely presented by the author. By following through in his treatment of curve fitting, to computing control lines of variation, the reader not only should gain a means of finding assignable causes but also will have a simple check on the goodness of his curve fit. Although nothing new is developed, the text is easy reading for the beginner with good recommendations for further reading. It is a good book for the beginner to have around, for it tells him where to go to get the answers to his problems in the application of statistical methods. The bibliography lists the books which should be in the bookcase of anyone wishing to establish a personal library of the best in statistical literature.

J Am Stat Assn 43:172–3 Mr '48. [For critical comments not excerpted, see John W. Dudley's reply to the above reviews by C. West Churchman, Joseph Manuele, and Roscoe Byers; and C. West Churchman's rejoinder.]

J Bus 22:70 Ja '49. Irving W. Burr. The author says....:"This book is an attempt to acquaint the engineer with some useful, simple, and adaptable statistical tools and to enable him to collect data in such a manner that they can be subjected to more elaborate analyses when such analyses are necessary and justified." The aim, on the whole, is fulfilled. * in a book of 113 pages only a brief introduction to each of the many topics can be made. This reviewer doubts that the reader who is relatively unacquainted with statistical methods will be able to apply the techniques discussed after reading the book. He should, however, have gained some idea of what statistical tools are like and may well have had his appetite whetted for further study. One of the better features of the book is the inclusion of many short examples to illustrate the techniques in application situations. Some novel ways of using the median and quartiles are included which are of interest, even if not so statistically efficient as those using the mean and standard deviation. The balance of emphasis does not always seem good. To spend only 18 pages on the control chart and none on acceptance-sampling does not seem sound. There are a number of technical imperfections, as, for example, the following: Articles 4.3 and 4.4 are too brief to give an uninitiated reader any real conception of averages and variability, since there are but a little over four pages with nine measures mentioned. A quartile is indicated as a measure of dispersion, which it cannot be, at least by itself. The example on page 28 will not appear, to a layman, to utilize either of the preceding formulas for standard deviation. On the top of page 43 the author talks about "correcting" an average range, which is hardly the word. In article 6.7 it is important to have had "good control" on the variability chart before it is worth while to try to estimate population variability. This is fundamental and is not mentioned. Also, it is suggested on page 52 that to estimate population variability it is desirable to break up a set of thirty measurements into subgroups of only

two or three each. Two subgroups of seven and two of eight are much more efficient. The control-chart approach for significant differences on page 73 gives a false impression that there is significance at just the "3 sigma" limits, but actually it is at "4.2 sigma." The efficiency of the median and quartile methods presented needs to be studied further. On the whole, the book would seem to serve the "acquaintanceship" aim rather well, but it can hardly be regarded as an adequate presentation of the methods for application because of its brevity and imperfections, such as those just listed.

[101]

★Edwards, Allen L. **Experimental Design in Psychological Research.** New York: Rinehart & Co., Inc., 1950. Pp. xv, 446. $5.00. *

[102]

★Edwards, Allen L. **Statistical Analysis for Students in Psychology and Education.** New York: Rinehart & Co., Inc., 1946. Pp. xviii, 360. $3.50. *

Am J Sociol 52:286 N '46. Josephine J. Williams. The author claims two distinctive features for this text: it demands almost no mathematical training beyond arithmetic, and it emphasizes small-sample techniques (pp. vi, vii). If it is advisable to teach modern statistical methods to persons unable to follow the simplest algebraic proof, at least we should make sure that the basic concepts and the limitations of statistical analysis are clear. In my judgment, the book fails to do either adequately. It is not necessary, for instance, to complicate the first computation of a median by inserting incidentally the definition of a frequency distribution, a discussion of the approximate nature of physical measurements, and the theory and technique of linear interpolation (pp. 41–43). Nor is it necessary to present "coding by division" as hocus pocus used to compute a mean (pp. 63–65), when all that is involved is the familiar notion that lengths, say, may be expressed in either yards or feet, and a mean may be computed in whichever unit happens to be more convenient. Although he is careful to avoid some of the errors common in discussions of tests of significance, Edwards does not consistently encourage his readers to be critical. To take a glaring instance, analysis of variance is illustrated by reference to hypothetical achievement scores for 10 students, 5 of whom were taught by the lecture method and 5 by the project method. Without a hint of the other factors that might influence the result or of the universe to which the conclusion would apply, the author concludes on the basis of the F test that "....we may be quite confident that the difference in achievement....is indicative of a real difference, or, *in other words, that achievement is reliably greater under the lecture method of instruction*" (p. 199, italics mine). Edwards disposes of the theoretical justification of depending on small samples in two sentences (p. 288):

> With respect to this persistent question of how many cases one should use, there is no one set answer. But we agree with McNemar "that the demonstration of a difference (or effect) which is large enough to possess any practical or social significance will not require large samples; certainly, a difference which is so small as to require 1000 cases in each sample to demonstrate it is apt to possess little psychological meaning" (Quinn McNemar, "Sampling in Psychological Research," *Psychological Bulletin*, 37, 1940, p 340).

Capping one quotation with another is no way to settle the issue, but we may note that McNemar himself has recently written:

> Despite the fact that the mathematical statisticians have provided ways for evaluating statistics based on small samples, the writer feels that the sampling techniques in social science are seldom if ever sufficiently adequate to justify using small samples. ("Opinion-Attitude Methodology," *Psychological Bulletin*, 43, 1946, pp. 339, 340).

Some sections of the book are better than those we have cited. The interpretation of the product-moment formula for r is good (pp. 87, 88), as is most of the chi-square chapter. The Bibliography is more than adequate. * On the whole, however, the book that is to succeed in the ambitious attempt to present so many modern methods to students unfamiliar with algebra must be better written, better organized, and more critical.

Brit J Ed Psychol 16:181 N '46. W. D. W(all). * written for those whose mathematical notions are rudimentary * the treatment is concrete and practical in application to those kinds of problems which confront the research worker in the social sciences. In this way it has advantages for the elementary student which outweigh the greater comprehensiveness and elaboration of such books as Snedecor's. The topics and techniques dealt with cover most of the range which is met with in research and the few omissions are points of specialised interest or methods which are no longer so widely used * more attention than is usual in an elementary text book is paid to tests of significance, the

analysis of variance and techniques applicable to small samples. * the stress is upon the design of experiments and the collection of data with definite statistical methods in mind rather than upon the application of statistics to unsystematised data at a late stage. Particularly interesting and valuable in this respect is the concluding chapter on "Research and Experimentation" in which the logical assumptions underlying the more important psychological and educational experimental set-ups are discussed. The book is well equipped with tables to simplify calculations and has a full bibliography of articles and books on statistical methods as well as references to research material which illustrates the use of the more common techniques.

Brit J Psychol 37 109 Ja '47. * The scope.... is more ambitious than is usual in elementary treatises. In addition to explaining the usual methods of computing means, standard deviations, correlation coefficients, chi-squared, *etc.*, he includes two chapters on the analysis of variance and gives Kelley's "epsilon" form of the correlation ratio. There is also a useful final chapter on experimental design. The writing is clear throughout, although the conversational and detailed style, particularly in the earlier chapters, may be irritating to intelligent readers. There is a good selection of exercises, with answers, and the student who works steadily through the book should have little difficulty in learning to compute the varied statistics described. Whether he would also acquire sufficient statistical insight to apply the appropriate methods to particular observational material is another matter. For example, the underlying assumption of normality in most tests of significance is indeed mentioned, but not stressed, and the reader may easily form the impression that most psychological qualities and attributes are in fact normally distributed. Again, in the cause of simplicity, the author works his examples with very small numbers. He constructs a grouped-frequency correlation table, for instance, with only thirty-two cases and performs an analysis of variance with only ten observations. This is rather dangerous for the uncritical student, who may gain the impression that statistical methods are very powerful tools for extracting reliable information from very meagre data. The insistence throughout on reducing the arithmetical labour of computation by "coding," or working from arbitrary origins, is good. The book may safely be recommended to elementary students working under the guidance of an experienced statistician. It should be read straight through before beginning detailed study and the discussions and warnings in the last chapter borne in mind thereafter.

J Am Stat Assn 41:397–8 S '46. David A. Grant. * not just another elementary statistics book. Unusual features and clean breaks with tradition are to be found in both structure and content, and several of the unique features are to be applauded. For example, one-third of the book is given over to the statistics of small samples, and *two* chapters are devoted to analysis of variance. * Other good points....include clearly written elementary chapters on "Probability and Frequency Distributions" and "Research and Experimentation," modern sampling treatment for the correlation coefficient, the use of the Charlier checks in computation, and a chapter on elementary algebra. This last-mentioned chapter is perhaps a bit too elementary omitting logarithms and exponents. * One can scarcely approve of....the deliberate omission of any treatment of the reliability of test scores. To begin with, this material has unique value for students in psychology and education. Its absence detracts materially from the usefulness of *Statistical Analysis* as a general elementary textbook in statistics for psychologists and educators. Furthermore, in spite of Edwards' comment that it does not "fall within the general orientation of the rest of the book," fallibility is a property of *all* actual mensuration, including reflex magnitudes, discrimination limens, reaction times, and other measures from "pure" psychology. To omit the topic of reliability even from an experimentally oriented statistics book such as *Statistical Analysis* would seem to encourage superficial interpretation of the nature of measurement in general. In the reviewer's opinion, *Statistical Analysis* suffers from a number of pedagogical weaknesses. These include: (1) an undesirable multiplicity of definition and computational formulae which seems bound to confuse the elementary student; (2) instances of unnecessary notational complications, such as the use of v for σ^2, and z for the critical ratio or significance ratio which requires the following footnote (p. 186): "Fisher has introduced a transformation of r into another statistic which is known as z (not to be confused with the z mentioned earlier)";

and (3) introduction of Peters and Van Voorhis' ϵ^2 as an alternative to F in analysis of variance, accompanied by the statement, "You may wonder at this point whether F or ϵ^2 should be used as a test of significance in a given problem. There is no definite answer to this question" (p. 236). It seems to the reviewer that an elementary textbook should avoid such sources of confusion. The reviewer's chief criticism centers around the general emphasis of the book. The reader, intrigued by the list of chapter topics, and led on by a promise in the preface that emphasis is to be upon use and function rather than calculation, is doomed to a real disappointment as he works his way through calculation after calculation, coding technique after coding technique. On the topic of correlation, for example, 12 pages are expended on the development and use of definition and computational formulae, but only two and one-half pages are given to interpretation of r, and most of this is rather superficial. In this respect, it would seem that Edwards is caught up in precisely the very "vicious circle" he promises, in the preface, to break. With respect to statistical errors, Edwards' book is very much like the first editions of most elementary statistics texts which reach the market. The slips are disconcerting, but minor. They include: (1) the statement that computation of the probable deviation requires computation of the S.D. (p. 50); (2) an inaccurate technique used to obtain fiducial limits for a proportion (p. 169); (3) a remark that [illegible] will cause no serious error in the S.D. (p. 70); (4) a formula for t which holds only when $n_1 = n_2$ (p. 182); (5) an erroneous assertion about σ_r (p. 185); and (6) an interpretation which accepts the null hypothesis when χ^2 does not exceed the 5 per cent point (p. 247). *Statistical Analysis* is better than many current statistics books. But, because of the points mentioned above, the reviewer does not think that it will prove to be an excellent teaching text. He does not rate it in the same class with the elementary texts of Lindquist and Helen Walker. Edwards' book is, in many respects, a more forward-looking text, but it lacks the teaching finesse and the depth of interpretation of its best available competitors.

J Am Stat Assn 42:315–8 Je '47. J. H. Curtiss. * the viewpoint is based entirely on modern sampling theory, except in the discussion of regression in the next to the last chapter * an overly abbreviated discussion of probability and frequency distributions * a good discussion is given of the advantages and disadvantages of pairing observations * The usual test for linearity of regression is....[included in the chapters on analysis of variance], although it would seem that this material should be relegated to the chapter on regression. * the purely descriptive approach in the chapter on regression is something of a letdown * The author seems to have followed a well-thought-out plan of graduating the difficulty of concept and rigor as the book progresses. * There is an abundance of interesting exercises for the student. * This reviewer can offer only a lay opinion on the author's choice of topics. There are certainly some rather spectacular omissions, such as the failure to cover the problem of the reliability and validity of tests; these will surely be criticized adversely by teachers in the behavioral sciences. * It nevertheless seems to this reviewer in the light of experience in other fields that the author has written an up-to-date text at the level at which he set out to work and has done a good job of organizing the material. The shortcomings of the book seem to fall into two categories: those which arise from the mathematical deficiencies of the intended audience and those which arise from an uncritical use of the available reference literature. * the author, in his attempt to meet the limitations of his readers, fails to give enough elementary distribution theory to enable him really to put across any of the descriptive concepts connected with continuous distributions. The thought seems to be present in his mind that the meaning of a continuous distribution will be clear to the student from outside sources of information. In any case, the "normal distribution," identified by that name, suddenly appears out of the blue sky on pages 39 and 40 in the midst of very elementary talk about the mean and variance of a set of numbers, before frequency distributions have been defined. Indeed, there is some room for doubt as to whether the author himself is entirely clear about the meaning of a distribution curve, because on page 141 he announces twice that the ordinate of the normal curve equals the frequency at the corresponding point on the "base line," and his method of curve fitting (p. 143) seems somehow to involve fitting ordinates rather than areas. But perhaps he got that idea from the literature on which he relies so heavily, because the concept appears on pages 299, 301, and 367 of Peters and Van

Voorhis. This reviewer found the rather abject dependence of the author on the reference literature, and in particular on secondary sources such as Peters and Van Voorhis, most annoying. No less than 102 references are listed in the course of the book. From time to time, apparently quite trivial assertions are supported by references * It is probably too much to expect that the author of a text on statistical methods in the behavioral sciences should be a highly trained mathematical statistician, but if such an author chooses to proceed in a completely derivative manner, the state of the literature is such that he might do well to seek guidance and criticism from an expert. It might be well to point out in this connection that Peters and Van Voorhis has been severely criticized on grounds of fact and rigor; the reader is referred, *c.g.,* to the review by F. F. Stephan in the *American Mathematical Monthly* for December 1941. In addition to the identification of ordinates with frequencies mentioned above, a number of the other errors in Peters and Van Voorhis pointed out by Stephan are carried over in this book. The following additional criticisms may be worth noting here: (*a*) The advice given on page 201 to the effect that a significant F test can be pursued by specific comparisons with the t test needs careful qualification, (*b*) the additivity and independence assumptions inherent in the analysis of variance model are never clearly stated, and (*c*) no information is given in the text or tables as to whether the tabulated distributions of r, t, F, and ϵ^2 are one-tail or two-tail tables, and no instructions are given for coping with negative r and ϵ^2. Perhaps these errors and omissions can be corrected in a second edition. The really important thing is that the author has made a serious and carefully planned approach to the problem of presenting the modern point of view at a low level of mathematical sophistication. It is the opinion of the reviewer that the book should prove to be a successful classroom text, provided that the omission of certain subjects held in high esteem by teachers of the behavioral sciences does not limit the usefulness of the text too much. From the statistical point of view, in spite of the blemishes pointed out above, it is as reliable as any of the currently popular textbooks in its field, and the mistakes are more than balanced by the progressive, forward-looking point of view. Moreover, quite proper emphasis is given to the importance of providing insight into the rationale of the statistical method.

J Appl Psychol 31:460–2 Ag '47. Kenneth E. Clark. * The advance publicity given the book having emphasized the summary of mathematics which it includes, the reviewer expected much more of a treatment than he found. The fifteen pages allotted to this topic give space for little more than a brief statement about each item, and give evidence either of excessive cutting or quick preparation. The lucid writing which characterizes the rest of the text gives way to such teasers as these: "The summation of a variable divided by a constant is equal to the summation of the variable, divided by the constant" (p. 25); "To find the number that a given proportion of a total equals, multiply the total by the proportion" (p. 18), and, "The summation of an algebraic sum of two or more terms is the same as the algebraic sums of these terms taken separately" (p. 24). A student who requires very much review of mathematics will find little help from this chapter. Excepting the chapter reviewing basic mathematics, the textbook is an exceedingly well written and easily understood text. The organization of material is in places unorthodox, but defensible as making easier the comprehension of the material presented. The integration of small sample statistics as an essential part of the discussion of large sample methods gives the book a coherence and logic which should serve to decrease the confusion which usually results when the introduction of small sample methods is delayed. Precision of description and definition of statistical terms and operations seldom suffer from the style of writing which Edwards uses, although there are a few statements where processes are short-circuited as in the following: "We pool the data of the two groups to get our hypothesis and then calculate chi-square, assuming the hypothesis to be true" (p. 249). In writing a text which would be easily understood by the beginning student, Edwards has also written one which adapts itself to self study more readily than any other book in the field. The industrial research worker, for example, who needs some review of statistics, or who needs a book to give to an ambitious but undertrained assistant, will find this book well suited to his needs. Students of psychology who need review of elementary statistics will find the book very usable. Professional psychologists who wish to become better acquainted with the

elementary aspects of the newer types of small sample statistics will find this volume an excellent reference.

Occupational Psychol 21:149–51 Jl '47. R. Cockett. * a very readable book giving an elementary but basic presentation of correlation techniques, sampling theory, tests of significance, analysis of variance and regression. * It is a little disconcerting to meet mistakes in Edwards's book, meant for beginners. *

Psychol B 44:183–5 Mr '47. Joseph Zubin. * A notable omission is the graphic treatment of distributions, and this is regrettable since some guidance in the graphic presentation of frequency polygons (or histograms) is an essential part of a student's training in elementary statistics * The treatment of fiducial limits and reliability of means....is treated here accurately but in a rather verbose manner. It is gratifying to see that analysis of variance has been finally divorced from the barn-yard imagery which adheres to this term in agricultural and biological textbooks. The chapter on χ^2 is primarily devoted to the treatment of qualitative or enumerative data and it would seem better to give it such a title. In general, this tendency to deal with the names of special techniques as chapter headings rather than with the contents of these techniques is unfortunate, for it gives the student the feeling that statistics is made up of disparate tools. It would be much better to organize the content according to topic and let χ^2 and comparison of percentages, for example, fall into the same group. Similarly, analysis of variance could well form part of a chapter or a series of chapters on comparison of means and thus give the student an integrated point of view regarding critical ratios, t tests, F ratios, and correlation ratios. This is done to some extent on p. 199, but because of the segregation of the techniques into separate chapters it may appear to be an accident rather than a necessary result. By bringing these methods together, the consistency of different treatments can be demonstrated and the unity of statistical method stressed. The final chapters on sampling prediction and design of experiments fulfill a basic need in an elementary text. In general, the text's chief advantage lies in the fact that it draws its material entirely from psychological sources and thus makes the student of psychology feel quite at home within its pages. In some respects, it descends to quite an elementary level, presuming very little, perhaps too little, on the part of the student. In other respects, especially in the chapter on analysis of variance, it goes far beyond the proper limits of an elementary text. In common with the majority of elementary texts, this book devotes little space to the consideration of even simple curvilinear relationships with the result that the student gets the impression that psychological data are primarily linearly related, and that functional or curvilinear relationships do not exist, are due to artifacts or are beyond the pale of psychological investigation. As a consequence, the student of psychology is completely at a loss when he begins to deal with such nonlinear relationships as the Weber-Fechner Law, the many functional relationships in the field of visual and auditory perception, and the growth curves in developmental psychology. The treatment of functionally related variables is no more complicated than that of analysis of variance or the correlation coefficient. Since it is so useful to the student of psychology it should find a place in the elementary texts.

Psychometrika 12.235–6 S '47. William B. Michael. * the author wisely has inserted....a survey of elementary principles of high school mathematics * Clearly evident is the emphasis upon small sample theory in harmony with the current trend in published research. The author presents in a lucid style two fairly comprehensive chapters upon analysis of variance—a distinct contribution to the subject matter of text books in psychological and educational statistics. Numerous illustrative examples for both independent and matched groups serve to clarify the applications of analyses of variance. * Among the best written and most helpful of the chapters is the....one upon research and experimentation * In another meritorious chapter, "Predictions and the Evaluation of Predictions," familiar topics of regression are considered. Particularly clear in its presentation is the chapter concerned with elementary probability and the binomial and normal distributions. * Much needed is an elementary, but adequate, discussion of reliability and validity of measures. Omission of consideration of the fallibility of measures is likely to leave the beginner with a distorted and unrealistic grasp of the actual precision of educational and psychological measurement. Some of the more recent trends in thinking upon the reliability and validity of tests might well have been in-

cluded. A helpful feature....is a set of examples at the conclusion of each chapter along with answers. Another aid is the comprehensive bibliography of one hundred and two references. Two tables not frequently found in current texts include one of values of the epsilon-square test at the five per cent and one per cent levels of significance and one of random numbers. * Technical errors are minor and few. * A technical point of considerable interest which is discussed at length (pages 179–180) is that of the number of degrees of freedom in the estimate of the standard error of a difference between means of samples in which the individuals of one sample have been paired with those of the other. Although *Statistical Analysis for Students in Psychology and Education* is forward-looking in its content, the omission of certain "traditional" topics, the value of which is still apparent, is regrettable. Familiar texts in the field by Garrett, Guilford, Lindquist, and Walker appear to be better oriented to most introductory courses in statistical method than is Edwards' book. The reviewer does recommend highly, however, its use as a reference aid and as a source of exercises.

[103]

★Eisenhart, Churchill; Hastay, Millard W., and Wallis, W. Allen; Editors. **Selected Techniques of Statistical Analysis: For Scientific and Industrial Research and Production and Management Engineering.** By the Statistical Research Group, Columbia University, Applied Mathematics Panel, Office of Scientific Research and Development. New York: McGraw-Hill Book Co, Inc, 1947. Pp xiv, 473. $6.00. (London: McGraw-Hill Publishing Co., Ltd., 1948. 36*s*.) *

J Am Stat Assn 43:321–3 Je '48. Henry Scheffé. * Almost anyone confronted with practical problems calling for statistical methods may be assured of finding in this book material of value to him, providing he has some background of statistical knowledge, perhaps the amount acquired in two year courses in statistics. A very thorough index of 43 pages of fine print increases the usefulness of the book. It would not be suitable for a textbook for various reasons, including the specialization of the subject matter. * Among the nonuniform aspects of the chapters is the mathematical preparation assumed on the part of the reader * Mostly the authors have conscientiously tried to meet the needs of the "practical man" for whom the book was written, and if he happens to be also a mathematician he may occasionally find somewhat painful† the verbal arguments where he would use symbolic. If unifying motifs are sought in this work, one is to be found in the wide use of the concept of the power function or operating characteristic of a statistical test; this occurs in chapters 1, 5, 6, 7, 8, 12, 14, and 17. The reviewer considers one of the main virtues of the book to be the influence it will have in making this concept a tool of the practitioner. The book brings to the reader a large amount of material which has been available before only in periodicals. Not even thus available has been much of the content of chapter 3 on multivariate quality control. Aside from the novelty of applying the T^2-type of statistic to quality control problems, we note also the following innovations: The distance apart of the control lines on the control charts depends on the length of the base period from which they are calculated (the distance decreasing with increasing length). "Yardsticks" are introduced on the control charts which allow us to judge whether the difference of the ordinates of two points is statistically significant. Where the ratio rather than the difference is statistically appropriate, the yardstick device is retained by use of a logarithmic vertical scale. It is clear that this group did some very fine statistical work. For their efforts in rescuing some of the results of permanent value from burial in the files the director of the group, Professor Wallis, and the other editors deserve congratulations.

J Bus 21:263–5 O '48. Paul Peach. * Since the chapters are by various authors, we might describe the work as a set of pamphlets bound for convenience as a book. The viewpoint, surprisingly uniform considering the divided authorship, is that of the physical scientist or testing engineer. To statisticians working in other fields this treatment may cause disappointment. Until recently engineers looking for study material in statistics have had to rely mainly on biological publications, and they have tended to shirk the job of translating articles on crop fertilization or animal husbandry into engineering language. *Selected Techniques* in a sense turns some of the tables, but not all. It presents enough material not readily available elsewhere to make its study by biologists worth

† Also that the one formally stated theorem in the book (p. 409) is possibly false, the proof certainly is, and in the two applications to discrete distributions the conditions of the theorem are obviously not satisfied [condition (14)]. Among the errors in the proof is the unjustified equating of $E(XY)$ to $E(X)E(Y)$ in several places A correct theorem of the sort attempted, namely, one that is easily and widely applicable, would be nice to have

while; but the engineers will still have trouble, for *Selected Techniques* is relatively advanced and assumes an elementary knowledge of statistics which is still most readily available in the biological texts. * these scientists will classify the book as a highly mathematical work solely because of the unfamiliar notation * How many such readers will turn to the section on notation for enlightenment? (This section, incidentally, is excellent.) It is easy to find minor faults. Mr. Bowker's definition of tolerance limits (p. 97) is certainly not the one generally used by design engineers. Hotelling's chapter on multivariate quality control is so long as to be forbidding, and it seems unlikely to this reviewer that his suggestions will get much consideration from testing engineers without being either considerably condensed and simplified or else elaborated into a book. The typography is on the whole good, though in a few places....it could be improved. All these are of little importance, and indeed a book with no greater faults than these might be called a paragon. Nevertheless, there is among all the roses one wilted bloom. Chapter vi, on "Variability of Amount of Inspection for Double, Multiple, and Sequential Sampling," should be either omitted or drastically revised in later editions. This chapter presents two sets of "equivalent" sampling plans and considers the average amount of inspection demanded by each. Now "equivalent" here should mean "having identical operating characteristics." This requirement cannot be met exactly, so we must be content with approximate equivalence. But chapter vi does not give a mathematical criterion for "approximate equivalence" and instead adopts the plans of the Navy manual as equivalent. In point of fact, the double sampling plan of Table 6.1 (p. 239) is not a very near equivalent of the other two, and the meaningfulness of the subsequent comparisons is thus considerably obscured. Moreover, the double sampling plans selected for comparison are by no means the most efficient possible, and as a result double sampling appears in an unnecessarily bad light. Nowhere is it pointed out that for a very large class of inspection-cost functions there exists a considerable region in which *efficient* double sampling plans are more economical than either single or sequential sampling. Save for this bobble, *Selected Techniques* sets a standard of excellence, in both theoretical competence and literary and expository clarity, that will be a challenge to statistical writers for a long time to come. It is a work of reference and can hardly be used as a textbook except possibly for graduate study. One can only regret that so few physical scientists have enough knowledge of elementary statistics to use the book, and hope that statistical training may become more usual in science and engineering curriculums. Meantime, the statistician who meets problems in technological fields will find the book most useful.

J Royal Stat Soc 110:367–8 pt 4 '47. S(tefan) V(ajda). During the last war the Statistical Research Group of Columbia University carried out work for the Applied Mathematics Panel, which administered contracts of the Office of Scientific Research and Development, the vast organization set up in the United States to utilize the scientific man-power of the country. The scope of the Panel included "Probability and Statistical Studies," and American statisticians have indeed proved that they were equal to their task. The staff of the Columbia group was drawn from universities and research organizations throughout the country, and included some of the foremost exponents of statistical theory. Naturally its work was mainly concerned with problems arising directly out of the war, but it is a pleasure to find that, as in Great Britain, statisticians of a more theoretical frame of mind were encouraged to make their contributions by developing theories incidental to their main duty of assisting the Army, the Navy and the OSRD in the statistical aspects of their problems. At the end of the war the group disbanded and it was felt that their results should be made available to a wider public. Some of the reports are still "classified," and thus only allowed to be communicated in confidential documents. Others have been published in book form or in papers, mainly in the *Annals of Mathematical Statistics*. Into this category belongs Sequential Analysis, which A. Wald developed as a member of the group. There remained work of, perhaps, less importance, which the group did not wish to be buried in inaccessible files and a collection of it is here presented as a book. This is probably a fair way of letting all members of the group have their share in deserved publicity, but it is responsible for a presentation much less even than one might wish for. * It is clear that the reader of such a book cannot focus his attention on any particular subject. He might

still find it useful for reference, if it were easy to find the exposition of any idea contained in it, if one searched for it at some future time. But though the Index is extensive, it is hardly appropriate for this purpose. We fear that it is very difficult to appreciate the traces of new aspects and novel methods which are undoubtedly contained in the chapters, but are not made very noticeable. In fact, only readers very familiar with the problems treated will recognize where the author has either ingeniously used a related technique or has been successful in creating a new one, which might be useful in other circumstances as well. However, one ought not to stress too much one's regret at lost opportunities, since the book was produced at a time when all collaborators were already naturally looking for other work than recording what must have become, by then, old stories. It is a consequence of the happy co-operation between the U. S. and this country during the late war that credit is fairly given, where due, to British statisticians. This is very gratifying, and at the same time it adds some bitterness to the feeling that too little is being done in this country to make the statistical contributions to our war effort more appropriately known.

Math R 9:365 Jl–Ag '48. H. Cramér. * The book is clearly written, and very complete references are given at the end of each chapter. Although relatively little new statistical theory is included, several topics are given fuller treatment than has previously been available and many new tables are included. The book will be very useful to everybody who has reason to apply the techniques it deals with. *

Nature 162:510–1 O 2 '48. M. S. Bartlett. * a series of more or less self-contained and independently written chapters by various authors. These have been arranged in three parts * Unfortunately this arrangement is at times extremely arbitrary * The references to sequential analysis seem unsatisfactory, an elementary account by Wallis concluding the volume, whereas the first chapter includes a sequential problem of strictly more complex type. Such limitations cannot, however, be entirely avoided in an *ad hoc* collection of this kind. Provided it is not regarded as a text-book, but as a record of miscellaneous work, it serves two purposes: (1) as a reference book (with some useful tables and charts, and an almost too exhaustive index); (2) as an indication of the potential value of such techniques, in peace as well as in war, to its intended readers—"scientists, engineers, managers, and statisticians." One may wonder how much the middle two, at least, of these groups like the presentation, and might not have preferred the technical notes concluding some of the chapters to have spread to cover most of the exposition, leaving a simple introduction in each case to summarize the article. This would, however, have meant still more editing to meet a rather speculative requirement, for many engineers and industrialists have by now recognized the value of statistical techniques and do not need to be so spoon-fed. *

Q R Biol 23:195 Je '48. A. Chapanis. * appears to be suitable for those readers who already have some understanding of elementary descriptive and sampling statistics. Most of the topics discussed are oriented toward industrial or engineering problems, but the biometrist should find a few items of interest among them. The inverse sine transformation of proportions —which was first introduced by way of theoretical genetics—receives a fairly detailed discussion, for example. There is an excellent chapter on the Effects of Rounding or Grouping Data, and there are several other good ones on planning efficient experiments for [illegible] or comparing certain statistics. This is the kind of book which the professional statistician or biometrician will probably want to have. The ordinary research worker, however, is likely to find it of little use.

Sci Progress 37:346–7 Ap '49. H. O. Hartley. [Not excerpted because of copyright restrictions.]

[104]

ELDERTON, W. PALIN, AND FIPPARD, RICHARD C. **The Construction of Mortality and Sickness Tables: A Primer, Fourth Edition.** London: A. & C. Black, Ltd., 1947. Pp. ix, 130. 6*s*. [This fourth "edition" is identical to the third edition except for minor corrections.]

For reviews, see 38:B604 and 2:103.

[105]

★ELLIS, R. K.; DAVIES, GEORGE R.; AND YODER, DALE. **Workbook for Business Statistics.** New York: John Wiley & Sons, Inc., 1941. Pp. 104. Paper, lithotyped. $1.25. (London: Chapman & Hall, Ltd. 10*s*.) *

[106]

★EMMENS, C. W. **Principles of Biological Assay.** Foreword by Percival Hartley. London: Chapman & Hall, Ltd., 1948. Pp. xv, 206. 21*s*. *

Ann Appl Biol 36:289–90 Je '49. D. J. Finney. * In this first book to be devoted to the statistical aspects of biological assay, Dr. Em-

mens presents an admirable account of basic principles, assay design, and methods of analysis, in a manner that may be understood by readers whose previous knowledge of statistics is slight. The author's personal experience of the practice of biological assay ensures that the techniques he describes are those of chief practical importance, but there is no attempt to conceal the difficulties of the subject by a pretence that the arithmetical rules can be easily learnt and applied without an understanding of the fundamental issues involved. The first half of the book is an introduction to statistical methods, with special attention given to regression. Valuable as this is for the reader who has no previous [illegible] of statistics, some may regret that Dr. Emmens did not content himself with references to standard texts in order that he might have more space for the full development of his main theme. * The interrelationship between design, scheme of randomization, and analysis is made very clear * A final chapter describes, briefly but clearly, assays, of the slope-ratio type. It is surprising to find no mention of the use of non-linear dose-response regressions in assay work, particularly as Dr. Emmens has himself published a valuable and interesting study of the application of logistic curves for this purpose. That a reviewer who is himself deeply interested in the subject of this book should find some grounds for adverse criticism is scarcely surprising. To regard the fitting of a probit regression line as an example of "least squares" is misleading, since the basis of the method is the maximizing of the likelihood, not the minimizing of χ^2. Calculation of expected probits to three decimals, and the resultant interpolation in order to obtain "corrected" (a better term is "working") probits is surely unnecessary unless large batches of subjects have been tested. The numerical examples of probit calculations do not seem to be ideal computational patterns, as excessive numbers of decimal places and unwanted columns have been included. The account of the fitting of probit planes seems irrelevant to assay problems, and indeed the whole chapter on reaction times —admittedly an awkward topic—is perhaps the least satisfactory in the book. An account of the simultaneous assay of three samples of penicillin is marred by the admission that the cylinders were not assigned at random to the doses; the comment that the sensitivity of the assay is thereby impaired is far from clear, but seems a serious understatement of a criticism that may destroy the validity of all assessments of precision. These are minor flaws. Dr. Emmens has written a book that is sure of a welcome in every laboratory where any form of biological assay is practised. The chief regret of the reviewer is that the book is not considerably longer. In spite of the disclaimer on the dust cover, it is by no means without value as a general text-book on statistical science. That is a minor function: more important is the fact that, as must be agreed by all concerned in the propagation of statistical methodology, the first book in this field is both sound in principle and clear in presentation, two features that will ensure its remaining in favour even when its success leads to the appearance of rivals.

Chem & Ind 22:354–5 My 28 '49. E. C. W. [Not excerpted because of copyright restrictions.]

Current Sci 18:55–6 F '49. N. N. De. * satisfies the requirements of sound and intelligible experimental design * a very useful book for exact tests of [illegible] and fully illustrates the variety of computational procedures * will be of great interest and value to the research workers and students of pharmacology and experimental therapeutics and to analysts.

J Am Stat Assn 44:448–50 S '49. Lila F. Knudsen. * *Principles of Biological Assay* compares with an excellent recent book entitled *Probit Analysis* by Professor D. J. Finney of Oxford, which covers the field of biological assay with special emphasis on quantal (or percentage) responses and gives a rather thorough background in design and interpretation of such biological assays. Dr. Emmens' book attempts to cover a wider approach and includes quantitative as well as quantal responses on biological assays with one chapter devoted to the work of Finney and Wood on microbiological assays. It seems that the title *Principles of Biological Assay* is misleading and should have been *Statistics in Biological Assay,* or maybe *Statistical Design and Analyses of Biological Assay,* since the entire book deals with the statistical design and analysis and not with the pharmacological aspects of assays * The book touches on the usual introductory statistical concepts; deals rather completely with dosage-response lines; describes various experimental designs (Latin squares, balanced incomplete blocks, *etc.*) that have been used in biological assay; gives formulas for

calculating potency, standard errors, fiducial limits, combining results of several assays, chi squares, *etc.* However, emphasis seems to be on the manipulation of numbers rather than the assumptions made and the interpretations to be given the results. Even at that, the worker in the biological laboratory is given no inkling that in many cases it is possible to greatly simplify the formulas for routine calculations. The organization of the book seems a bit jumbled to the reviewer. The twenty chapters are each very short and each section does not seem to lead logically into the next section. The two chapters devoted to design of experiments are widely separated. Various tests of significance are scattered through the book. An entire chapter is devoted to a rather hazy explanation of polynomial coefficients and when factorial coefficients are introduced three chapters later, the author does not mention that they include the impressive polynomial coefficients. Student's *t* test occupies one paragraph and the only formula given is that for comparing a sample mean with the population value of the mean. Though the symbol *t* is used later in comparing two slopes and in calculating fiducial limits of the potency, nowhere in the book is an explanation given of the assumptions underlying it and the way it should be interpreted. The section on degrees of freedom seems unnecessarily complicated for absorption by a pharmacologist. * Emmens probably didn't realize that he gives three widely different concepts to *C* on pages 84, 86, and 105. * Another thing that may be confusing is the omission of the usual parentheses after the summation sign *S* in many equations. It is rather surprising to see a book of this kind without lists of references for additional reading. It must have been an oversight that no mention is made of many of the numerous articles and statistical texts that would add to the reader's comprehension of the subject; although full credit is given in the text for examples cited and most formulas quoted. * On the whole, this book will be a welcome addition to the library of a pharmacological laboratory, particularly as a source book for formulas, and very helpful in promoting the use of statistics in biological assay.

[107]

★ENRICK, NORBERT L. **Quality Control: A Manual of Quality Control Procedure Based Upon Scientific Principles and Simplified for Practical Application in Various Types of Manufacturing Plants.** New York: Industrial Press, 1948 Pp. vi, 122. $3.00. * (Brighton, England: Machinery Publishing Co., Ltd. 21s.)

Adv Mgmt 13:181–2 D '48. Joseph M. Juran. [Also a review of *Quality Control Methods* (see 192) by Clifford W. Kennedy and *Quality Control in Industry* (see 265) by John G. Rutherford.] The publishing houses, if not the industrial companies, are adopting quality control. Each of these three new books marks the initial entry of a publisher into this field. Little in the books is new. Most of the discussion is devoted to acceptance sampling, control of processes by Shewhart charts, and other well known statistical techniques Emphasis appears to be guided strongly by the personal experience of the respective authors. Kennedy, well known for his conduct of the successful conferences at Federal Products Corporation, has supplied a most readable work. It is well illuminated with analogies, anecdotes, and a light informality of style which will be acceptable to many readers. Rutherford's book comes closest to adding materially to the available literature. He supplies a good discussion of the managerial and economic aspects of the subject before he takes up the statistical techniques. He exemplifies the latter by instances from a variety of experiences which render them more realistic. Enrick's book reflects an experience in government rather than industry. Emphasis is on acceptance sampling techniques while the diction has a strong resemblance to the language of government directives. Yet, the quality problems of the armed services are of great concern to industry in the event of another emergency and any enlightenment on these problems will materially aid mobilization. In the aggregate, these books are reminiscent of the early books on scientific management which emphasized the techniques of time study, the formula for wage curves and other technical detail. The broader problems of human relations, organization and even underlying philosophy were fully considered much later, following the availability of a body of experience. Quality control stands in a pioneer position today. Experience is being accumulated but has hardly been yet disseminated. It is this dissemination of experience which should be the objective of the literature for the next few years.

Am Machinist 92:191–2 S 9 '48. * This book is intended for the practical man who is primarily interested in basic statistical methods

in inspection as a working tool and is less concerned with their mathematical derivation. As such, it accomplishes its purpose.

J Am Stat Assn 44:139–41 Mr '49. J. H. Curtiss. * intended for practical men in inspection who do not want to be bothered with "higher mathematics" * "Higher mathematics" here means anything beyond grade school arithmetic. The spirit of the book is perhaps best conveyed by reporting the fact that the presentation of control charts for averages is so arranged that in setting up the control limits, the mean range of a set of samples never has to be multiplied by any factor more complicated than unity! Thus the author has imposed rather severe conditions of limited visibility on the flight of his muse. The result is a sort of minimum cook-book of statistical quality control recipes, supplemented by some practical advice on the management aspects, and by some rather sketchy and disjointed remarks on tolerances and gages. An elementary discussion of the underlying theory is also given in a few pages at the end of the book. * At the outset of the chapter on lot-by-lot inspection, the author promises to demonstrate later that one should not use lot-by-lot inspection on inspection lots containing less than 300 items, but the reviewer was unable to find the demonstration of this theorem in the ensuing text. Sampling tables are given in the form of double entry tabulation, one argument being lot size range, and the other "allowable per cent defective." There are two tables for discrete items, one of them containing sequential sampling plans, and the other single sampling plans with operating characteristics similar to the sequential ones. These tables are supplemented by two roughly parallel ones for use on continuous products. Although no credit is specifically given in the text, the sequential sampling tables are copied from the "Inspection Handbook on Sampling for Quality Control," QMC-M605 — 15, published by the Office of the Quartermaster General in 1945. Presumably the other tables are taken from material developed for later editions of the QMC Handbook. The concept of "allowable per cent defective" used in this book seems to be a sort of mixture of Average Outgoing Quality Limit (AOQL) and Acceptable Quality Level (AQL) as these terms are now used in the technical literature. Mathematically, the "allowable per cent defective" ascribed to each plan is approximately equal to its AOQL, a fact implied by the brief elementary discussion of the theory of the plans given at the end of the book. The instructions and examples, however, seem to handle the "allowable per cent defective" as if it were an AQL. The control chart for averages is set up as a test of the compound hypothesis that the population mean μ lies in the range $T_1 + 3.1\sigma \leqq \mu \leqq T_2 - 3.1\sigma$, where T_1 and T_2 are preassigned lower and upper tolerances for individuals and σ is the population standard deviation. * This type of control chart of course differs from the standard Shewhart control chart for averages from the viewpoint of both engineering and mathematical theory. An obvious minor disadvantage (which, however, may be a grave one for the intended users of this manual) is that a pair of tolerance limits must be given before the recipe can be carried out. A major disadvantage is that a fundamental Shewhart control chart doctrine is ignored: a principal goal in quality control is the achievement of a state of statistical control about stable population values of μ and σ. In the present type of chart, μ is theoretically permitted to wander about at will between the limits given above. But the book is written primarily for the line inspector, and not for management, nor for quality control engineers; and perhaps a control chart which places first emphasis on the immediate avoidance of nonconforming product, as this one does, is the right one to present under the circumstances. The control chart for the range is given the orthodox treatment. In his effort to be brief and clear, the author omitted some points which the reviewer considers rather essential for the proper application and interpretation of even the few simple techniques here treated. No operational meaning is given to the words "random sampling," which are explained in a circular manner by simply repeating the word "random" in a couple of different contexts. Rational subgroups are not adequately discussed in connection with control charts. In the discussion of tolerance ranges, the correct *location* of the range, as determined statistically, is ignored, and only the width of the range is discussed. As stated before, the technical material on statistical control takes up a little less than half of this 120 page book, and in the opinion of the reviewer, it could have been presented in an unhurried pamphlet of about 25 pages. The density of thought in the chapters on tolerances and gaging, and in other later chap-

ters, seemed rather low, and the reviewer wondered how much of that material would be new or useful to an experienced inspector. The book certainly does not begin to cover adequately the non-statistical aspects of quality control, and indeed the author would probably disavow any intentions in this direction. On the other hand, the style is simple and clear; the many examples are well-chosen and informative; and all-in-all, this is a very readable little treatise. It must be left to members of the intended audience, rather than to this reviewer, to judge whether the extra pages were well worth the time and effort. The judgment may very well be in the affirmative.

J Am Stat Assn 44 142 Mr '49. E. H. MacNiece. This book effectively leads the reader into a simplified quality control program. The program is clearly outlined and stated in such a manner that the shopman is familiarized with the use of the method without the complicated terminology and mathematics so frequently found in books on this subject. Perhaps its greatest service will be in the conditioning of nontechnical shop personnel for the acceptance of quality control as a means of achieving productivity in terms of acceptable quality with low waste rather than high production with too much of it finding its way to the scrap pile or the salvage department. Mr. Enrick's book is highly recommended as primary reading for men in industry who want to produce acceptable economic quality.

[108]

★Ezekiel, Mordecai. **Methods of Correlation Analysis, Second Edition.** New York: John Wiley & Sons, Inc., 1941. Pp. xix, 531. $5.50. (London: Chapman & Hall, Ltd. 44s.) *

Am Econ R 33:153–6 Mr '43. Harry Pelle Hartkemeier. One reviewer of the first edition of this book wrote:

> Failure to appreciate fully the merits of mathematical curves has led the author to give much less attention than would be appropriate in such a text to consideration of characteristics of different types of equations. The treatment of this subject (pp. 66–70) is not only very brief, but is occasionally inaccurate.†

Although these mistakes were pointed out clearly, Dr. Ezekiel evidently chose to repeat nearly all of this material without correcting them (pp. 76–81). The present reviewer feels impelled to point out several additional mistakes of a similar nature. On pages 224–26 we read:

> There may be certain temperatures to which the plant does not respond and then certain higher temperatures which produce a marked response. Again, if the temperature is too high, a marked reduction in yield might be produced. These considerations lead to the following conditions for the temperature curve:.... (3) It might have two points of inflection, one where it started to rise rapidly, the second at the optimum.

At the optimum temperature the maximum yield would be obtained. A curve does not pass through a point of inflection at the maximum. In a footnote on page 103, Ezekiel refers to the United States Department of Agriculture Bulletin 1351, by Hugh Killough, and states, "Here equations of the general type (*c*) and (*e*) were both found to yield almost identical curves, within the range covered by the observations studied." Ezekiel's equation (*c*) is a logarithmic form of the parabola while (*e*) is an hyperbola. Although no page number was given by Ezekiel, the present reviewer found only one chart in Bulletin 1351 which contains two equations (p. 8) and Killough states, "The curve in this figure is described by two formulae, a reciprocal formula used by Working coinciding with an exponential formula used by Moore." It looks as if Ezekiel does not distinguish between a parabola and an exponential function. It is interesting to add that an exponential function does not appear in this book. The coefficient of part correlation has been dropped from this edition. Although he and B. B. Smith collaborated in the discovery of this measure, Ezekiel is brave enough to state, "Little practical use has been found for this coefficient." The reviewer wishes that Ezekiel were as quick to recognize that a significant index of multiple correlation does not establish the significance of all of the constants implied in the use of freehand curves. Even though Ezekiel emphasizes the necessity of adjusting the index of multiple correlation by using an estimate of the number of constants involved in the freehand curves, he does not point out anywhere in his book that many of the constants may turn out to be merely random fluctuations from zero if the standard errors of the individual constants are computed. This is the outstanding weakness of the freehand method—no one has shown how it can be extended to include some measure of the reliability of the individual constants in the curvilinear regressions. On page 263 Ezekiel concludes (somehow!) that his freehand curves involve eleven constants, so he adjusts the standard error of estimate for the loss of eleven

† *Jour. of Farm Econ.*, Vol. XIII (Apr., 1931).

degrees of freedom. The reviewer will venture a forecast that if anyone would actually fit the function involving the eleven constants suggested by Ezekiel, at least four (and probably as many as seven) of them would not turn out to be significant if the 5 per cent probability point is used as the criterion of significance. Furthermore, Ezekiel's failure to test the reliability of the difference between standard errors of estimate is a serious oversight. He points out on page 247 that after his second approximation the standard deviation of z''' is 2.80 bushels, or slightly smaller than the "standard deviation of z'', 3.0 bushels [obtained from the first approximation]." The difference between these two values is not significant, so the second approximation is worthless. If Ezekiel had adjusted these two values for the loss of degrees of freedom he would have found them to be practically identical, for at least one more constant was used to obtain the value of 2.80 bushels. The failure to test such differences led Ezekiel to give the unfortunate advice on page 247, "The process ordinarily would be carried through one or more additional approximations by repeating the steps shown." He had already gone too far in making the second approximation, but advises one or more additional approximations! This reviewer wonders if Ezekiel had forgotten that he wrote:

If we....use up more degrees of freedom by employing more constants in the curves, we obtain a certain amount of spurious increase in the apparent correlation (p. 265). Attempts to get a more accurate answer from a set of data than they are statistically capable of yielding are time and energy wasted.†

On page 247 we read:

So long as the standard deviation of each new set of residuals is smaller than that of the previous set (and no more complicated curves were drawn in, which would require more constants to represent them), the approximation curves may be regarded as approaching closer and closer to the underlying true curves.

The reviewer maintains that every time you bend one end of the curve without bending the other end in a similar fashion you should admit that you are using a more complicated curve which requires more constants. Strangely enough, on page 263, Ezekiel admits that he used at least one more constant in the second approximation than he did in the first, "....probably a quartic parabola, involving four constants, would be required to represent $f_2(X_2)$ with its final shape, or three constants with its first form."

On page 247 Ezekiel states:

....if it is desired to have a mathematical expression of the several curves, equations may be selected capable of representing the several curves whose shape has been determined by the graphic successive approximation process, fitting the mathematical curves according to the methods presented briefly earlier in this chapter....

The reviewer doubts the ability of Ezekiel or anybody else to fit to these data curves capable of representing the freehand curves shown and predicts that, if anyone would actually fit the function involving two cubic parabolas and a "quartic parabola" (a total of eleven constants), he would not obtain regression curves which bend like the freehand lines shown. It is odd to find the author adding a footnote which proves the opposite of what he states in the text. On page 306 we read, "It is evident that there *is* some correlation between X_5 and the other variables." A footnote covering two-thirds of the same page ends with the conclusion, "So adjusted, η_{25} shrinks to 0, showing no real correlation." Chapter 9 is the most unfortunate one in the book. In it Ezekiel sets out to refute the general impression that the better the correlation, the better we can estimate the values of the dependent variable. He uses three hypothetical cases and presents them graphically. The statistics assumed are given in the first three lines below. The reviewer computed those in the fourth line.

A	*B*	*C*
$r = .83$	$r = .71$	$r = .47$
$b_{yx} = 2.5$	$b_{yx} = 3.1$	$b_{yx} = 0.5$
$S_{yx} = 2.2$	$S_{yx} = 3.8$	$S_{yx} = 1.15$
$\sigma_y = 3.9$	$\sigma_y = 5.4$	$\sigma_y = 1.30$

Ezekiel states on page 161:

Only a small part (22 per cent) of the variation in yields is associated with rainfall differences, as indicated by the low correlation (0.47) [in case C]....Yet in spite of this low relation, it is possible to estimate yields more accurately, given the rainfall, in this case than in either of the other two, as is shown by the standard error of estimate of 1.15 bushels as compared to 2.2 bushels for A and 3.1 for B.

Ezekiel's statements lead most students to the absurd conclusion that, when the correlation is low and the standard deviation is small, we can estimate Y from X even though Y does not depend much upon X. This is sheer nonsense! What he apparently failed to see is that, without any knowledge of X or the correlation between Y and X, we can estimate Y in case C better than we can estimate Y from X in cases A and B with a knowledge of the correlation between Y and X. The standard deviations which the reviewer calculated prove that, if we use the mean yield every time we have to estimate the yield in case C, we will have better estimates

† *Quart. Jour. of Econ.*, Vol. LIV (Nov., 1939), p. 342.

than we can possibly obtain in cases A and B by using the regression lines to estimate yield. Ezekiel confuses "improvement in the ability to estimate" and "ability to estimate." From the point of view of the student who is just beginning the study of correlation, a serious weakness of the book arises out of the fact that apparently Ezekiel carried out most of his computations to more places than were finally published in his book and then independently rounded off each number separately. * when a new student is being guided through a series of computations for the first time, he should be shown the square of the number given on the page or he should at least be enlightened about what the author is doing when he does not use the square of the number shown. More serious errors appear on other pages. Quite a few of the errors appeared in the first edition and are reproduced in the second edition eleven years later. To summarize, the reviewer thinks that this book has disadvantages which seriously limit its usefulness as a textbook.

Am Econ R 33.902–3 D '43. Charles A. Stephenson. [A reply to the above review by Harry Pelle Hartkemeier.] * it seems to me that the practical validity of the methods set forth in the book depends upon their ability (*a*) to guide students in their choice of methods to be used and (*b*) to guide practical research workers in making analyses which will stand up in practice. I belong to the latter group and, during the past eleven years, have used Dr. Ezekiel's methods extensively in the analysis of transportation and traffic problems. In these studies I have frequently forecasted the change in volume of traffic or the amount of revenue which would result from proposed changes, such as raising or lowering the fare, increasing or decreasing the frequency of service, *etc.* These forecasts provided a basis for management decisions as to what it would be profitable to do. When the changes have been put into effect, the results of forecasting have been within the ranges indicated by the error formula as the expected reliability of the forecast. I hold that just as "the proof of the pudding is in the eating," so the value of any [illegible] technique is its ability to yield reliable forecasts. Viewed in this light, *Methods of Correlation Analysis* sets forth methods and procedures which are workable and reliable. I could furnish details of many analyses to show the amazing results which have been obtained through the use of Dr. Ezekiel's methods. [*Photostats of a number of letters commenting on the accuracy of a number of these studies were submitted to the editor, but could not be published for lack of space.—Editor*] As a matter of possible interest to students and research workers, my practice is to determine the net linear relationships as a first step in order to obtain an indication of the direction and approximate strength of each of the several important force veins operating in the problem. From that point forward, I employ the "successive approximation" technique so well described by Dr. Ezekiel and thus permit the data to unfold themselves and reveal the nature of the relationships involved. I use the freehand curves in making my predictions for the simple reason that they yield results. There is one other point upon which I should like to comment and that is in connection with Professor Hartkemeier's strong exceptions to chapter 9. I do not believe his criticism of that chapter is justified by the text and I, for one, did not arrive at the conclusions which he said his students had reached. To me, the chapter clearly states just what was intended, namely, the meaning and use of the three measures of correlation. This, of course, is something quite different from what the reviewer says it shows. After eleven years of study, testing and application, I am of the firm conviction that *Methods of Correlation Analysis* is one of the most outstanding contributions in the field of statistical method to appear in modern times. It is a decidedly superior piece of work and I heartily recommend it to students, research workers, and business men.

Am J Sociol 48:260–1 S '42. Chester E. Kellogg. Outstanding features of this work are its simplicity and its thoroughness. * a book which, in the words of the Preface to the first edition, is "readily comprehensible to anyone who has had courses in elementary algebra," yet shows none of the sketchy inadequacy common to most books of which that can be said. Here, then, is an opportunity for the student whose mathematics is very scanty or very rusty to acquire fine craftsmanship in an important branch of research method. Advances due to Ezekiel and his associates, presented in the first edition, included the use of the Doolittle method in solving normal equations, the development of methods for treating curvilinear multiple regression, the recognition and treatment of joint functional regression. The Doolittle method is now available

in various textbooks; for the other techniques "Ezekiel" remains the standard reference. Moreover, in the new edition, the treatment of Bean's rapid graphic method for multiple curvilinear regression has been revised and expanded, the discussion of the significance of samples has been improved, with a new chapter on the reliability of forecasting; and there is a new insistence, in selecting regression curves, that the mathematical functions employed shall be logically appropriate to the nature of the data in question, *i.e.*, that relationships implied by a mathematical formula shall not be attributed to the data merely because the figures conform over a limited range. Technique is thus subordinated to insight, and this is characteristic of the whole work. * The reader of Ezekiel must be prepared to give a little attention to the relations between acreage, number of cows, number of hired men, and farm income, and to other problems of our basic industry. This is surely no great hardship for students in other fields, and there is every reason to believe that both theoretical and practical researches in psychology and the social sciences would benefit greatly by the use of the more precise methods of studying relationships presented in this treatise.

Am Sociol R 8:102 F '43. Thomas C. McCormick. Although this revised edition adds nothing essential to the original, it represents a somewhat more finished piece of work. * The title of the book is too inclusive, since only quantitative methods of correlation, with emphasis on those of common use to agricultural economists, are covered. Except for brief reference to the correlation ratio, the whole range of non-quantitative methods of correlation, including coefficients of contingency, bi-serial *r*, tetrachoric *r*, and the like, which often must be used by psychologists, sociologists, educators, and others, is omitted. Such important recent developments as R. A. Fisher's improved method of fitting orthogonal polynomials and Sewall Wright's theory of path coefficients are barely mentioned. The main distinction of the work continues to be its exposition of successive approximation methods of multiple curvilinear correlation and joint relations. * As a clear non-mathematical presentation of quantitative correlation in time series analysis and other straightforward practical applications this book remains the best available.

B Am Math Soc 49:347–9 My '43. E. L. Welker. The first edition of this well known work appeared in 1930 and had a marked influence upon the users of correlation theory in this country. Before its appearance attention had been centered upon the calculation of correlation coefficients to many decimal places with too much reliance upon probable errors and too much faith in Blakeman's tests. Ezekiel's book emphasized the regression side of correlation with particular stress on nonlinear regression functions. The use of free hand fitting of regression curves in simple and multiple correlation is clearly and quite completely discussed. As a result of the simplicity of explanations and the careful description of calculation procedures, it soon became one of the most important books in the field of correlation. * major changes have been "first, in the interpretation of the meaning of standard errors and, second in the application of logical limitations to the flexibility of graphic curves. Other significant developments have been in the perfection of new and speedier methods of estimating the reliability of an individual estimate or forecast." Remaining portions of the subject matter are left practically the same. In general these changes are well made. Treatment of the reliability of an individual forecast is given in Chapter 19. Probability statements arising in the interpretations of standard errors have been correctly made, but the author did not introduce the terminology of "confidence interval" and "fiducial limits." This would be advisable. In discussing logical limitations of graphic curves it is carefully noted that extrapolation is based on these logical considerations rather than the statistical analysis. * The method of identifying classes by open class limits is superior to the one used. For example (p. 5) change the notation from 22.5–25.4 bushels to 23–25 bushels. The latter form gives the lowest and highest values included in the class and indicates the accuracy of the measurements. On p. 10 the text states "Most of the reports come at about the middle values and then thin out to both ends (that is, the distribution approximates normality). In such cases the standard deviation gives a measure of the range within which a definite proportion of the cases will be included." This is followed by a statement of the common area values for the normal curve of error. The author should explain that these area values are only approximate for non-normal distributions which satisfy the given conditions, and that normality

requires a particular functional relationship, not merely a graphic similarity. On p. 156 the following statement appears. "Since the index of determination is simply ρ_{yx}^{-2}, it is 71.0 per cent." According to the definition given it should be .710. In another discussion involving the coefficient of determination (p. 159) the following statement is made. "Since the coefficient is a ratio, it is a "pure number," that is, it is an arbitrary mathematical measure, whose values fall within a certain limited range, and it can be compared only with other constants like itself, derived from similar problems." The arithmetic mean is a ratio, and it depends on unit! Furthermore not all ratios are arbitrary! The meaning of the quotation is vague. The point in question is an important one, and a clear explanation should be given. On pp. 160–162 the author discusses the interpretation of the three types of measure of correlation; regression coefficient, correlation coefficient, and standard error of estimate. He states that the most accurate estimate of values of the dependent variable made from the regression equation calculated from a sample will be made from that sample for which S_y, the standard error of estimate, is the smallest. The accuracy of an estimate of y should be interpreted with reference to the importance of a unit change in y. In a sample with small variation in the dependent variable two situations may be considered: (*a*) a small variation may be important in case the population itself has small variation, or (*b*) the dependent variable has been so controlled in sampling that the variation is materially biased more than the usual sampling bias. It is well known that sampling under case (*b*) tends to lower the correlation coefficient and thus to make the whole correlation analysis unreliable. In case (*a*) it is clear that S_y must be interpreted in relation to σ_y. The factor $(1 - r^2)^{\frac{1}{2}}$ measures the improvement in estimation of y due to the use of regression, and the smaller the value of r, disregarding sign, the smaller is the amount of information supplied by the regression. In introducing linear multiple regression (p. 164) it should be pointed out that the form of the equation assumes the relationship between the variables to be additive. The discussion given might lead the reader to believe that the linear equation includes all cases. Statisticians interested in factor analysis will question the recommendation that not more than ten, usually five, variables be used in a study. To obtain such quantities as ΣXY and ΣX^2 it should be mentioned that the extensions as made in the text are not needed. An explanation of the use of a calculating machine to shorten the work might well be given in the text at an early point. One rather general criticism of the book should be made. There is throughout the tendency to over-correct calculated constants and to over-refine tests of significance. More care should be taken to explain the fact that experimental data frequently do not justify the use of many of these refinements. To an untrained reader they may imply an accuracy of analysis not actually present. In some cases the significance tests suggested are actually incorrect, as for example the use of the standard error of the coefficient of multiple correlation. In spite of the above criticisms the reviewer considers this book still to be the best in its field.

J Am Stat Assn 37:298–9 S '42. John H. Smith. This book contains the same leisurely, readable development of correlation methods which made the first edition an outstanding success. All of the desirable features have been retained and some important improvements in exposition have been made. Of the relatively few additions to subject matter the most important is the emphasis on logical limitations to flexibility of regression functions. Another interesting addition is the study of the reliability of an individual forecast in Chapter 19. * None of the recent methods for computing correlation constants based on determinants is seriously considered by the author. In the reviewer's opinion this is an unfortunate omission. Presentation of Stephan's treatment of the wheat problem (this *Journal,* March, 1931, p. 58) would serve to make a valuable but neglected device available to a wider group of readers. The use of degrees of freedom in the table of t (Table A) would eliminate confusion in testing correlation and regression coefficients. A different symbol should be used for the number of variables when n is used in the same equation for the number of observations in the sample (p. 211). In view of the great emphasis on "corrected" measures of correlation and "unbiased estimates" of standard errors of estimate a correct statement of the known properties of such estimates is badly needed. They are not median estimates (p. 143); neither are they unbiased in the usual sense of that word. Although discussion of part correlation (in-

volving one independent variable) has been dropped from the text, it is defined in a footnote and derived in Appendix 2. Part correlation involving two independent variables is discussed in squared form (p. 218). The corresponding function appropriate for tests of significance, $(R_{1.234}^2 - r_{12}^2)/(1 - r_{12}^2)$, is simpler and has a "Beta" distribution with 2 and $n - 4$ degrees of freedom. The author refers to complicated techniques and tests of significance in a manner suggesting a degree of exactness and applicability which they do not possess (pp. 99, 320, 323, 367). The standard error of the mean which is exact under less restricted conditions than any other sampling formula in the book is "proved" in such a way as to suggest that it is approximate. On the other hand, the standard error of r is said to be "precise" (p. 318). The appropriate formula (in which $n - 1$ is substituted for $n - 2$) is exact for uncorrelated normal bivariate universes, but even the appropriate formula is an approximation for correlated universes. Standard errors for the index of correlation and the multiple correlation coefficient (given without qualification) are greatly in error and of questionable usefulness. The author even advocates the t-test for each of these inherently positive statistics and for "more exact interpretations" he suggests Fisher's z-transformation! The foregoing criticisms of the material on sampling are not intended to detract from the merits of a great book. According to the preface the book is intended to cover "that portion of the field which is concerned with studying the relationships between variables." Appraised on this basis the book has no equal nor even a close rival.

J Pol Econ 50:794–5 O '42. Gerhard Tintner. The second edition of Ezekiel's classic methods of correlation analysis has been awaited with impatience by many workers in the statistical field. There is hardly a book which has exerted so much influence on empirical studies by economic statisticans and in related fields using the techniques so lucidly presented in this book. Chapter xxiii of the second edition gives a survey of types of problems to which correlation analysis has been applied. It is in itself an eloquent tribute to the importance of the first edition of the book. Almost all the studies listed in the different fields owe a great deal to the ideas and methods presented by Mr. Ezekiel. The new edition brings no fundamental changes in the approach to the problem and the methods advocated. * The discussion of the use of error formulas with time series is by necessity somewhat sketchy and disappointing. The author, however, is not to blame for the fact that there is as yet no generally accepted solution to many of the problems connected with this very difficult question. * An extensive bibliography on graphic methods is given. * The author has....presented mainly R. A. Fisher's point of view about fiducial limits and has (perhaps wisely) not gone into the more recent developments in the theory of estimation and the testing of statistical hypotheses as developed especially by J. Neymann and Egon Pearson, and by A. Wald. The new edition of Ezekiel's correlation analysis is more useful than the old one and can be expected to exert even greater influence in the field of applied statistics. The changes made represent in general genuine improvements. It is to be hoped that the author will be able to incorporate in the third edition solutions for many as yet unsolved problems of correlation analysis.

Rural Sociol 7:112–4 Mr '42. C. Horace Hamilton. * a great improvement over his earlier pioneer work * an excellent but highly specialized contribution to statistical method * The illustrative material is taken almost entirely from the field of agricultural economics. Scant attention is given to applications in the field of sociology. Nevertheless, rural sociologists engaged in systematic research will do well to keep a copy of Ezekiel's text close at hand.

Social Forces 21:119 O '42. Margaret Jarman Hagood. * especially welcome to those who learned most of what they know about correlation analysis from the first edition, but who were finding an increasing amount of time necessary to explain recent advances in interpretation of standard error, *etc.*, to students currently using the book as a text * the changes and additions....are quite adequate to make the book again suitable for use as a text for a course in correlation, and the illustrative problems are not too far removed from the interests of sociologists, certainly of rural sociologists. Students not very far advanced in statistics will get most from the book by a straight reading through, but all will find it usable and unequaled as a reference on the methods of correlation.

South Econ J 9:78 Jl '42. Edgar Z. Palmer. * The changes have not disturbed the excellent

arrangement of this book, and have improved its usefulness as a teaching manual. * the proposal of a coefficient of "part correlation" has been dropped. Alternative and complementary methods, such as variance, factor analysis, cluster types, *etc.*, have been given little or no attention. One wonders why the controversy which has taken place around the Ezekiel methods has not incited him to expound more fully his scientific philosophy. The examples of analysis may illustrate but they do not define the purposes to which he would put the techniques of correlation. The difference between a generalization for the sake of immediate action, and a fundamental scientific contribution, is not brought out. The new section on "Universes, Past and Present," adds a little light, but yields no real understanding of the technical difficulties of delimiting a universe. The book is unquestionably the best available manual on multiple correlation, both for the beginner and the experienced statistician. For philosophy we can always go back to Karl Pearson.

[109]

★Feller, William. **An Introduction to Probability Theory and Its Applications, Volume I.** New York: John Wiley & Sons, Inc, 1950 Pp xii, 419. $6.00 * (London: Chapman & Hall, Ltd. 48*s*.)

[110]

★Ferber, Robert. **Statistical Techniques in Market Research.** New York: McGraw-Hill Book Co., Inc., 1949. Pp. xiv, 542 $6 00. * (London: McGraw-Hill Publishing Co, Ltd. 36*s*.)

J Am Stat Assn 45:300–1 Je '50. Melville J. Ulmer. * a lucid account of many of the most important techniques required in the collection and analysis of data for marketing research. It is written at the elementary level and requires of the reader no mathematical background beyond college algebra—and not much of that. Somewhat more than half of the book, excluding appendices, is devoted to a nontechnical discussion of the logic of sampling theory and its applications. This allows a much more comprehensive presentation of some topics (such as testing of hypotheses and problems of sampling precision) than the usual elementary text provides, and the inclusion of certain other topics (such as sequential analysis and an appraisal of area and quota sampling) which are ordinarily omitted. In these passages Mr. Ferber is eminently successful in illuminating ideas which heretofore have been inaccessible to the general reader. Tests of significance, including chi square and variance analysis, are presented in some detail and applied to problems which bear an interesting resemblance to those encountered by marketing analysts. The description of correlation techniques follows the pattern customary at this level of presentation but deviates to include the standard error of a forecast and application of variance analysis to correlation problems. Thus strenuous—and, in the reviewer's opinion, generally successful—efforts were made to direct content *away* from the usual format and *toward* achievement of the book's explicit objective of providing instruction in the statistical techniques most important for marketing research. Nevertheless, two limitations in this connection may be noted. Discussion of the principal descriptive constants of a frequency distribution is limited to 23 pages. This provides a convenient review for students with some previous knowledge of statistics, but would probably prove an inadequate foundation for beginners. The decision to exclude such topics as measures of seasonal variation and index numbers lends further weight to the opinion that this book can be most profitably employed for students who have already had the advantage of a standard one-semester introduction to the fundamentals of business statistics. In addition, from the standpoint of use by marketing analysts (as well as by economists), it is unfortunate that virtually no attention is given to the special problems involved in correlating time series. * Appendices include an extensive and conveniently classified bibliography, a few mathematical derivations, and an unusually full complement of reference tables. * It is essentially a recipe book which provides answers elucidated with unusual clarity, but furnishes little training in the principles from which these answers are derived. As such, it cannot prepare the student to solve statistical problems independently or even to appraise the made-to-order solutions with which he has been equipped. As an introduction to more advanced work in statistics, therefore, it is wasteful—a remark which should be construed not as criticism of Mr. Ferber's excellent work but rather as a limitation inherent in this level of presentation. In the same category may be placed the occasional compromises with strict accuracy of concept which are encountered in this book. On the other hand, for students who plan to engage in marketing research and who lack the time or inclination for the mathematical training essen-

tial for specialization in statistics, this text will prove illuminating, practical, and superior to any directly competitive product now available. It is useful likewise as a reference work for practicing marketing analysts.

J Marketing 14:623–4 Ja '50. Charles J. Marsh. * The book is intended....to supply an up-to-date account of modern statistical methods in the simplest manner possible, with emphasis on the most useful procedures and on translating the mathematical theories into "English." With this very worthy objective in mind, Ferber has written an excellent brief statement, as Chapter One, concerning Statistics and Market Research, appealing to the practical commercial researchers and highly skilled statisticians to "meet each other halfway" so that both may profit from the experience. * It is likely that the statistically naive market researcher, having been promised a text which translates statistics into "English," will get along nicely until page 18, where the concepts of statistical *moments* is introduced, along with Greek formulas. Having survived this brief hurdle, the market researcher may be quite puzzled about the reason for including the geometric mean, complete with two Greek formulas, in a chapter on Elementary Concepts. The next seven chapters are devoted to sampling theory—211 pages in all * In this prolonged discussion of sampling, the introductory discussions at the beginnings of the chapters, and the summaries at the ends of the chapters, are excellent. The statements concerning the problems of obtaining proper samples, within the limitation of costs, are well organized and clearly stated. The brief examples, drawn from the practical use of sampling techniques, are well chosen and inherently interesting. But when actual statistical handling of data is presented, the involved language of the skilled statistician emerges, along with those endless formulas in Greek notation. The statistically naive researcher will find much of this territory pretty rough going, and will almost certainly fall back on his antiquated methods, especially if he has a deadline to meet. The chapter on Sequential Analysis is an important one for any researcher using sampling techniques. * The charateristics, requirements and limitations of sequential analysis are well stated, and three good illustrative examples are presented. However, these inevitable Greek-letter formulas show up again, this time accompanied by logarithms! The last four chapters of the book deal with Multivariate and Correlation Methods—108 pages in all. * In these chapters the technical language and the lengthy Greek-letter formulas seem to smother the treatment of the use of multivariate analysis in market research. * Since this book is primarily devoted to a treatment of sampling statistics, it is obviously misnamed. Important as it is, sampling is not virtually the only statistical technique employed in marketing research. * Unfortunately, it is unlikely that this book will find much audience among persons employed in marketing research in general, or in sampling work in particular. The conceptual diet is simply too rich for the "practical" researcher. This is regrettable because there are great values to be gained from a study, not a mere reading, of this volume. The best use of the book would be in graduate level classes in "Sampling Techniques." A competent instructor, with plenty of time for thorough exposition and with well chosen examples from the "practical" field of sampling, should be able to build an excellent course upon this book. Possibly, in this way, the antiquated and faulty statistics which may sometimes be found in sampling techniques, can eventually be eliminated.

[111]

★FINKNER, A. L.; MORGAN, J. J.; AND MONROE, R. J. **Methods of Estimating Farm Employment From Sample Data in North Carolina.** North Carolina State College, Agricultural Experiment Station, Technical Bulletin No 75. Raleigh, N.C.: the Station, June 1943. Pp. 35. Paper. Gratis. *

[112]

★FINNEY, D. J. **Probit Analysis: A Statistical Treatment of the Sigmoid Response Curve.** London and New York: Cambridge University Press, 1947. Pp. xiii, 256. 18*s.*; $4.00. *

Am Math Mo 55:374 Je–Jl '48. S. Lee Crump. Biological assay in general is the measurement of the potency of some stimulus by the reaction it produces in living material. This kind of measurement has been used for many years in assessing the potency of vitamins, hormones, toxicants and drugs of all kinds. One type of assay which has been widely used, especially in toxicological studies, is that depending on quantal, or all-or-none response. The most obvious example of this kind of response is death. Mr. Finney has written a book about the statistical treatment of quantal assay data by means of probit analysis. * The viewpoint of the individual, untrained in statistics,

who has to analyze quantal assay data is maintained throughout. Although this is the viewpoint that is emphasized, enough of the theory is given at regular intervals to enable the trained statistician to follow the theoretical basis for the methods. Examples with detailed explanations and discussion are given to illustrate each new method or variation of a method. The examples are well chosen, largely from insecticide test data. In places the explanations of the computations seem unnecessarily detailed. This, however, is probably not a serious objection, at least from the viewpoint of workers in the applied field. One finishes reading the book with the feeling that it is a worthy companion to books by other members of the Rothamsted group of statistical workers.

Analyst 73:301–2 My '48. Kenneth Mather. Many types of bio-assay depend on the observation of an all-or-nothing or, as it is called, quantal response in some test subject, usually an animal. The subject shows the effect or fails to show it: it convulses or fails to convulse: it lives or it dies. No gradation of individual response can be recognised. The gradation of effect, produced by gradation of dose of the material or substance under test, is therefore observed as a gradation in proportion of the animals responding out of the groups to which the various doses are given. The potency of the substance under assay is measured by the dose necessary to produce the response in some given proportion of the test subjects. Usually 50 per cent. is taken as the standard proportion, and the dose producing this effect is termed the ED 50 (effective dose 50), or the LD 50 (lethal dose 50) in the special case where the response is death. The statistical problem is thus to find from the available observations the relation of the proportion of response to the dose given, so as to arrive at the best estimate of ED 50 (or whatever other ED may be used). The calculations should further show the level of error to which this estimate of ED 50 will be subject, or speaking inversely tell us the confidence we can place in the estimate and in its comparison with other similar estimates. The solution of this problem is the subject of Mr. Finney's book. * Mr. Finney has provided us with a complete compendium of the probit method of analysing quantal response data. With its aid we can pursue the subject just as far as we wish because he caters for all tastes, from those who only want as quick and simple a method as possible of reducing routine data, to their more specialised colleagues who use the probit method as an instrument of research. We can stop at the simple arithmetic or we can go on to learn how to apply the method algebraically in new fields. No matter what our needs may be, simple routine or complex research, practical calculation or theoretical derivation, so far as they involve the analysis of quantal response data, we cannot do better than consult *"Probit Analysis."*

Analytical Chem 20:494 My '48. Lloyd C. Miller. * "Since data obtained in toxicological, insecticidal, and fungicidal tests plot as sigmoid curves, this treatise is of interest to chemists, entomologists, and pharmacologists. * The examples are down-to-earth and focus attention on a frequently overlooked fact that when the basic data are good only to the nearest 1%, approximations are sufficient. No one should expect to find solved examples of all the problems to be encountered in quantitative toxicology but this volume is a handbook for every entomologist who tests insecticides. Chemists synthesizing economic poisons may reasonably insist that their products be tested by the methods Finney describes. * The book is virtually free of typographical errors, one benefit resulting from the otherwise regrettable delay of two years in publishing the work. Several useful tables are included.

Ann Appl Biol 34:469–70 S '47. Kenneth Mather. * Finney brings together the special statistical methods associated with toxicology and bioassay where the responses are quantal—methods to whose development, as Dr. Tattersfield points out in the foreword, the author has himself contributed much. The problems raised by quantal response are not confined to bioassay and toxicology. They have long been familiar in psychophysics, yet it will come as a surprise to many biologists to learn that their statistical treatment was understood in broad outline by psychophysicists some thirty years ago. The method has had to be rediscovered several times, the last being when, in the hands of Gaddum and Bliss, it began a dozen years ago to develop into its present form of probit analysis, with all the power and refinement that Fisher's principles could give. The wheel has now come full circle, for it appears that just as the earlier work of the psychophysicists escaped the biologists, with the consequence that they had to reinvent the analysis, so the

improvements that the biologists have made are at present largely unknown to the psychophysicists! The method of probit analysis is remarkable in both its underlying principle and its statistical practice. * the probit value should show a straight line relation to any transformation (usually the log) of the conventional measure of dose which would give a normal distribution of tolerances. Finney demonstrates this theoretical basis of the probit method by the more rigorous, but (to the biologist) less easily comprehended, comparison of certain fairly formidable formulae. * The process of fitting the regression line, calculating its error variances, and using it to compare the relative potencies of drugs, are all described with a wealth of illustrative example. The treatment of the fiducial limits to the line, to the ED 50 (which, where the response is lethal, becomes the LD 50) and to the measures of relative potency, is unusually informative and should go far to ensure that these limits are put to the best use in future. Finney then moves on to consider further extensions of the method; extensions in which, one feels, he has had a special interest. He first shows us how to make the proper adjustment for natural mortality, as estimated from untreated subjects in toxicological work, and he provides a table which leaves no excuse for adopting more rough and ready adjustments on the plea that the labour of computation would otherwise be too heavy. * *Probit Analysis* is indeed a comprehensive, as well as an authoritative, treatment of its subject; and as such it is to be highly recommended. Its value is increased and its field of interest widened by its two Appendices and seven Tables. The first Appendix shows how the calculation and checking of a probit analysis can be reduced to a foolproof code, while the second extends the interest of the book in the other direction by developing in some detail the derivation of the method of analysis from Fisher's principle of maximum likelihood. Of the Tables nothing more need be said than that they form the most comprehensive collection of probit tables yet published, and that they will be indispensable to all who have probit analyses to do.

Biometrika 35:423 D '48. N. L. J(ohnson). The publication of books relating to specialized statistical techniques is a welcome feature of recent years. In such books it is possible to give an account sufficiently detailed to provide a practical guide to the user of these techniques in most of the problems to be encountered * Finney's volume....is an excellent example of this specialized type of book * techniques covering almost every eventuality in the field commonly described as "dosage-mortality" are developed and their practical application illustrated by means of numerical examples. The standard methods of probit analysis are carefully described and very useful sets of tables (Tables I–IV) are provided. Tables III and IV, in particular, should considerably facilitate the computation of working probits. * Chapter 6 is devoted to the consideration of methods of allowing for natural mortality and should prove most useful. While the methods described are not new, it is the first time that they have appeared in a systematic treatise in such a way as to bring them to general notice. Similar remarks might be made about the other special features of the book—the treatment of factorial experiments, of the joint action of different poisons and of quantitative responses, for example. Most of the methods described have already been published in individual papers, but Mr. Finney has performed an important task in bringing them together in one consolidated account. The method of development is not, of course, theoretically complete or rigorous, but it is logically clear, and should provide an invaluable aid to experimentalists in their appreciation of the statistical tests described. It may seem ungenerous to extract for special criticism the very few passages in this useful book which seem to be ambiguous or capable of improvement. Such criticism will be made, however, as a modest attempt to help readers of the work to avoid certain difficulties and confusion which they might possibly experience. It appears to the reviewer that some difficulties may result from the author's desire to simplify the presentation of the underlying theory. While it must be admitted that some simplification is necessary, this should not be such as to allow of false impressions of the theoretical situation. As it appears that considerable knowledge of general statistical theory is expected of the reader, there would seem to be no need to avoid the use of simple technicalities in clarifying the exposition. We may instance the arguments for introducing the heterogeneity factor (p. 33), the working probit (p. 48) and the correction for natural mortality (p. 88). In the first of these cases it should be noted that the interval

of estimation will be on the average too long if there is no heterogeneity; while if heterogeneity is present the occasional use of normal factors will be incorrect. On p. 48, the implication that it is merely the asymmetry of the distribution of p which gives rise to the need for working probits gives a rather incomplete notion of the theory. Finally, the arguments on corrections for natural mortality could be much simplified if they were based directly on equation (6.2). The use of both LD 50 and ED 50 to symbolize the same population parameter, LD 50 being restricted to cases where the response is death, may be somewhat confusing. We note, indeed, that the author himself uses the symbol ED 50 on p. 124, when considering "kills." It may save some confusion to point out that the quantity x_1x_2, defined as x_3 on p. 117, is afterwards represented as x_{12} (there is also a misplaced bracket in the first equation on this page); there is also a misprint on p. 89, where the reference to equation (3.5) should be to equation (3.4). The comparatively minor importance of the above criticisms must be emphasized. The book as a whole is a valuable addition to the statistician's library and is indispensable for persons concerned with "dosage mortality" problems, in whatever form they arise. Apart from its other merits, the very full bibliography makes the book invaluable as a reference index in its own field. May other works of this specialized nature maintain the standard set by Mr. Finney!

Brit J Psychol, Stat Sect 1:71–2 O '47. Godfrey Thomson. "There is a need to-day" says Dr. Finney in his preface, "for books in which the specialized statistical methods appropriate to certain branches of science will be discussed in sufficient detail to enable biologists to appreciate them and apply them to their own problems." His book fulfills this task admirably and explains and illustrates probit analysis by description, by examples, by supplying the necessary tables and by giving, in an appendix, its mathematical bases. In addition, Dr. Finney gives an account, which is of peculiar interest to psychologists and especially to the present reviewer, of the history of the method. In its modern form it was devised and developed mainly by J. H. Gaddum (1933) and C. I. Bliss (1934), but much earlier it had under another name, the *Constant Process,* and with another nomenclature, been developed by psychophysicists. It is a remarkable instance of the water-tight compartments of specialized science; for those of us who earlier had a hand in developing the statistics of the *Constant Process* remained quite ignorant of the fact that Probit Analysis was practically the same thing. The accident that Dr. Finney was a friend and correspondent of Dr. D. N. Lawley, who at the time was on my staff, led to our enlightenment. * A "probit" (spendid selling name!) is simply a normal deviate with 5 added to it to avoid negative numbers. * Finney rightly gives the credit for inventing the method to Fechner (1860), and describes the recognition by Muller (1879) of the need for certain weighting of the equations, and by Urban (1909, 1910) for further modifications thereof. The combined Muller-Urban weights were given by Urban in the *Psychological Review* in 1910 and are to be found in Appendix I of *The Essentials of Mental Measurement,* first edition (Wm. Brown) 1911, and in all subsequent editions (Brown and Thomson). That table exactly corresponds to Table 4 on Finney's page 32, except for a constant factor .637 and for the fact that Urban tabulates the weights against the percentage *kill,* while the probit form tabulates them against the probit or normal deviate corresponding to that *kill.* Thus at a 69% *kill* Urban gives $w = .914$. Finney's Table 4 gives .581 (*i.e.* $.914 \times .637$) at probit 5.5, that is at a normal deviate of 0.5, which in a Gaussian curve corresponds to a *kill* of 69%. The constant factor .637 is of course immaterial in weights, and is due to the simplification in the Muller-Urban table of making the largest weight unity. It has already been mentioned that the Probit Method uses the Method of Maximum Likelihood where the psychophysicists used the Method of Least Squares (the former having not then been invented). The other big difference is that the Probit Method goes carefully into the statistical significance of the estimates arrived at, giving their confidence limits. This was a refinement beyond Fechner and Muller. But Urban made an attempt to do something of the sort. All credit is due to him for seeing the necessity and for trying, but in fact he erred grievously in his confidence estimates. It fell to the present reviewer to correct this (in the *Brit. Journ. Psychol.,* May 1914) by a sound but very cumbersome and inelegant form of calculation, to which Finney gives full acknowledgment, saying "His revision put the constant process into a form very similar to that of the probit method to-day,

except that the weights were taken from....the observations and not from....a provisional line, and that his formulae for the standard errors of the parameters were much more complicated." It is clear that students of statistical psychology must possess and study Finney's book. He has himself applied Probit Analysis to the results of mental tests (*Psychometrika,* March 1944) following a paper by George Ferguson (*Ibid,* Feb. 1942)....using the *Constant Process.* Ferguson wrote this in ignorance of the probit work. Still more remarkable, D. N. Lawley, also unaware thereof, proceeded to apply the method of maximum likelihood to Ferguson's problem (*Proc. Roy. Soc. Edin.* March 1943), that is to advance the *Constant Process* along the path already taken by the insecticide people. As I said at the outset, if Finney and Lawley had not been correspondents this independent breaking of the same path might have gone on still longer. I have used my space mainly on a comparison interesting to psychologists and helpful to them. I will only say further about Finney's book that it is most welcome, most "efficient," and deserving our "confidence."

J Am Stat Assn 43:145–8 Mr '48. Margaret Merrell. * The method of analysis is almost completely identified with the bioassay problem to which it is applied, and vice versa. * The type of assay most fully treated in the book is that of the all-or-nothing response, such as lived or died. With graded doses of the stimulus, changing proportions of the test animals will respond and a sigmoid response curve usually results. Around this curve, numerous biological and analytical questions arise, concerned with both the variation in the product being tested and the variation in the biological form used for test. Finney gives an excellent discussion of many of these problems. * a considerably more comprehensive discussion of the problems than is available in other books on bioassay, and will serve a very useful purpose in bringing together material that is scattered rather widely through the literature * The more exact maximum likelihood estimates obtained by a series of successive approximations are presented in Chapter 4. The reasons stated for using more exact methods are that the observations may be too irregular for any confidence to be placed in an eye estimation of the fitted line, or differences in weights of the observations may be hard to allow for, or the experiment may involve several different factors which are under test which call for more involved analytical techniques. The last reason is a sound one for using the more involved techniques in certain problems, and the second may occasionally be a justification, but the first is dubious. In general it is the very good observations, not the crude ones, that justify elaboration of the analysis. The fact is, that for an enormous number of problems in bioassay, a graphical fitting of the straight line gives adequate estimates; for if the observations are very smooth, the graphical estimates agree well with the maximum likelihood estimates, and if the observations are irregular, the sampling errors are so great that graphical estimations are within sampling range of the more exact estimations, even if they show a sizable arithmetic difference from them. This is true in the examples given by Finney. The question of graphical versus more exact estimates is intimately connected with the design of experiments, for it involves a balance of gains through time spent on refinements of estimates from a given experiment versus additional experimentation, at various stages of an investigation. As stated earlier, Finney has considerable to say on design of experiments in this field, yet he gives no guidance on this point, saying that "Only experience of the subject and of the experimental technique used can be a sound guide in this matter" (p. 24). This is an issue on which the statistician is frequently consulted, and rightly so, by the experimenter; and the discussion of design of experiment should incorporate consideration of this point. Methods of analysis of the dosage response curve through other equations than the normal curve are mentioned but not seriously considered. It is stated (p. 47) that none has been found to compare in usefulness with the probit transformation. It is true that none has been as fully explored, and in this sense Finney's statement may be accepted. There is perhaps no reason to expect a book on probit analysis to deal critically with other methods. It is to be hoped, however, that the virtual identification of the problem of bioassay with a particular statistical treatment will not lead the applied man to the view that this is the "correct" analysis to the problem. Referring again to the title, it should be emphasized that this analysis is "a statistical treatment" of the problem, and not *"the* statistical treatment." Since it is a widely used treatment at the present time, it is very useful to have this comprehensive summary of the procedures

made available, and at the same time, a thorough discussion of the problems in one field where they are applied.

J Am Stat Assn 43:148–53 Mr '48. Joseph Berkson. This is a very exceptional if not a unique book. I doubt whether ever before an entire volume has been devoted to the statistical treatment of one particular curve. Confining the specialization still more, only one aspect of the function is considered, for it is not with the normal curve as such that this book deals, but only with its integrated form. Singleness of purpose is further exhibited by the technic of analysis dealt with, for the author gives attention, not to the multitudinous sorts of mathematical methods that conceivably can be applied to the curve, but to one particular type, which is called "probit analysis." Within the probit scheme he largely confines himself to the statistical methods advanced by R. A. Fisher and his students. And finally, the data considered are only those of biologic assay. Such a concentration of topic and method affords an opportunity for thorough and careful presentation, and this opportunity the author has embraced and exploited effectively. The book as a whole is well planned pedagogically; the simpler elements are expertly separated out for initial presentation, and step by step the more intricate aspects are dealt with in successive chapters. * There are ample tables, a good list of references, and a good index. I noticed only a few misprints * In the list of references the absence of the article by Galton, which presented Shepard's calculated table of normal deviates, is conspicuous because it is from this that the probit tables used today are in all likelihood derived. * The consideration of weights is related to what I believe is an error in the text. On pages 53–54 we read: "This quantity is $Snw(y - \bar{y})^2$ reduced by $[Snw(x - \bar{x})(y - \bar{y})]^2/Snw(x - \bar{x})^2$; the calculation is shown in Table 6, and $\chi^2 = 1.67$, which differs from the χ^2 of Table 7 only on account of rounding-off errors." The value of Table 7 referred to, 1.62, is the actual χ^2 of the observations in relation to the fitted curve defined as $\Sigma \frac{(o - t)^2}{t}$. In the probit iteration, at each step, we use, for the regression being determined, approximate weights and working values derived from the previously determined regression. It is the sum of the squared residuals of the working probits around the fitted line thus falsely weighted that is given by the expression referred to. The χ^2 directly calculated refers to the actual observations and is equal to the sum of their squared residuals with the weights of the present solution. These two sums will not be equal, no matter how many decimal places are carried, until finally when the maximum likelihood solution is obtained. In fact a signal, and a useful one, as to whether this point has been reached is just this comparison. * Since the chapters are comprehensive and clearly written, the volume serves as a good text for the use of....[statistical technics worked out for straight lines] apart from their application to bio-assay. If one considers it timely to offer a didactic text on probit analysis, as here delimited, to represent bio-assay, then this book is a job well done. However, I myself doubt the appropriateness of such a volume. That the probit is a handy and generally good-enough tool for dealing statistically with the data of biologic assay need not be doubted. If easily applied methods for fitting are utilized and if the associated formulas are considered as suggestive only and are used with ample safety factors, no harm, and very probably much good, can come of its use. But the impression often conveyed by its devotees that this particular transform is a thing unique, possessing some intrinsic superiority, and that the methods used are mathematically "exact" and therefore unexceptionable, is open to question. Out of some 200 pages of text, the author devotes only about one to curves other than the integrated normal curve and says: "None of these relationships has yet been found to compare in usefulness with the probit transformation." It would be more accurate to say that no comprehensive examination has been attempted of the comparative merits of different transforms and that such comparisons as have been made have not been examined adequately if at all by the author of the present text. Some studies indicate that there are certain advantages in other transforms. The angular transformation, for instance, has been found simpler to fit and the logistic not only easier to fit but better in accord with bio-assay data. Before a particular curve is adopted as the statistical norm, do we not need to know whether it represents the actual physicochemical mechanism of the bio-assay reaction; that is, do we not need a study of the differential equations representing the theoretical mechanisms involved? As a minimal responsibility it would seem that the author of so

definitive a text should himself have ascertained which of several proposed curves *fits the data best,* before committing a public that is gullible with regard to any statement printed in a textbook to the curve that happened to have emphasis in his statistical schooling. In fairness, however, it should be said that the methods worked out for the probit transform can, with appropriate modification, often be applied to other linear transforms, should it be desired. A statement to that effect would, I believe, strengthen the present work. The sectarianism shown by the author in regard to the choice of curve is exhibited likewise in respect of the statistical methods advanced for applying it. The method advocated for fitting the curve is that of maximum likelihood, as proposed by R. A. Fisher, rather than least squares, on which most of us oldsters were brought up. For the situation of biologic assay as dealt with here these two methods do not give the same estimates, as the author clearly recognizes (p. 54). An example for which I have made some necessary calculations is one used by Fisher and Yates and for which Garwood calculated the maximum likelihood solution by the probit method. Four successive approximations were required before constancy of the estimates of the parameters was achieved. For the first provisional solution the estimates of a and b were respectively 4.600 and 0.600; for the fourth solution they were 4.566 and 0.713, showing an appreciable difference between the first and last estimates. Now the likelihood was highest for the last solution, but the successive values of χ^2 beginning with the first provisional solution were 3.54, 3.67, 3.77 and 3.79. The χ^2 test is often used as a measure of goodness of fit, and its use is in fact a part of the prescribed procedure of probit analysis. By this criterion, in the successive iterations in this example we were laboriously moving toward a worse and worse solution! Which solution is the "best": the first, of which the value of χ^2 was smallest; or the last, for which the likelihood was largest? Which of the two estimates has the smaller variance? And does not the use of the χ^2 test require that no part of any possible excess of χ^2 found be due to the method of estimate used? These are not impertinent questions; indeed they must be answered before we can say that the basic procedure used in probit analysis rests on a logical foundation. For the difference between graphic fits by eye and the exact maximum likelihood solution is of the same order as the difference between minimum χ^2 and maximum likelihood estimates. If we are to proceed from fitting by eye, using a rather laborious arithmetic procedure, toward a more refined solution, it can only be because we are assuredly moving toward a better solution. But if, as is possible, the minimum χ^2 solution is the better, then in seeking a maximum likelihood solution we are, as would be illustrated in the case of Garwood, actually achieving a worse estimate than the one with which we started. My own questions regarding the probit method for fitting are for the most part on an intuitive and "common sense" basis and are little assisted or embarrassed by knowledge of the higher mathematics. However, misgivings evidently have been felt by the mathematically mature and competent. Thus, speaking of the probit solution, Thompson said: "A general theorem of convergence has not been proved for any set of points (log. *Di, pi*), or with certain specific exceptions, where we are required to fit a given curve or a straight line in transformed coordinates in the indicated manner. Indeed, the general theorem without such exceptions can easily be disproved....and reference to it as 'the exact' method....may lead to a false appreciation." Similar doubts will assail one on careful examination of many other phases of the probit analysis. On the basis of practical experience I have always felt instinctively that the use of observed values of zero or 100 per cent when these are asymptotic values is hazardous in curve fitting procedures. Others apparently hold similar views; for instance, Knudsen and Curtis in advocating the arc-sine transform advise against the use of any observations outside the range of 0.05–0.95. Cannot the basis of this hesitancy to use the absolute rates be found in mathematical considerations? In assuming that the integrated normal curve represents the true quantal responses to increased dosage, it is implied that for very large samples, a rate of zero or 100 per cent will not occur except with infinite doses. This is of course in marked contradiction with actual observations, in which such rates are always encountered with finite and even moderate doses. In his basic article on "The case of zero survivors" Fisher does not evidently make any allowance for this difference between theory and fact. But it is not to be taken for granted that this difference between the mathematical model and reality is without

practical consequence, and that it may be disregarded without biasing the estimates. In view of the practical worker's hesitation to use absolute rates, the burden of proof would appear to rest with those advocating their inclusion in statistical schemes. Do we not have the right to require of the mathematical statistician that he demonstrate that the consequences of likely departures from theory are negligible, before developments based on the theory are considered definitely established? The fallacious practice of applying a test of significance by first offering lip service to the doctrine that a nonsignificant P (not low, that is) does not establish the hypothesis tested but only fails to disprove it, and then *acting* as if it did establish it, a fallacy that has been warned against repeatedly by authorities in mathematical statistics, is illustrated in Finney's book in the use of parallelism of probit lines for estimating relative potency. First parallelism is *assumed* in order to make the estimates, then a χ^2 test is performed for parallelism on the basis for instance of two degrees of freedom (p. 71). *Mirabile dictu,* the P turns out not significantly small. *So the estimates based on the assumption of parallelism are accepted.* Before such a test can be considered to rest on a sound mathematical foundation we must have some knowledge of the *power* of the test relative to the alternative of nonparallelism. How large a departure from parallelism must exist, I wonder, before the χ^2 test, as used here on the basis of two degrees of freedom, will probably show a significantly small P? And is it not a fact that departure from parallelism much smaller than this will render seriously inaccurate estimates of the parameters which have been made on the basis of an assumed parallelism? Perhaps Finney will have this calculation for us in the next edition of his book. Or perhaps he will find that parallelism cannot be tested effectively by means of tests of significance based on two degrees of freedom. Another matter inviting attention is the tacit assumption made throughout the text that there is no error in x, the measure of dosage. Actually this is an idealization, for to err is human, even in the direction of the abscissa. Do we not need a mathematical investigation to ascertain the possible effect of such errors? So far as I know, no such inquiries have been made, but it is not hard to see intuitively that such errors, even if moderate in size, may play havoc with many of the formulations set forth as "exact" in this book. Aside from such specific questions, I sense a broad uncertainty as to whether the structure of assumptions as a whole underlying the formulas is warranted for the data as they actually are encountered. It is notable that this entire book contains not a single repetition of experiment to test whether the theoretical error formulas represent the real variations which occur in repeated trials. My own practical experience, admittedly small, indicates that the formulas underestimate the actual errors considerably and sometimes vastly; and this conclusion is confirmed by veteran workers in the field of bioassay. Sometimes this sort of objection is met with the rejoinder that the formulas give only the "statistical" or "sampling error"; but, if dosage to patients is guided by measures of error as given by these formulas and a patient succumbs from an overdose, it will be little consolation to reflect that it was not the sampling error that killed him. For the reasons cited and other similar ones we cannot be certain that probit analysis furnishes the exact method for bioassay nor even that, of the methods proposed, it necessarily is the best. At the moment about all we can be sure of is that it is the most elaborate.

J Royal Stat Soc 110:263–6 pt 3 '47. J. O. I(rwin). * a first class book * The first five chapters give an excellent account of the usual theory and practice of the method. The main treatment is rightly based on the maximum likelihood solution, though graphical and other approximate methods are briefly considered. Section 14, Chapter 3, is devoted to an interesting historical account of the probit method. * In Chapter 5 there is a remarkably good section (21) on the combination and comparison of relative potencies; in one example non-orthogonal analysis of variance is skilfully used. The reviewer would like to recommend this, quite apart from probit-analysis, as the clearest exposition he has seen of how to apply non-orthogonal analysis of variance in practice. Section 22 is very short, but rightly emphasizes the importance of experimental design, and envisages the further use that can be made of modern design in this field. Chapters 6, 7 and 8 are mainly concerned with important developments due to the author himself. Chapter 6 develops the technique necessary for allowing correctly for a natural mortality not caused by the stimulus applied. The maximum likelihood

equations become more complicated, but the pilot clearly steers the course to be followed. Chapter 7 is equally good, and shows how to deal with the case when the response has to be related to *two or more* stimuli, which may or may not interact. Chapter 8 deals with the toxic action of mixtures of poisons. Here the author's exposition of his own contributions is first rate; but the chapter suffers a little in clarity from his careful attempt to be courteous to other writers. The difficulty in the subject seems to be due to the use of the ambiguous term *"independent joint action."* The term *"similar joint action"* is quite clearly defined; the poisons or drugs produce similar effects in the sense that one component can be substituted at a constant proportion for the other, and variations in individual susceptibility to the two components are completely parallel. This last statement is to be taken literally, the curves relating reponse to log-stimulus are parallel in the two components and in the mixture, and the ambiguous phrase "similar but independent effects" in Bliss's original definition is modified by the omission of the last three qualifying words. "Synergism," positive or negative, is then defined as departure from similar action. Though the term *"independent joint action"* is so ambiguous that its use in connexion with this subject should probably be banned altogether, just as the term *"minimum lethal dose"* has been in other connections, it is worth while trying to clarify our notion of its meaning. The equation

$$ {}_jP = {}_jP_1 + {}_jP_2(1 - {}_jP_{1|2}) \quad . \quad (1) $$

—where ${}_jP$ denotes the probability of the characteristic effect being produced by a mixture of definite amounts of two poisons (the suffix $_j$ denoting that the poisons are applied jointly), ${}_jP_1$ is the probability that the characteristic effect is produced by the dose of the first poison, whether it is produced by the second or not; and ${}_jP_2$, ${}_jP_{1|2}$ have the usual analogous definitions—is true whenever the symbols have a meaning. They cease to have a meaning if the two poisons react to form a chemical compound, for then we cannot speak of the probability of one producing an effect whether the other does or not. It does not follow that ${}_jP_1$ is the same as the probability that the dose of the first poison produces the characteristic effect when it is administered by itself. Bliss spoke of action as independent whenever equation (1) held, except that he wrote $(1 - {}_jP_1) \times (1 - r)$ for $(1 - {}_jP_{1|2})$ and took no account of the suffix $_j$. It would, however, be better to confine the term independence to cases in which ${}_jP_{12} = {}_jP_1 \cdot {}_jP_2$, *i.e.* independence in the statistical sense. It is to be noted that the correlation coefficient between the "susceptibilities" to the two poisons, where susceptibility is defined to be 1 when the effect is produced and 0 if it is not, is

$$ \frac{{}_jP_1 + {}_jP_2(1 - {}_jP_1) - {}_jP}{\sqrt{\{{}_jP_1 {}_jP_2 {}_jQ_1 {}_jQ_2\}}} \quad . \quad . \quad (2) $$

while the coefficient r in Bliss's formula has the same numerator, but denominator ${}_jP_2 \cdot {}_jQ_1$ $({}_jP_1 > {}_jP_2)$. Bliss's r is not a correlation coefficient and the author notes this. Thus except when the poisons react to form a new compound all action is independent in the sense of (1); but similar action, except perhaps for one particular pair of dosages, is not independent action in the statistical sense; indeed such action would rarely, if ever, occur. Chapter 8 ends with an interesting example of a compound response curve, such as would arise when the proportion of the two constituents in a mixture is a function of the concentration. A probit log-dose relation of the form

$$ Y = a + b \log\{\rho + (1 - \rho)10^{-k\lambda}\} + b \log \lambda \quad (3) $$

where λ is the concentration, ρ the relative potency of the two components, is derived, which for $\rho < 1/(e^2 + 1)$ has both a maximum and a minimum. Chapter 9 is concerned with some miscellaneous problems, heterogeneity of response in batches of animals on the same dose, the treatment of individual mortality records when only one animal receives each dose, with the *average kill,* and with the theories of Parker Rhodes which involve an equation of the form

$$ Y = \alpha + \beta\lambda^i \quad . \quad . \quad . \quad (4) $$

In equations of this form i cannot be determined precisely from the data usually available, but the quantity $1/ib^2m^2$, where b is the slope estimate, m the median effective dose, changes very little with i. It is to be noted that if (4) be written in the form

$$ \begin{aligned} Y - 5 &= (x^i - \mu)/\sigma \\ &= \{(1 + i \log x + \ldots) - \mu\}/\sigma \end{aligned} $$

and we write $\mu' = (\mu - 1)/i\,\sigma' = \sigma/i$

and let $\mu \to 1, \sigma \to 0, i \to 0$, μ' and σ' remaining finite we obtain

$$ Y - 5 = (\log x - \mu')/\sigma' \quad . \quad . \quad (5) $$

so that (5) is a limiting case of (4) when $i = 0$. This discussion brings out the fact that the normal equivalent deviation is sometimes easier to use in theoretical discussions than the probit; the same applies to the "average kill," where the use of the quantities $\alpha = 5 - (\mu/\sigma)$ and $\beta = 1/\sigma$ is distinctly awkward. We may require to know the expected kill when a selected average dose is given, but the individual doses are normally distributed about a mean ξ with variance γ^2. If the probit-dosage relationship for whole groups is

$$Y - 5 = (\xi - \mu)/\sigma \quad . \quad . \quad . \quad (6)$$

the proportion receiving the dose x will be $(2\pi\gamma)^{-\frac{1}{2}}e^{-\frac{1}{2}(x-\xi)^2/\gamma^2}\,dx$ and the proportion of those receiving it who are killed by it will be

$$\int_{-\infty}^{(x-\mu)/\sigma} (2\pi)^{-\frac{1}{2}}e^{-\frac{1}{2}u^2}du \quad . \quad . \quad (7)$$

Thus the expected mortality of the group will be given by

$$P = \int_{-\infty}^{\infty} dx(2\pi\gamma)^{-\frac{1}{2}}e^{-\frac{1}{2}(x-\xi)^2/\gamma^2} \int_{-\infty}^{(x-\mu)/\sigma} (2\pi)^{-\frac{1}{2}}e^{-\frac{1}{2}u^2}du$$

$$= \int_{-\infty}^{\infty} dt(2\pi)^{-\frac{1}{2}}e^{-\frac{1}{2}t^2} \int_{-\infty}^{(\xi-\mu+\gamma t)/\sigma} (2\pi)^{-\frac{1}{2}}e^{-\frac{1}{2}u^2}du \quad (8)$$

whence

$$\frac{dP}{d\xi} = \{2\pi(\sigma^2 + \gamma^2)\}^{-\frac{1}{2}}e^{-\frac{1}{2}(\xi-\mu)^2/\sigma^2+\gamma^2} \quad (9)$$

so that P is the mortality whose probit is $5 + (\xi - \mu)/\sqrt{(\sigma^2 + \gamma^2)}$. The effect of spreading the doses is thus the same as increasing the variance of tolerances by γ^2. The treatment in the text obscures this. The last chapter shows that probit analysis may occasionally be useful in dealing with graded responses. If there is an upper limit to a graded response, the probit corresponding to the response expressed as a proportion of this limit may be linearly related to some function of the dose. This is illustrated by some data on the uptake of lime sulphur by the honeybee. In fitting, the necessary weighting involves the variances of the original response at the different dosage levels. These will not in general be known *a priori;* the author assumes them to be equal; and this will often, as here, be quite a good enough assumption. But a transformation which equalizes the transformed variances sufficiently closely for practical purposes saves all the labour of obtaining the maximum likelihood solution by successive approximations; and it will often be possible by transformation to find a linear relation for which the transformed variances can be regarded as equal. Thus the probit method is not likely to be the best method very often, in dealing with graded responses. This book should serve as a model to others who intend to write a text-book on a particular statistical technique. It demands a little more mathematical knowledge from the reader than some books which have purported to explain statistical methods to the research worker who is not a mathematical specialist. On the other hand, it is not too difficult for the mathematically minded to fill in the gaps either for themselves or by reference to original papers. The balance is very well preserved. Further, one has the feeling that the author really understands the methods himself—he will pardon this seeming platitude—but this cannot be said about all text-books which have attempted to explain modern statistical methods while easing the path for the non-mathematical. There has been, at times, too much tendency to quote this or that authority, without really understanding the original work or the limitations of the field of applicability implicit in its original presentation. We congratulate the Lecturer on the Design and Analysis of Scientific Experiments in the University of Oxford on the successful performance of a difficult task.

Q R Biol 23:102 Mr '48. John W. Fertig.

* While this book will not be easy reading for research workers generally, it should offer no difficulty for those with some knowledge of elementary statistical procedures. There is much in it, including an appendix on the theoretical basis of the method, that will be of interest to the mathematical statistician. The book is a very valuable tool for anyone connected with assay techniques.

Sankhyā 8:390–1 Je '48. A. Bhattacharyya.

Mr. Finney's book has removed, to some extent, the growing need for a book of this type by the investigators in toxicological problems. The restriction of the subject matter to probit analysis alone is however regretted by the reviewer. A more comprehensive book containing all the statistical aspects of biological assays is a crying need of the day, as the literature published on the subject in various journals is both numerous and varied, and consolidation and systematization are needed both by the beginner and the professional toxicological

analyst. * The style is lucid and with the numerous examples it is not difficult to master the routine procedure of the statistical analysis. * The extensive reference will prove a help to those who want to pursue advanced study on the subject. The printing is quite satisfactory, though one thinks the price to be a bit too high for the quality of the paper and the binding. The book is useful and a copy should be kept in the bookshelf of every worker engaged in biological assays and toxicology.

Sci 107:76 Ja 16 '48. F. M. Wadley. This little book draws together developments of recent years in the dosage-mortality field, including the author's own important contributions. The format is clear and attractive. * A valuable chapter on joint action of mixtures is included, with tests for similar action and synergism. * The discussions are well illustrated throughout with arithmetic calculations. Rapid graphic solutions, and design of experiments, are touched upon but not elaborated. * The mathematical bases of methods are well presented. On the whole, the book is an extremely useful source of information.

[113]

★FINNEY, D. J. **Table of Significance Levels for the Fisher-Yates Test of Significance in 2 × 2 Contingency Tables.** Reprinted from *Biometrika*, Vol. 35, Parts 1–2, June 1948. London: Biometrika Office, University College, 1948. Pp. 145–6. Paper. *2s. 6d.*

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★FINNEY, D. J., AND STEVENS, W. L. **A Table for the Calculation of Working Probits and Weights in Probit Analysis.** Reprinted from *Biometrika*, Vol. 35, Parts 1–2, June 1948. London: Biometrika Office, University College, 1948. Pp. 191–201. Paper. *2s. 6d.* *

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★FISHER, RONALD A. **Contributions to Mathematical Statistics.** Editor's preface by Walter A. Shewhart. Index prepared by John Tukey. New York: John Wiley & Sons, Inc., 1950. Pp. 676, unnumbered pages. $7.50. (London: Chapman & Hall, Ltd. *60s.*)

[116]

★FISHER, R. A. **The Design of Experiments, Third Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1942. Pp. xi, 236. For latest edition, see 118.

Brit Med J 4284:192 F 13 '43. * one of the most important contributions to methodology of our time * A book like this cannot be easy reading, and its success is good evidence that intelligent persons are increasingly interested in the statistical control of experiments, so that the maximum of information may be had with the least expenditure of time and money. *

Eug R 35:16 Ap '43. F. Yates. It is gratifying to see that this book has now reached its third edition. This edition differs little from the second, the only addition being a section systematizing the confounding of a number of factors each at two levels (2^n type of design) and a section giving a brief account of the method of double confounding. The need for a better appreciation of the fundamental principles of experimental design is extreme in almost every branch of experimental biology, and nowhere more so than in the fields of medicine and human nutrition. * If all biological and medical students were compelled to familiarize themselves with the ideas contained in the first few chapters of *The Design of Experiments,* controversies such as these could hardly take place. More important, the progress of biological and medical research would unquestionably be very greatly accelerated by the use of more efficient experimental methods.

J Am Stat Assn 39:522–3 D '44. Lowell J. Reed. * The book contains a number of ideas of great importance to individuals engaged in experimental work in the field of science. The fundamental issues presented in the first two chapters should be reviewed in detail by every scientific worker. The mathematical concepts and methods used by the author in his approach to experimental material have all of the beauty that one so often finds in illustrations of the art of pure mathematics. Considered, however, as an expression of applied mathematics, they seem to the reviewer to place too much stress on refinements that lead to the greatest efficiency in the analysis when the conclusions that are to be drawn from it are very strongly influenced by assumptions and judgments on which the analysis is based. One important assumption of this character Fisher calls attention to on page 179 when he states that the methodology of the preceding seven chapters is subject to the assumption: "In this kind of hypothesis all discrepancies classified as error, and not eliminated from our comparisons by equalization or regression, are due to variation, in the material examined, following the normal law of errors with a definite and constant, but unknown, variance." The effects of this assumption may be and very often are far greater than those resulting from the differences between the more exact methods developed by Fisher and the approximate and simple methods that are in fairly common practice. The judgment issue involved in statistical tests is the one which Fisher brings out in his discussion on

page 13 where he states "It is open to the experimenter to be more or less exacting in respect of the smallness of the probability he would require before he would be willing to admit that his observations have demonstrated a positive result." When, as scientists, we are faced with the fact that the 5 per cent level of significance is nothing but a "convenient convention," methods which classify our results with a high degree of accuracy relative to this conventional limit seem over-elaborate. A good illustration of this issue is the example which Fisher discusses on pages 137–149, where he considers the result of an experiment carried out at Rothamsted in 1927. The mathematics of this analysis is beautiful but when one looks at the scientific conclusions as summarized in Section 53 one realizes that they do not differ in any degree from those that would have been reached by the conventional approximations to this exact analysis. In addition to that the analysis seems to this reviewer to completely omit one of the important scientific issues involved and that is that experiments of this type certainly fall into the realm of dosage reactions and although Fisher has used quantities (0), (1), and (2), the analysis pays no attention to where these quantities fall on a dosage scale. Table 23 on page 147 has a very strong suggestion that quantity (2) which is the level at which he draws his final conclusion is at entirely different relative positions on the dosage curve for the chemicals under consideration. One could wish that the author had devoted more attention to the methods by which the scientist may check the effects of some of the necessary assumptions and to the ways in which we may justify "confounding," not by the internal evidence of the experiment at hand, but by experiments designed for this purpose. Both of these are of great importance in the design of experiments and fall very definitely within the field of responsibility of the mathematical statistician.

Med J Austral 1:494 My 29 '43. * only a little new material * To the student of some standing in statistics, and especially to one who has had a thorough grounding in the author's companion volume "Statistical Methods for Research Workers," this new edition is an invaluable treatment of the uses to which statistics may be put. It is not a book for beginners, and while it possesses a definite agricultural bias, there is sufficient leaven of examples from other fields to indicate how biological and medical research could be strengthened by the use of modern statistical methods. *

Plant Breeding Abstracts 13:272 Jl 1 '43. O. Kempthorne. The third edition of this valuable book differs little from the second edition. *

Q R Biol 18:300–1 S '43. * The first two chapters....orient the reader with regard to Fisher's philosophy of scientific experimentation and are worth careful reading in order to understand the emphasis the author places on certain portions of statistical methodology. *

For reviews of earlier editions, see 36:B106, 38:B610–1, and 2:109–10.

[117]

★FISHER, RONALD A. **The Design of Experiments, Fourth Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1947. Pp. xi, 240. * For latest edition, see 118.

Eug R 39:75 Jl '47. K. H. We welcome the fourth edition * It is pleasant to notice the improvement in paper and binding as compared with the 1942 war-time edition.

J Am Stat Assn 43:323–5 Je '48. A. E. Brandt. * Familiarity with the statistical procedures presented by the author in his *Statistical Methods for Research Workers* is taken for granted as a background for understanding this book. However, the pleasing literary style and nonmathematical treatment in all but the last chapter have led some persons who lack this background to expect great benefits from reading it. Those readers who complain that the book is hard to understand are admitting their own shortcomings. * The general test of the hypothesis that two samples are random samples from identical populations presented in the last section of the third chapter merits greater study by statisticians who lack experience in experimentation in some field of science such as biology, medicine, or physics. * Chapter 10 on the generalization of the null hypothesis and fiducial probability contains much of interest to the practical experimenter but is especially important for theoretical statisticians. The final chapter on the measurement of information is especially commended for serious study, not because of the calculus involved, but because the principles in it are ignored so frequently. Though the author has used the results of actual experiments to illustrate the requirements of sound and intelligible experimental designs and means of drawing valid conclusions from them, he has avoided producing a compendium of designs which have been used successfully in various

fields of experimentation. It would seem, however, that there is a distinct need for such a book.

Nature 160:775 D 6 '47. K. M(ather). * the only new addition, a valuable one, is a section on the fiducial limits of a ratio. The reappearance of this book will be welcomed by all who have an interest in biological experimentation.

Sci Progress 36:184–5 Ja '48. J. Wishart. [Not excerpted because of copyright restrictions.]

For reviews of earlier editions, see 116, 36: B106, 38:B610–1, and 2:109–10.

[118]

★FISHER, RONALD A. **The Design of Experiments, Fifth Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1949. Pp. xi, 242. 12*s.* 6*d.* (New York: Hafner Publishing Co., Inc., $3.75.) * ["In the fifth edition, Section 35.01 [pp. 83–6] on configuration in three or more dimensions has been added."—Preface to Fifth Edition.]

For reviews of earlier editions, see 116–7, 36: B106, 38:B610–1, and 2:109–10.

[119]

★FISHER, R. A. **Statistical Methods for Research Workers, Eighth Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1941. Pp. xv, 344. * For latest edition, see 122.

J Am Stat Assn 37:291–2 Je '42. W. G. Cochran. * The principal addition consists of an extension of the section on the use of discriminant functions. * The present edition contains a numerical example illustrating an approximate test of significance of the difference between the "best" discriminant and the discriminant obtained from any given linear compound of the measurements. * This test should be illuminating to those readers who wish to understand the relation between the discriminant function approach and previous methods of handling the same type of problem. The preface contains an interesting discussion of the extent to which the book is dated. In the author's opinion, this is most evident in the order of presentation of the topics; in particular, he suggests that the analysis of variance might profitably be presented sooner and developed more fully. As a step in this direction, paragraphs have been inserted in this edition indicating the relation of the *t*-test to the analysis of variance tests of significance, though the detailed discussion of the analysis of variance still follows the section on intraclass correlations, and Professor Fisher excuses himself from the heavy task of a complete revision. Owing to the author's insistence on giving exact formulae rather than approximations wherever possible, the book remains as up-to-date a laboratory manual as any in the literature. From the point of view of its use as a text-book, however, the arguments in favor of a rearrangement will increase in force as the editions grow with the years. Presumably on account of wartime restrictions on the use of paper, the type has been reset so that the lines of print are closer together. The size of type is unchanged, however, and the book is still very comfortable to the eye. Some printing errors have unfortunately crept in during the resetting *

Nature 149:451 Ap 25 '42. M. G. Kendall. * the standard manual of statistical practice for research workers throughout the English-speaking world * One of the signs of the success which the book has enjoyed is a change in methods and emphasis over the last seventeen years which would have justified a rather more drastic revision. The author evidently feels this himself, for in the preface he excuses himself from "The difficult task of a fundamental rearrangement" on the grounds that "it is of real value to understand the problems discussed by earlier writers and to be able to translate them into the system of ideas in which they may be more simply or more comprehensively resolved." Perhaps so, but we may hope that on some future occasion Prof. Fisher will be able to find the time and opportunity to remould the book a little nearer to the heart's desire. In some respects this is a difficult book, partly because of Fisher's condensed style and partly for a more important reason. * the reader has to accept important results without proof and often without any hint as to how they were derived or precisely what hypotheses underlie them. If he is sufficiently interested and has the leisure to look elsewhere for the basis of the authority so much the better; but he will not find it in this book, and it is difficult to see how Fisher could have provided it without expanding a relatively short handbook into a comprehensive treatise. This raises the question how far the powerful methods of modern statistics can be properly applied without some conception, however general, of their rationale. Its importance is heightened by the fact that the book, though not intended as a course of instruction for statisticians, is often referred to as if it were. Fisher has, in fact, suffered from a

want of self-control on the part of some of his disciples, who betray a rapturous and undiscriminating enthusiasm which would be out of place even at a promenade concert. This in turn has excited a certain amount of criticism of the book. Orthodox statisticial teachers have expressed doubts whether Fisher's broomstick can safely be entrusted to any apprentice who can memorize an invocatory formula. It is replied that one can use a telescope intelligently without being an optician. It is retorted that only qualified practitioners are allowed to administer powerful drugs. This sort of argument trails indecisively through a good deal of the statistical literature of the past fifteen years, but the whole question is one which might well be seriously discussed. In a large laboratory the difficulty may be overcome by the employment of a statistical specialist, and perhaps as research becomes more centralized the problem of the individual research worker who has to be his own statistician will disappear. But the question how far a knowledge of statistical *theory* is an essential part of the equipment of a research worker remains unanswered; it is a problem which could with advantage be studied by those responsible for the training of such workers. However that may be, the influence of "Statistical Methods" on scientific method has been profound. To Fisher and his school goes the credit for having brought home to scientific workers two things. One is that the proper use of experimental data is itself a science which can be brought to a high degree of precision, even when the material is imperfect and the sample small. The second is that though in certain sciences and in certain classes of experiment error cannot be reduced, it can be controlled by experimental design. This latter lesson, indeed, has been inculcated by Fisher in a separate book and has not yet been fully learnt by research workers. It is a useful rule that statistical advice should be sought *before the experiment is carried out.* * Notwithstanding the interest aroused by the newer methods in statistics as applied to experiment, "Statistical Methods" has few competitors. To some extent this is due to the fact that it is largely a record of Fisher's own achievements, but that is not the whole story. The challenge of Fisher's ideas and his long record of success have made this book a sort of symbol of a new statistical creed and a banner around which his followers rally themselves. Research workers will long continue to buy this book, to wrestle with its ideas and to apply its methods to an ever-enlarging field of discovery.

Q R Biol 17:189–90 Je '42. * Although for the uninitiated this will always be a difficult book, the more advanced student of statistics is enabled to find in it a clearer outline of the objectives of the recent analytic techniques than in the many other texts which presumably are prepared for elementary courses on the subject.

For reviews of earlier editions, see 36:B107, 38:B612–3, and 2:111–3.

[120]

★FISHER, RONALD A. **Statistical Methods for Research Workers, Ninth Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1944. Pp. xiv, 350. For latest edition, see 122.

Brit Med J 4393:371 Mr 17 '45. * This valuable book will continue to spread knowledge of sound statistical technique.

J Royal Stat Soc 108:235 pts 1–2 '45. Further evidence, if any be needed, of the great use and ever-increasing popularity of Professor Fisher's manual is provided by the appearance of another edition—the ninth. * The publishers are to be congratulated in that, in spite of wartime restrictions, they have maintained such a high standard of printing and binding with such a slight increase in price.

Nature 155:132 F 3 '45. K. Mather. The appearance of a further edition....might easily pass almost unnoticed, for nine editions have appeared at regular intervals in the last nineteen years. In fact, the cessation of this flow would be more remarkable than its continuation. * "Statistical Methods" is in fact....now a standard work, which has exercised, and must continue to exercise, its influence on research methods especially in biology. It is justly recognized as an essential part of all biological libraries and research laboratories.

For reviews of earlier editions, see 119, 36: B107, 38:B612–3, and 2:111–3.

[121]

★FISHER, RONALD A. **Statistical Methods for Research Workers, Tenth Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1946. Pp. xvi, 354. * For latest edition, see 122.

For reviews of earlier editions, see 119–20, 36:B107, 38:B612–3, and 2:111–3.

[122]

★FISHER, RONALD A. **Statistical Methods for Research Workers, Eleventh Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1950. Pp. xvi, 356. 16*s.*

For reviews of earlier editions, see 119–20, 36:B107, 38:B612–3, and 2:111–3.

[123]

★FISHER, RONALD A., AND YATES, FRANK. **Statistical Tables for Biological, Agricultural, and Medical Research, Second Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1943. Pp. viii, 98. * For latest edition, see 124.

Brit Med J 4306:76 Jl 17 '43. * The great value of the work is testified by the appearance of a new edition. Were a biological statistician confined to the use of one volume he would probably choose this. It might easily form part of active service equipment. *

Eug R 35:16–7 Ap '43. F. R. Simpson. * The second edition....retains all the good qualities of the first, but has been enriched by the inclusion of several new and useful tables. Tables V_1 and V_2 (by P. V. Sukhatme) are intended for tests of significance of differences between two means obtained by different methods. Table VIII (due to W. L. Stevens) allows the calculation of the exact limits of expectation (at a given probability level) for the binomial and Poisson distributions; the older standard error method is highly inaccurate when expectations are small, as is often the case, for instance, in the estimation of mutation rates; the table also allows putting an upper limit (corresponding to a given probability level) to the frequency of an event which has not occurred at all in a given sample; for instance, in an experiment involving N animals, no crossover individual has been observed between two genes G and H; what is the crossover value which once in twenty (or once in fifty, or at another probability level) would result in a sample of N non-crossovers and no crossovers? Tables $VIII_2$, also due to W. L. Stevens, is useful for the estimation of organism densities by the dilution method, as often used in bacteriological and virus research. Other additions are important mainly for agricultural research, such as an account on Youden's Squares included in the new edition. Authors and publishers alike are to be congratulated on the production of this extremely useful work under the present difficult conditions. The tables are printed on excellent paper, and it is very gratifying that despite greatly increased cost of production and an increase by eight pages, the price of the work has only been raised from 12*s.* 6*d.* to 13*s.* 6*d.*

Lancet 245:416 O 2 '43. In this edition of a collection of tables which have proved their value to statisticians a few corrections have been made and some useful additions inserted. * the tables are beautifully spaced and printed.

Math R 5:207–8 S '44. W. G. Cochran. * An interesting extension of the t-test is provided in table VI (due to P. V. Sukhatme) which gives the 5 and 1 percent significance levels of the Behrens-Fisher test for the difference between two independent sample means from normal populations whose variances are not assumed to be equal. * Tables XVII–XIX describe a useful series of experimental plans known as balanced incomplete blocks. *

Nature 152:491 O 30 '43. J. Wishart. * the introduction is a mine of knowledge in itself, and the tables cover all the contingencies envisaged. This edition, which maintains the standard of the first even to the quality of paper used—no small achievement these days—incorporates new features. Additional tables are provided for precise testing of the significance of the difference between sample means when it is not valid to pool the estimates of variance. One essentially practical problem can thus be dealt with, namely, the comparison of estimates of a physical constant, one based on numerous data of low precision, the other on a small quantity of precise observations. An extra table provides the limits of expectation for the probability of an event observed to occur a number of times in a series of trials, and thus supplies a more direct solution than hitherto of another practical problem. The densities of organisms estimated by the dilution method can be easily calculated from a new table. * The value of the volume is enhanced by the worked examples illustrating the use of the tables.

Plant Breeding Abstracts 13:272 Jl 1 '43. J. O. Irwin. The second edition of these invaluable tables will be welcomed by all workers in the general field of biological statistics. *

Sci 98:346–7 O 15 '43. C. I. Bliss. In the past five years no book in my possession has had more constant use than the first edition of these tables. It has furnished in compact form the data needed in designing an experiment, computing its results and interpreting the statistics obtained by analysis. The second edition, therefore, is as welcome as an old friend. * the adequacy of the Behrens-Fisher test has been questioned by some mathematical statisticians who accept the rest of the book * Additions that would be welcome in a third edition may be suggested. Since few [illegible] take readily to

interpolation, several tables could be expanded to advantage. Thus the variance ratio might be given for more intermediate degrees of freedom, the angular transformation assigned a more detailed table and Tables VIII and XI expanded. Useful new tables could include tests for the significance of runs; the range of the normal distribution in different-sized samples at various levels of significance, in terms of the standard deviation computed with varying degrees of freedom; other terms of value in statistical control of quality; and criteria for identifying discordant observations. These omissions, however, are not vital. The appearance of a second edition on good paper, in the same convenient format as before and with as many additions as have been made, must rank as a real achievement under present war conditions.

For reviews of the first edition, see 2:115.

[124]

★Fisher, Ronald A., and Yates, Frank. **Statistical Tables for Biological, Agricultural, and Medical Research, Third Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1948. Pp. viii, 112. 16*s.* *

Q R Biol 25:125 Mr '50. A. Chapanis. * The third edition of these highly useful tables has been improved mainly by a number of additions to and extensions of the tables in the second edition. *

For reviews of earlier editions, see 123 and 2:115.

[125]

★Fitzgerald, A. A. **Statistical Methods as Applied to Accounting Reports, Second Edition.** Melbourne, Australia: Accountants Publishing Co., Ltd., 1941. Pp. 104. Paper. 4*s.* *

[126]

★Fix, Evelyn. **Tables of Noncentral χ^2.** University of California Publications in Statistics, Vol 1, No. 2, pp. 15–19. Berkeley, Calif.: University of California Press, 1949. Pp. ii, 19. Paper. $0.25. *

[127]

★Forsaith, Carl C. **Statistics for Foresters, [Revised Edition].** Bulletin of the New York State College of Forestry at Syracuse University, No. 19, No. 1-a; Technical Publication No. 62. Syracuse, N.Y.: the College, March 1946. Pp. 69. Paper. Out of print. *

Plant Breeding Abstracts 15:92 Ja 1 '45. S. N. Collings. This bulletin is written for prospective foresters, who are given an elementary knowledge of statistical technique and the principles involved. The operations described cover the standard practices of grouping data, plotting frequency histograms, comparing the difference of means against a standard deviation, plotting correlation or scatter diagrams and drawing regression lines. Some of the procedures included are followed by minute instructions, and numerical examples are never lacking. In fact, if more attention had been paid to the mathematics and the symbolism, and less to the numerical examples and tables, it is probable that a more concise and precise exposition would have resulted, for although the bulletin may be consulted to advantage in finding out how to perform a given operation, the explanations are hardly adequate. It is not true that all populations or even most populations obey the "normal law." What usually happens is that a statistician interested in inducing the frequency distribution of a large population and in assessing his probability of error, postulates a certain distribution and sees how well it fits the facts. For reasons of simplicity he postulates the normal distribution where possible. The treatment of σ (the standard deviation) also calls for some comment. The rules given on p. 39 for the choosing of the numerical division in its estimation are hardly acceptable, for they suggest that, if the range of values in the sample is smaller than what one might intuitively suppose from a knowledge of the range of values in the whole population, the value of the estimate may be increased by dividing by $n - 1$ instead of n, (the sample size) thus obtaining a more exact estimate. Such an arbitrary procedure based on intuition is of doubtful value.

[128]

★Freeman, H. A. **Industrial Statistics: Statistical Techniques Applied to Problems in Industrial Research and Quality Control.** New York: John Wiley & Sons, Inc, 1942. Pp. x, 178. $2.75. (London: Chapman & Hall, Ltd. 22*s.*) *

J Am Stat Assn 37:559–60 D '42. Joseph Manuele. * Freeman has attacked the problem of quality control in a novel but effective manner. He starts out by determining the answer to the question: Of two or more lots of materials, did they all come from the same universe, or, in the language of the shop man, were they all produced under identical conditions? * From this test, Professor Freeman proceeds to the use of correlation and the analysis of variance to be applied to manufacturing operations during the manufacturing cycle. Unfortunately, on this subject, Professor Freeman does not have too much to say about the control of quality applied to the metal working industries. However, the quality control engineer will find this study a practical guide, though somewhat

too mathematical for the ordinary shop man. Professor Freeman attempts to get around this difficulty by segregating into separate sections the more theoretical treatment of the mathematics of the problem. The tables at the end of the book are a boon to the serious student of this subject, since in the past he has had to go to half a dozen books to get this information.

J Am Stat Assn 41:406–11 S '46. [For critical comments not excerpted, see John W. Tukey and Charles P. Winsor's letter to the review editor. For H. A. Freeman's reply, see *J Am Stat Assn* 42:348–52 Je '47.]

Mgmt R 31:363–4 O '42. John R. Riggleman. * The book is one in which any advanced student or practicing statistician will find many valuable suggestions. While it is intended for beginners who are "short on mathematical training," the fact is that it will be of little use to those whose mathematical preparation is no greater than that of most students of elementary statistics. But for those who have completed the first courses in statistics or those who have had considerable experience in the application of statistical methods, it provides much helpful information, particularly in connection with such problems as those involving frequency distributions, analysis of variance, and correlation. Here, in compact and convenient form, the industrial statistician will find methods and examples which will help him to improve and extend the applications of statistical methods to industrial problems.

Mech Eng 64:613–4 Ag '42. George P. Wadsworth. * can easily be understood and applied by one who has had no previous statistical training. Not only is its emphasis upon the practical use of statistical methods as applied to industrial and engineering problems, but also it has the added advantage that the assumptions and hypotheses underlying the formulas are clearly explained. * The book deals with two types of problems of utmost importance to industrial engineers, scientists, development engineers, and research workers. (1) The arrangement, analysis, and significance of experimental data already obtained in previous work and as yet in such form that the maximum amount of information has not been obtained. (2) The available methods and schemes which can be used to outline and perform experiments in order to maximize the information and minimize the number of experimental observations that must be made. * the question of design of experiments is one on which the industrial statistician has not until recently spent much time and thought and is generally not treated so thoroughly in an elementary textbook on this subject. The idea of carrying out small-scale experimentation right on the production line in order to obtain a large amount of valuable information is a really new idea. As applied to the design of experiments for development work, this method in many cases greatly reduces the time necessary to carry out experiments for the purpose of obtaining or verifying essential information. Analysis of variability is handled in an especially effective manner in that it is treated continuously throughout the book in connection with each subject discussed. In most textbooks analysis of variance is considered separately and this procedure makes the tie-up with other statistical methods rather obscure. Professor Freeman's treatment brings out the significance of differences of several averages, regressions, correlation studies, and covariance by clearly indicating their important interrelationships. This certainly is one of the distinguishing features of the book. The author at the beginning takes up the general question of sample theory from the small-sample viewpoint—a method of approach which makes the book immediately useful in the first few pages for industrial and experimental work. * [The] first three chapters are well integrated and the relationships between individual techniques are carefully explained * At the end of the book is a fine selection of useful tables, especially tables involving the distribution of statistics for the testing of normality and the L_0 and L_1 tables. These tables facilitate the solution of a large number of industrial problems without the necessity of searching elsewhere for the level of significance of distributions which occur frequently.

[129]

★FREEMAN, H. A.; FRIEDMAN, MILTON; MOSTELLER, FREDERICK; AND WALLIS, W. ALLEN; EDITORS. **Sampling Inspection: Principles, Procedures, and Tables for Single, Double, and Sequential Sampling in Acceptance Inspection and Quality Control Based on Percent Defective.** By the Statistical Research Group, Columbia University, Applied Mathematics Panel, Office of Scientific Research and Development. New York: McGraw-Hill Book Co., Inc., 1948. Pp. xx, 395. $5.25. * (London: McGraw-Hill Publishing Co., Ltd. 31*s.* 6*d.*)

J Am Stat Assn 43:605–11 D '48. Edwin G. Olds. * The reviewer's main criticism of this important book might be that no treatment of

acceptance sampling by variables has been included. In view of the book's subtitle probably this is an unfair cavil and merely reflects the reviewer's disappointment that this companion problem still lacks the same comprehensive exposition which the present volume now makes available for acceptance sampling by attributes. * With the restriction noted above, the book succeeds admirably in accomplishing....[its] three purposes. It will meet the needs of three kinds of readers: those who want a ready-made sampling-inspection program, those interested in building their own programs, and students of acceptance sampling. * It would be very culpable for the reviewer to imply that this book contains merely a set of sampling plans together with brief instructions regarding their utilization. On the contrary, the book treats the subject of sampling inspection by attributes in great detail. The bases for the decisions necessary in installing and operating acceptance sampling are discussed from almost every angle. The methods of constructing the sampling plans are carefully illustrated. Various possible alternatives are examined and the reasons why they were discarded are given in full. The reviewer has been unable to think of any question regarding the tables which has not been answered somewhere in the book. Nor has he entertained any criticism of choice of procedures without being able to discover that the authors have anticipated the possibility of just this criticism and have prepared a strong brief in support of their procedures. This insistence on complete coverage makes the book a valuable reference, especially in view of the scarcity of general publications in the field. The introduction to the principles of sampling inspection for attributes which is given by Part II is excellent. * Part III describes how the set of tables in Part V can be used as the basis of an integrated inspection program. * It is an expert job and major excerpts will, no doubt, be quoted in many an inspection manual. The somewhat limited class of readers who are concerned with methods of constructing sampling tables will welcome Part IV with enthusiasm. Up to the present time detailed knowledge of the procedures used in calculating tables has been restricted largely to those intimately connected with the actual task. * given alternative sets of desired properties, none of which can be satisfied exactly, the problem of discovering which properties can be imposed on a set of sampling plans at a satisfactory level of uniformity and then planning the execution of the necessary computations is neither small nor easy. Therefore, anyone who has this last problem to solve has the greatest interest in the philosophy, principles and techniques basic to previous solutions. The clarity and comprehensiveness of Part IV will be appreciated. There are a few harmless misprints in the book, and there is an occasional statement with which the reviewer could not entirely agree. On page 12, for instance, the remark is made that "the acceptance or rejection of an entire inspection lot on the basis of the quality of a sample drawn from that inspection lot provides a strong incentive for the supplier to improve the quality of his product." If, as often happens, the customer's inspection is preceded by a final inspection by the producer, then it is the improvement of this final inspection for which the customer's rejections provide a strong incentive. In an attempt at simplification the authors have decided to redefine acceptable-quality level (AQL) as "percentage of defective items in an inspection lot such that the sampling plan will result in the acceptance of 95 per cent of submitted inspection lots containing that percentage of defective items" (p. 144). This reviewer is not alone in deploring the placing of this additional, and seemingly unnecessary, hazard in the path of the lay reader of statistics. But, in spite of his few minor criticisms, the reviewer is convinced that this is an outstanding book. Anyone who is at all concerned with the problem of acceptance sampling by attributes needs to be thoroughly conversant with its content.

J Am Stat Assn 43:611–3 D '48. Paul S. Olmstead. * basically, the book is for a consumer who is unwilling to accept any evidence concerning the quality of a lot except that given by test of a sample of that lot * Chapter 5.... points out many of the difficulties associated with sampling inspection, dwelling at length on the vagaries of selecting a "random sample." The answer reached in one instance associated with spottiness is not apt to satisfy engineers who feel that one of the objects of sampling inspection is to discover evidence for just such a condition. Such evidence is often provided by keeping track of the order in which defectives are encountered. Order is not mentioned in this book. * the authors use the words "take corrective action" as applying to this 5% of the points rather than the more appropriate "look

for trouble." The engineer "takes corrective action" only when he finds that a criterion based on experience as associated with trouble is exceeded. In other cases, he may "look for trouble" but, ordinarily, would not find it necessary to "take corrective action." * Part III considers a "standard sampling inspection procedure." * Most engineers will find much of the material useful as a general guide to a larger number of things that may cause trouble in setting up inspection procedures. * Some mathematical statisticians may object to the use of the Poisson Exponential as an approximation to the Hypergeometric Series. Considerable space is devoted to showing how to compute the average amount of inspection (ASN—Average Sample Number) required to reach a decision to accept or reject for each of the three types of sampling. Readers should be careful not to confuse this average amount of inspection with the average amount of inspection required to give assurance that the quality of product meets the AOQL. * It is quite likely that many engineers will find the sampling tables useful in their work. The underlying philosophy associated with their use, however, may lead to a somewhat different "standard sampling inspection procedure"—one that would place more emphasis on process control and less on acceptance inspection than the one outlined in Part III of the book. Consequently, this reviewer would classify *Sampling Inspection* as a good reference book but not a textbook.

J Bus 22:134–5 Ap '49. E. U. Condon. * The authors....point out briefly the wide range of applicability of the material which makes up their book. The reviewer wishes to emphasize it further because it is his opinion that workers in all these fields will profit by a careful study of the book, in addition to those for whom it was specifically written and who are certain to find it indispensable. * Nearly all this book is concerned with the development, analysis, and presentation of the *OC* curves for various sampling plans. This, off hand, may seem like a very narrowly specialized topic. But in the reviewer's opinion almost any worker who has occasion to use sampling methods will be astounded at the variety of behaviors shown, at seemingly rather similar plans, and at the rather different efficiencies of plans in regard to the amount of investigative effort needed to obtain the same precision of information. Here, indeed, is a field in which great economies can be achieved by the careful substitution of precise methods for the rough-and-ready, common-sense methods which are so often employed. Although the underlying mathematical theory is moderately complicated, this part of the book has been kept neatly in the background. Throughout the book the emphasis is on practical use. This leads to specific discussion of actual operating problems in sampling procedures and to the presentation of a very large amount of specific information on various plans. The matter is not simple enough so that the same plan is best under all circumstances. The book gives a clear and detailed exposition of the considerations underlying the choice of methods for different situations. It also gives a wealth of tabular data and theoretical curves for various plans, so that the practical user can find all the information needed for practical application without working through the fine points of the theory. The book is indispensable to those working in the specific fields of acceptance-testing and quality-control. But it is also deserving of wide study by others who are concerned with other fields of application of the theory of sampling; they will be well repaid for the slight effort needed to recognize the applicability of the wealth of curves and data here presented to their own field.

J Marketing 13:576–7 Ap '49. H. D. Wolfe. * a major contribution * there existed a vital need for a book of this type. It provides a systematic and comprehensive account of some of the best current inspection procedures with detailed instructions for carrying out these procedures. * The material is presented in a most systematic and logical manner * The Statistical Research Group is to be commended for its publication of such a comprehensive and vitally needed book on sampling inspection. This book is more than an extensive collection of sampling plans. It provides invaluable assistance as a basis for an integrated inspection program since it presents a standard procedure for selecting and operating a sampling plan, with a separation of responsibilities for different phases of the inspection program. The organization of the book produces a considerable amount of repetition but, as explained in the preface, it is this organization which gives it its ease of reference and adaptability to a wide variety of uses. Many of its parts are self-contained, which makes possible reference to only those parts which are essential for the particular purpose intended.

It is sufficiently scientific, in specific parts, for those interested in the mathematical-statistical aspects of sampling inspection. Other parts are intended primarily for those interested in the practical application of sampling inspection to industrial problems. In short, this book is a very significant addition to the literature on quality control and an extremely useful manual for those persons interested in the practical application of sampling inspection.

Math R 10:52 Ja '49. H. Cramér. * presents, in a form suitable for the needs of industry, an extensive and highly useful set of sampling tables * The first 13 chapters....[are] written for nonmathematical readers, and only very few formulae are given. In chapters 14–17 [78 pages], the construction of the sampling tables and the methods of their computation are discussed. Though these chapters will hardly be fully understood by a reader not familiar with the basic formulae of the subject, these are given only in chapter 17. *

[130]

★GADDUM, J. H. **Methods of Biological Assay Depending on a Quantal Response: Reports on Biological Standards, III.** Medical Research Council Special Report Series, No. 183. London: His Majesty's Stationery Office, 1933 [reprinted 1949]. Pp. 46 Paper. 1*s.* (New York: British Information Services. $0.35) *

[131]

★GAGE, N. L. **Scaling and Factorial Design in Opinion Poll Analysis.** Purdue University, Division of Educational Research, Studies in Higher Education LXI; Further Studies in Attitudes, Series X. Lafayette, Ind.: the Division, December 1947. Pp. vi, 84. Paper, $1.25. *

[132]

★GARRETT, HENRY E. **Statistics in Psychology and Education, Third Edition.** New York and London: Longmans, Green & Co., 1947. Pp. xiii, 465. $4.00; 25*s.* *

Am J Psychol 60:662 O '47. Reginald Bell. * highly serviceable text *

Cath Ed R 45:254–6 Ap '47. John W. Stafford. * One is not enthusiastic....that the Summaries of Formulas and the Bibliography, included earlier, have been omitted. The omission of the earlier Statistical Tables, since they were quite inadequate, causes no regrets. The text might have been brought more up to date by a relatively greater emphasis on standard scores and a briefer treatment of the popular but less useful percentile measures. It might be too ambitious to include factor analysis in a text of this level, but a treatment of this increasingly more important technique would have been welcome. The text has always been weak in the mathematical basis of the formulas used. Most students and perhaps many instructors would perhaps whisper that this is a blessing. But, with mathematics more and more required as a prerequisite for advanced students in psychology, the need for greater treatment of the derivation and precise mathematical interpretation of formulas is increasing. In this text, the formula for the normal probability curve, magnificent in all its proper detail of pi, sigma, "*e*" and negative exponent, seems to perform a merely decorative function to impress and probably frighten the unsuspecting. However, this is a good book, a very good book. It is perhaps the very best text we have to introduce our students in psychology and education to the mysteries of statistics. The discussion is full and dazzlingly clear. The graphs and tables are expertly chosen and excellently integrated with the text. The problems are very good, and not too hard. (There are answers, too.) Although the text is somewhat on the light side for a graduate class, it could be used with profit there by students allergic to mathematics. On the college level, from sophomore through senior, in the words of Professor Woodworth's Introduction to the first edition, this book "to an unusual degree succeeds in meeting the student upon his own ground."

Ed Forum 12:249–50 Ja '48. H. C. Christofferson. * The writer....has used each of the former editions as a textbook * To review the new edition seems like reviewing a new edition of the Bible or of Webster's Dictionary. * Presentation of new techniques or principles is effected by means of well-chosen, illustrative problems. * The book is a usable, practical guide for students who are interested in the quantitative treatment of social data. * When the first edition was written, Dr. Garrett was Assistant Professor of Psychology at Columbia University; at the time of the second edition, he had advanced to Associate Professor; and now his rank is Professor of Psychology. These significant steps of recognition in his career indicate substantial and consistent contributions to research. They also indicate the substantial and dependable nature of this book.

J Am Stat Assn 42:318–9 Je '47. Joseph F. Daly. * The book is neither a collection of formulae nor a series of closely knit arguments. It requires very little of the student in the way of mathematical background and yet maintains

a reasonably successful compromise between readability and rigor. * There are, of course, some faults * For example, in Chapter 2, in spite of a helpful summary telling when to use the various measures of central tendency, one is left with the false impression that the median, mean, and mode are always estimates of the same quantity and that the mean is always the most reliable estimate of it. Again on page 70, there appears a statement which sounds a bit strange to a mathematical statistician: "This result [that the mean of the sample is 4.77], while mathematically correct, is rather difficult to interpret in a practical way, as it is obviously impossible for a family to have four and a fraction of children." This reviewer believes that it would have been better to take the occasion to point out that a mean value is a property of a distribution and not in general an attribute of a single observation. In Chapter 5 the author has not been entirely successful in his presentation of the uses and limitations of the normal probability curve; for in spite of the obvious care which went into the preparation of this chapter, the untrained reader is likely to infer that normality and symmetry are equivalent. This is a chapter that must be read in its entirety (footnotes included) before conclusions are drawn from it. The discussion on sampling and reliability represents a step in the right direction, but it seems unfortunate that more was not said about actual sampling techniques. The definition of random sampling on page 223 could easily have been made accurate with the aid of a short discussion on cluster sampling, stratified sampling, and quota sampling. Finally, the author has taken an apparently unnecessary liberty with standard terminology in Chapter 8, where on page 234 he confines the term "null hypothesis" to the case in which the difference between means is assumed to be zero. Notwithstanding these defects, the book serves its intended purpose well and should be of definite value in helping the nonmathematician "to understand, or withstand, the statistics that are constantly thrown at him in print or conversation."

Psychol B 45:87–9 Ja '48. David A. Grant. The 3rd edition....retains the breadth of scope, clarity of exposition, attractive format, abundant examples and illustrations, frequent cross-references, and other features which made the 2nd edition so popular. The book has been completely revised, however, and in addition to desirable rearrangements, new material has been included on topics such as the statistical significance of *r*, Taylor-Russell selection ratios, Kuder-Richardson reliability estimates, the Wherry-Doolittle test selection method, testing experimental hypotheses, small sample statistics, chi-square, *t*, and the analysis of variance. In addition to being thoroughly up-to-date the book includes a number of other excellent features. The chapters on the normal curve and on correlation are truly outstanding. The problems and answers at the end of each chapter are good teaching aids. A wide variety of useful tables, many of them new, are interspersed throughout the text. Unfortunately, however, the tables are accompanied by few source references and are not indexed, which will prove to be an inconvenience to readers. There are almost no typographical errors, and except for the general topic of probability and sampling, there are relatively few errors. * It seems to the reviewer that Garrett's treatment of sampling is the only topic which merits serious criticism. Chapter VIII on *Testing Experimental Hypotheses* is spotty and Chapter VII on *Sampling and Reliability* contains frequent errors which detract materially from what is otherwise an outstanding book. The chapter on sampling and reliability is considerably improved over the second edition counterpart, but it is still inadequate. The author continually (*e.g.*, pp. 186, 192, 196, 297, and 335) slips up on distinction between *a priori* and *fiducial* probability. The use of improper, informal expressions, such as, "....there is only 1 chance in 20 that the sample Q of 4.9 differs from the population Q by more than $\pm$ .40....," does not solve the problem. The reviewer's opinion is that a straight-forward interpretation in terms of confidence levels and the two kinds of errors and their consequences is called for with no more beating around the bush. This is by no means a trivial point. Other shortcomings of the sampling chapters include unclear and misleading discussions of *degrees of freedom* (pp. 191, 241); overemphasis on distinctions between large and small samples; "acceptance" of the null hypothesis (pp. 200, 208) (*e.g.*, "For *t*'s less than 2.09 we accept the null hypothesis and mark the difference 'not significant' "; an inaccurate method of determining the confidence intervals for percentages (p. 219) which often prove to be asymmetric; and recommendation of *inadequate* criteria for

the adequacy of random sampling (224–225, 227). The good chapter on *Testing Experimental Hypotheses* adds materially to the book, but certain specific points of criticism should be raised against the use of expected frequencies of 1.5 in the cells of Table 35, when computing chi-square, and the statement warning about the use of chi-square when "table entries are small" (p. 246)—here the criterion *should be* in terms of the *expected frequencies,* not the *observed frequencies.* Also the reviewer thinks that the use of the term *variance* for the *mean squares* or *variance estimates* of analysis of variance is inaccurate and misleading. One amazing statement appears on p. 224 to the effect that "....in small samples, wide deviations from the mean cannot appear if the sample is truly representative of a normally distributed group." Such measures, it is advised, should be discarded. This is an extremely dangerous practice unless there are *clear* rational grounds *other than extreme dispersion* for discarding a measure. To sum up, in the reviewer's estimation *Statistics in Psychology and Education* represents a fine achievement with the definite exceptions noted above. He believes the book will prove most valuable to those teachers and students of statistics in psychology who emphasize correlation and descriptive statistics.

Psychometrika 13:47–9 Mr '48. William B. Michael. * Garrett has made several noteworthy changes. * the clarity of the exposition remains at a high level. Pedagogically, the text deserves highest commendation. Numerous illustrative examples in most sections serve to clinch the points the author attempts to make. An ample supply of problem exercises along with answers renders the text highly teachable. * Contrary to the practice of many writers in statistics, Garrett does not overestimate the mathematical background of his readers. Despite the many favorable features of the text.... the author's viewpoint is conservative—perhaps ten or twelve years behind current practices employed in much educational and psychological research. The highly mechanical discussion of analysis of variance is inadequate as evidenced by the fact that only eleven pages are devoted to this important topic. Little is said concerning the assumptions underlying the procedures employed, and nothing apparently is said about the limitations, or weaknesses, of the analysis-of-variance approach. Only the "one way" classification is treated. Even more disappointing is the omission of analysis of covariance. Further evidence of the author's conservative outlook is the lack of any discussion of factor analysis. Any attempt on the part of the student to consider test reliability and test validity in terms of factor pattern is therefore impossible. Recent work concerning the relationship of test reliability and/or test validity to the range of difficulty of items and their degree of intercorrelation receives no attention. Although the chapter on "The Reliability and Validity of Test Scores" is well written, it does not represent any marked changes over the mode of presentation in the Second Edition (1937). Surely, the recent experience gained by psychologists during World War II in the areas of reliability and validity of tests offers ample opportunity for a broader consideration of these topics in the revision. In addition to a possible criticism of the relatively great emphasis placed upon large sample statistics, attention should be called to the erroneous manner in which probability statements are employed concerning the fluctuation of population parameters. Although the author frequently makes correct assertions concerning the probability that a statistic in random samples will vary within a certain interval above and below the value of a population parameter, he interpolates, for example, such contradictory statements as, "We may be confident (probability is .95) that the population σ is not larger than 2.61 nor smaller than 2.53 inches ($2.57 \pm 1.96 \times .02$)," (p. 194, lines 26–28). The obtained sample standard deviation is actually 2.57. (Moreover, the distribution of sample sigmas is not "normal.") * Apparently, the author has taken.... statistic values as "best estimates" of population parameters without stating explicitly such a step. The inexperienced student is likely to be confused when Garrett shifts from a discussion of the range of values of an obtained sample statistic about a population parameter within certain fiducial limits to the erroneous approach just described. Another misleading point arises in the consideration of the standard error of the difference between two percentages (p. 220). Garrett has failed to pool the two p values of both groups as his best estimate of the population value of p in testing the null hypothesis. Much needed are reasonably detailed, or at least adequate, definitions of such terms as *degrees of freedom, t-distribution, fiducial limits, confidence intervals, null hypothesis, representative*

sampling, and biased sampling. For example, the definition of the *null hypothesis* is restricted to a zero difference in the instance of the difference between two means rather than extended to any prescribed difference which the experimenter wishes to test. In the treatment of skewness and kurtosis some reference to third and fourth moments might appear desirable. The reviewer was considerably disturbed at the misleading statement on page 224, "and in small samples, wide deviations from the mean cannot appear if the sample is truly representative of a normally distributed group. When working with small samples, therefore, deviations far removed from the mean should be discarded much as a laboratory worker throws out measures of reaction time which are obviously premature or delayed." Obviously, some of the wide deviations represent rare events which can be expected to occur at least once in several replications of an experiment. What could be potentially more undesirable than having the inexperienced student throw away certain data in order to make his observed results conform to values he had anticipated or desired! Garrett fails to point out any standard for the rejection of obtained data and to warn of hazards involved. In the next paragraph a somewhat less startling error—perhaps the term "slip" is appropriate—is the implication that two "independently drawn" samples with approximately the same means and the same standard deviations are representative of the same population. Obviously, the identity of the two respective statistic values in the two samples could be due to a common bias. * Although there is sufficient basis for considerable criticism of the Third Edition, it probably still remains one of the better texts in the field. Its lucid expository style and its pleasing format will continue to appeal to many instructors and students. However, the student requiring a substantial background in quantitative methods will find it necessary to consult other standard texts commonly used in courses open to advanced seniors and graduate students. Forthcoming revisions of the other texts in the field, as well as the appearance of new books with a somewhat more forward-looking point of view, will challenge the position of leadership and prestige that *Statistics in Psychology and Education* has held for so many years.

For reviews of the second edition, see 38: B621.

[133]

★GILMAN, STEPHEN. **What the Figures Mean.** New York: Ronald Press Co., 1944. Pp. ix, 127. $2.50. *

Accounting R 20:249 Ap '45. Nina L. Youngs. * Gilman says in his preface: "The book has been written for people who want to understand and use business figures but who have never had it explained that the way to do this is to enlist the aid of a few simple, easy methods of statistical analysis to bring out of the figures important meanings otherwise difficult to perceive." While the book might have been more extensive, this aim, within the scope of the book, has been accomplished. * succinctly written * Gilman shows the situation to be interpreted, and then chooses the simplest measures to apply to the problem. * Personally, it was a delight to see some of the more difficult statistical concepts robbed of their terror. The "standard error" and the "factor of safety," for example, have been reduced to a mere matter of simple arithmetic. The question naturally arises, however, as to whether such a procedure has meaning without adequate statistical background. Business people should find this volume of practical value insofar as it points out situations where simplified statistical procedures could be applied. It might also be indirectly useful by influencing them to review a text in elementary statistics, and extract therefrom other statistical procedures which would be applicable to their business problems.

J Am Stat Assn 40:388–9 S '45. Harry Pelle Hartkemeier. * If the business man cannot or will not employ a good business statistician, then the reviewer is willing to grant that the methods given in this book would be the next best choice. This book is the best one of its kind the reviewer has encountered. It is not very suitable for a college textbook in business statistics, for the author uses many technical terms in the field loosely in an every-day conversational sense which is different from their technical meaning. * In only one case does the author use data for as many as four years. "Seldom is it practical to undertake studies covering a period of more than two years or 24 months" expresses the opinion of the author on time series analysis. The author never uses the term *business cycle,* and the reviewer suspects that when the author refers to the trend he means primarily the business cycle. This practice is fairly general among business men. In those universities and colleges which still

cling to the practice of giving a course in business management or industrial management to students who have not previously completed a course in business statistics, this book would serve very well as one of the textbooks for the courses in business management.

[134]

★Good, I. J. **Probability and the Weighing of Evidence.** London: Charles Griffin & Co., Ltd., 1950. Pp. viii, 119. 16*s*. (New York: Hafner Publishing Co., Inc. $3.00.)

J Royal Stat Soc 113:250 pt 2 '50. P. A. M(oran). This book is the latest and one of the ablest of the long series of attempts to construct a theory of probability based on "degrees of belief." It is, therefore, not primarily concerned with the technical aspects of the theory of statistical inference. The theory put forward is somewhat similar to Jeffreys's but has a number of twists of its own. Dr. Good attempts to build a system of axioms for the probabilities of propositions, and regards his whole theory as consisting of these together with a set of "rules" and "suggestions." Being a theory of the probability of propositions rather than of events it is essentially dependent on the individual who uses the theory. This has the intriguing result that the word "you" is used throughout in a technical sense. The difficulties of this method of approach are well-known and before we can be convinced of its superiority we naturally ask what can be urged against the orthodox method of inference, rejecting inverse probability, employed by most practising statisticians. Good's objections to the latter appear to be twofold. Firstly, he regards the ordinary theory defective in that it is unable to give a meaning to the expression "the probability of a hypothesis." Many, however, would regard this as empirically meaningless and not of great value in practice. Secondly, he criticizes the ordinary theory for requiring the use of judgment after (say) the significance level in a given problem is calculated. But it seems that judgment must be used in applying any theory of probability and that it is better to use a theory in which the resulting numerical magnitudes do not depend on some entirely subjective prior probability. After describing the foundations of his theory the author considers its application to the weighing of evidence and statistical inference. The discussion is based on wide reading and is always stimulating, although there appear to be occasional obscurities in statement. For example, it is difficult to find a meaning for the statement on p. 36 that the purpose of the design of experiments is to ensure "that the intervals in which the probabilities are judged to lie are narrow rather than wide." Again on p. 76 statistics is divided into a descriptive part and a "predictive" part and in using the latter the statistician is said to "forecast" the properties of a population. Theorem 21A on p. 52 is not a generalization of theorem 21, as stated, and in the latter it should be made clear that $E(X)$ must exist absolutely. It is also a pity that in discussing various methods of fitting curves no mention is made of their efficiency or of the mistake of applying χ^2 as a goodness of fit test when the method of estimation is inefficient. Some other topics might well have been included, for example, Smirnov's theorem on the convergence of an empirical distribution to a theoretical one, and Frechet's discussion of the "method of arbitrary functions," which is an example of ergodic theory and throws some light on why empirical events appear to obey the laws of probability. Statisticians fascinated by theories of probability will find this book pleasant and instructive to read and they are advised to read it, but it is doubtful if they will be convinced that the theory is preferable to the more usual approach.

[135]

★Grant, Eugene L. **Statistical Quality Control.** New York: McGraw-Hill Book Co., Inc, 1946. Pp. xii, 563. $5 00. (London: McGraw-Hill Publishing Co., Ltd. 40*s*.) *

Chem & Eng News 25:1077–8 Ap 14 '47. Kenneth J. Arnold. * timely and carefully written * Errors of fact appear to be almost entirely confined to incidental statements apart from the main current of the argument and no one of them is serious enough to deserve specific comment. One fact, recognized by Mr. Grant, deserves greater emphasis and use. Much in the literature of quality control and some of the discussion in the present work could be simplified by making use of the fact that a sample from a lot offers no direct evidence on the quality of the remainder of the lot. The possible deductions about the uninspected portion of a lot are exactly those which can be obtained by considering the uninspected portion as another sample from the same process which produced the sample inspected. * Grant's discussion of control charts leaves nothing to be desired in detail or coverage. With respect to sampling

plans, comparable detail is physically impossible. Nevertheless, few presently available methods fail to receive some discussion. * written at a level which is sure to make it most popular among workers in the field and among others who should know what statistical quality control has to offer.

Ind Qual Control 3:21–2 Mr '47. H. F. Dodge. * an excellent presentation of those simple but powerful statistical techniques that can be widely used in industry, more particularly in production and inspection operations, to control the quality of manufactured products, and to reduce costs * The author has attained.... [his] objective, writing with a clarity that should take much of the mystery out of the specialized language of the statistician. * The author has brought together under one cover and....skillfully coordinated much of the wartime training material in quality control methods, interweaving the results of his own wide experience in this field as a consultant to industry and as a teacher. * One of the outstanding features of the book is its treatment of many excellent examples, a total of 45. This is done realistically and in a way that will appeal to the practical man. The facts of the case are given, then follows the detailed method of approach, results obtained, the action taken, and a thorough discussion of the particular contributions of statistical approach. Moreover, the examples quite generally represent actual problems, not made-up ones. In a number of cases it is refreshing and convincing to find out that there was no gilded Cinderella solution, although there did result a better understanding of the inherent limitations of the manufacturing process. It is of interest to note that the examples cover a wide range of products and topics, such as electrical devices, steel castings, machined parts, textiles, aeroplane components, thermostatic controls, electric cable, discrepancies of gages, overfill of containers, revision of tolerances, and so on. * The reviewer has very few critical comments to make. The rule *"never under any circumstances* encourage misunderstanding by drawing the specification limits for individual values on a control chart for $\bar{X}$" is likely to be interpreted as meaning *"never* draw the specification limits," a rule to which some will find exceptions. The choice of the phrase "quality assurance of a sampling plan," referring to the operating characteristic or to specific risks of a plan, may be questioned by some. The restrictive statement that the Dodge-Romig tables are designed for use in the situation where the consumer performs the 100% inspection of rejected lots, may be the result of incomplete information, since standard practice in the use of these tables over the years has called for such 100% inspection to be performed by the producer. What is apparently overlooked is that the practice just referred to is readily accomplished by adopting a standard administration procedure; specifically by the adoption of appropriate implant rules of procedure, where the producer and consumer are different departments of the same company, or by the use of requirements or contractual agreements involving a system of certification with respect to producer inspections of rejected lots, where the producer is an outside concern. In summary, this book will be found helpful to all who are concerned with the economic control of quality of manufactured products. For those who ask the question "What is this thing called quality control and is it anything I can use?", the reviewer would class this book as a "must." For the quality control engineer already well advanced in his profession, this book with its wealth of examples and practical suggestions will be enthusiastically received. And for teachers and those responsible for in-plant training programs in quality control, this book with its large number of problems to be solved will be found well suited as a text.

J Am Stat Assn 42:180–2 Mr '47. Sebastian B. Littauer. * The presentation is clear and simple, and the text entirely readable. * Throughout the text well chosen examples buttress the exposition, giving it reality and conviction. In fact, these illustrative examples together with the many exercises which round out a number of the chapters provide valuable teaching material. * The treatment of control charts makes an entirely clear and comprehensive picture. It will undoubtedly be found very appealing to quality control personnel. * While reference is made to the existing and forthcoming works of the Statistical Research Group on sequential and other acceptance procedures, these topics are not developed. No general classification of sampling plans is given. Some operating characteristic curves are discussed, but *OC* curves as such are not made the focus of acceptance sampling plans. The author's emphasis on the lot tolerance is open to question. He states (p. 348), "Thus it is apparent

that a single figure p_t from each of a number of sampling acceptance plans gives a rough measure of their relative quality assurance throughout the entire range of possible operation." At best, the implications of this statement are misleading. The effectiveness of a sampling plan lies in its power of discrimination given by the operating ratio $R_0 = p_2/p_1$. This is the basis for the design of a number of sampling plans. In the case of the Navy sampling plans (not treated here) where choice is based on the *AQL* for a fixed producer's risk, the accompanying *OC* curve provides a measure for the power of discrimination. The merit of acceptance criteria based upon variables inspection is considered, but sampling plans for variables inspection following from the work of Romig or that of Johnson and Welch on the non-central *T*, for example, are not treated. In fact, it may be considered by some a serious omission that the practical possibilities contained in these works as well as in the existing applications of Wald's sequential methods to acceptance by variables has not been brought out. This book will unquestionably be used widely in industry both as a text and as a reference manual.

J Am Stat Assn 42:182–4 Mr '47. L. H. C. Tippett. The methods and practice of statistical quality control have developed considerably during the recent war, and there is a large literature on the subject, which is somewhat scattered and fragmentary. There is need for a book that brings all this material together and is, in itself, a sufficient guide to the latest practice. This book goes a very long way towards meeting this need. It is fairly described as a "working manual" aimed at giving a "general understanding of the principles underlying the various types of control charts and sampling tables," and an "understanding why these methods work, how to interpret their results, and how to decide which method to use in any particular case." There are two introductory chapters showing what the methods do, which serve to put the reader in a receptive mood, although parts of them may be too condensed for the reader who has not had previous acquaintance with the subject. There follows a section of about 180 pages devoted to the Shewhart mean and range charts. The essential statistical ideas and calculations associated with frequency distributions are well described * The whole section gives a well-balanced mixture of just the right amount of statistical theory, working instructions and practical examples and advice; it is a good foundation to the book. * The superiority of procedures based on control charts is well brought out. One limitation that may be removed in future editions is the dismissal of sequential methods with little more than a mention. One specially interesting chapter, all too short, is on the economics of quality control, showing how the costs of various control procedures should be set against the savings in manufacturing costs. * The many examples from a wide field of industry are actual, and not "cooked" or unduly simplified; they are dealt with realistically and served as occasions for bringing out many general points in just the kind of way they arise in practice. * The form of the book is open to criticism. The exposition is not entirely systematic, there is some repetition and there are too many cross references. For example, the equivalence and relative value of sigma and the range as measures of variability is a topic on its own that should, one would imagine, have been discussed once and for all in one place; in fact it is mentioned and dealt with in part in four places (pp. 105, 116, 152 and 201). And on page 439, in a chapter on acceptance procedures, there are comments on an example that refer to psychological considerations that arise in using mean and range charts for process control. Professor Grant's essentially practical approach has undoubted merits and will appeal to many (perhaps most) of the readers he aims at, but it leads to some disorder of presentation. Had he combined his method with a more systematic presentation he could have made a shorter, better book. A small criticism of the otherwise excellent layout is that it hardly seems necessary to disfigure the page with the heavy type of such uninformative headings as "Some Comments on Example 29." Perhaps these points of criticism are points of personal taste; but in any event they should not be allowed to detract from our appreciation of Professor Grant's book.

J Bus 20:116–7 Ap '47. H. A. Freeman. * This book has several merits: (1) it is the first book to discuss at length both quality control charts and acceptance sampling inspection; (2) it is filled with interesting practical examples and much useful incidental information which bespeak the author's extensive and successful experience in the application of these methods; (3) it has problems at the end of most chapters and these are very helpful when the

book is used as a text; and (4) it has a good glossary and Bibliography, is well indexed, and is admirably printed and bound. There are several deficiencies: (1) The mathematical structure of quality control and sampling inspection is loosely presented, often intermixed with, and even incidental to, the examples. There is no hard core of elementary mathematical statistics to which the reader can ever turn to find out what is at the bottom of the 550-odd pages of discussion. Moreover, no mathematical formulas are derived; nothing is proved. (2) The tables are designed for a book which regards quality control as a system rather than as a flexible scientific method. Except for the normal deviate, no tables of the distributions of the various statistics are given; instead, values of the statistics are given at one or a few points, usually at plus-or-minus three standard-error units. (3) The length of the book is a handicap; the few principles and basic techniques of quality control and sampling inspection seem lost. In his Preface, Grant writes, "This is a working manual....the aim has been to give just enough theory to supply practical working rules that will enable one to recognize the limitations of the methods as well as their many uses." This might be considered by some to minimize the import of such criticism as is made above; in fact, what I have termed deficiencies may be regarded as merits. But I feel that it is time that this tradition in quality-control literature is ended. The many manuals of this kind—of which this book is the latest, and perhaps, the best—have provided a broad base for the pyramid of industrial statistics. What the field now needs badly are personnel somewhat higher up in the pyramid, personnel who can apply elementary statistical methods with greater flexibility, and even somewhat more advanced methods, when they are called for. I am aware that much money has been saved and can still be saved by industrial personnel who were educated by such manuals. But authors in these fields should now, I think, make a great effort to raise, if only slightly, the level of their texts, this is a principal means of improving the effectiveness of the hundreds of men and women engaged in quality-control and inspection work in American industry, and this will provide a sounder base for those who are beginning in these fields. Two details: an errata sheet has been issued by the publishers; the term "Army Service Forces," which is used throughout the latter part of the book in connection with certain sampling-inspection plans, is too broad. At least one important branch of the A.S.F. used quite different sampling-inspection plans.

J Royal Stat Soc 110:146–7 pt 2 '47. S. V(ajda) * a comprehensive survey of industrial Quality Control, excluding only most recent developments, such as sequential analysis, which is merely mentioned in a footnote * The reader is invited to take part in an adventure of learning from examples, from mistakes and from accidental discoveries. This is surely a stimulating way of studying a new subject. A few of the characteristic headings of paragraphs may be quoted: "165. Probability has a mathematical meaning." "230. Specification limits are not always enforced." "326. Who should get credit for savings from quality improvement?" Extensive use is made of examples. No. 10, for instance, is headed, "An unsound proposal for sorting product into classes." The first paragraph then deals with the "facts of the case," the next with "errors in reasoning involved." The list of contents suggests a more methodological approach than is in fact intended. Control charts of variables, for fraction defective and for defects per unit, are dealt with, in this order, but the theoretical background is not entirely satisfactory. A Chapter on Probability introduces the binomial and the Poisson distribution (the reviewer finds the frequent reference to "the Poisson" irritating). Much earlier in the book the normal distribution is dealt with, but its connection with the other two types is ignored. The Dodge-Romig sampling schemes and the Standard Sampling Tables of the U. S. Army Service Forces receive the space which they deserve and the explanation of such notions as characteristics and AOQL, *etc.*, is clear and competent. The last part, "Making statistical quality control work," makes good reading. At the end of chapters we find "Problems," most of them well chosen, as for instance, "Why is it that an increase in universe dispersion with no change in universe average throws the $\bar{X}$-chart out of control as well as the R-chart?" Problem 69 (p. 219), on the other hand, is less happy, as it suggests that a certain approximation holds for n larger than (precisely) 25, leaving the reader guessing where this exact number comes from. The reviewer....makes an emphatic plea for references to be made to pages or articles, but not to tables and figures, which one cannot find without some hunting.

The book is excellently produced, and it will soon be acknowledged as one of the standard treatises on its subject.

Math Gazette 31:122–5 My '47. Frank Sandon. * [There are] some interesting features in what is called sequential sampling. The Operating Characteristic Curves suggest analogies with the fisherman's percentage release curve, and should be applicable to the educationalist's problem of repeated examinations for borderline candidates. * there is rather a full explanation of the Poisson distribution in connection with the *p* charts, with an *abac* (p. 240, Fig. 43), and a table in the appendix (Table G). There are interesting references to certain practical devices, some due to teachers in this country, for teaching features in connection with frequency distributions and with sampling (pp. 480–482). * Educationalists may be interested in the possibility of using some of the control chart devices for their own special purposes: a suggestion has been made above, while the x, R charts have already been found of value in revealing differences between the members of a panel of examiners marking various scripts of the same paper. The idea of consulting mathematical statisticians for handling problems by the techniques of this book may also appeal to readers. The book, says the author, is a working manual. It is a pity that figures and tables are identified solely by their serial reference number: there is no index to them and it is not easy to turn the pages quickly to find any particular one required. We have already referred to an important *abac* lost on p. 240: in the same way some important standard tables needed for the computing of some control limits are Tables 23 and 24, and it is impossible to locate these on pp. 210, 211 without hunting through the book. Some of the tables used in the examples have no reference number, and there are no answers to the examples. * Taken in all, however, the book is likely to be a most serviceable volume about the techniques so far developed for the practical use of control charts, especially in the field of industrial production.

Mech Eng 69:164–5 F '47. Paul T. Norton, Jr. The ideas expressed in this timely and important new book will prove useful to all those who are in any way concerned with the quality of manufactured product. * Statistical techniques are used throughout the book but one does not need to be a statistician to understand these techniques. Much of the book is devoted to a clear discussion of the use of statistical techniques in inspection and in acceptance procedures, but this reviewer feels that the most important single contribution is the explanation of a too little understood fact; that for real economy it is necessary that quality be manufactured into a product, rather than obtained by selecting a satisfactory portion of a product that is made without any real regard to whether the overall quality of the product as made is satisfactory. The author is peculiarly well equipped to explain these techniques. * Some of the ideas expressed—and proved—will doubtless come as a great shock to most experienced manufacturing executives. * The techniques....find their most obvious uses in quantity production, but.... the author has proved beyond any doubt that an [illegible] of the fundamental principles underlying the control of quality....will be most helpful to every manufacturing executive, no matter how few the number of pieces of any kind which may be involved in his particular case. For example, if it is once understood that variability within certain limits is not only normal but cannot possibly be avoided, one may more readily understand why attempts to improve a process by making changes may often make things worse instead of better. Also that from the viewpoint of real economy due consideration should be given to process limits when setting specification limits. If ideas like these, and others which may be found in various parts of the book, are once thoroughly understood, almost any manufacturing executive can find ways to improve the quality—and economy—of his product, even though he does not use a single one of the specific techniques that are explained. As stated earlier in this review, the principles outlined in this book can and should be used by every person who is concerned with the quality of manufactured product. This includes top executives, designers, production supervisors, and inspectors. Persons with experience in these lines should be able to adapt the ideas given in the book to all possible conditions, and this task is made easier by the fact that the author has included some 45 worked out examples from many different industries, practically all of which use actual data. There are also many tables and charts, a glossary of symbols used, an excellent bibliography, and what seems to be a very good index. This book will doubtless find its widest use as a reference

book in industry, but it should also prove to be an excellent college textbook. The teacher will be especially glad to note the large number of problems—nearly 150 in all—which are well distributed through the book. It is hoped that many of those who use the book in industry will work many of these problems; this will surely be helpful in obtaining an understanding of the underlying principles of statistical quality control.

Nature 159:454 Ap 5 '47. Maurice Kendall. * this book....exhibits throughout a most admirable appreciation of the practical aspects of the subject * [in Parts 1–4] the author is on fairly familiar ground, though the abundance of his illustrations and the careful development of the basic ideas will make these sections well worth reading even for the expert. Prof. Grant then turns, in Part 5, to the practical problems of making quality control work, and has some most interesting comments on the cost and organisational factors involved in introducing statistical methods into a factory. * The problem of teaching the engineer to think "probabilistically" is in many ways an easy one. He need not worry about refinements in the theory of inference or torment himself with the question whether probability is a limiting frequency or an undefinable idea. His samples are as large as he likes to make them; probability for him is very much the same thing as relative frequency; and in the course of a very short time he accumulates so much data that he can convince himself that the ordinary laws of probability work in practice whatever their theoretical basis may be. For this reason the engineering world, from Shewhart onwards, has developed a sort of pragmatic frequency theory of probability. It may be difficult to justify logically, but it works. Prof. Grant accordingly introduces probability as a frequency concept * There is a gratuitous footnote on page 112 which would be better omitted. "There seem to be," says the author, "two reasons why the standard error is so frequently misused in applications outside the field of quality control in manufacturing. One reason is that Shewhart's contributions to statistical theory, originally applied in manufacturing, are not so well known as they ought to be to statisticians in other fields * The other reason is that statisticians in other fields are not subject to the immediate check on the accuracy of their predictions which is so common in manufacturing." One can share Prof. Grant's admiration of Dr. Shewhart, one of the pioneers in introducing quality control into industry; but I do not think Dr. Shewhart would claim to have made any contributions to statistical theory or to have taught statisticians anything they did not know about the use of standard errors. Prof. Grant invites the comment that the engineer should stick to his lathe. But this is the only passage in the whole book to which I would take exception. The work is fluently written and well produced, and may confidently be commended to engineers and statisticians as an excellent account of the subject.

[136]

★GRIFFITH, A. L., AND RAM, BAKSHI SANT. **The Silviculture Research Code: Vol. 2, The Statistical Manual: Being the Application of Statistical Methods to Silvicultural Research in India.** Dehra Dun, India: Forest Research Institute, 1947. Pp. viii, 214. Rs. 11/2; 17*s.* 6*d.* *

J Forestry 47:990–1 D '49. Lewis R. Grosenbaugh. * This 1947 revision....is quite successful in giving many illustrations of tests of hypotheses involving forestry, with special emphasis on the mechanics of partitioning sums of squares in essentially simple balanced forms of analysis of variance. It does not go into the parametric structure of mean square tests nor into confounding, dummy plots, disproportionate frequencies, *etc.*—probably wise omissions in a field manual. The examples and description of randomized block layouts, Latin square layouts, simple factorial designs, and split plot designs are good. The value of covariance analysis and adjustment for initial differences is emphasized and illustrated in detail. There is also a good section on classical least squares fitting of straight lines, simple polynomial curves, and non-integer potential and exponential curves. The following topics are woefully neglected: principles of stratified sample design, assessment of sample precision, optimum allocation designs for various sampling objectives, *c*-multiplier techniques in multiple net regression, joint regression, orthogonal polynomials, analysis of Chi square into component elements, shortcut Chi square contingency table formulae, shortcut square and cross-product summation formulae for equispaced variables, shortcut correlation table techniques, fiducial desirability of an orthogonal set of single degree of freedom comparisons constructed in advance of outcome, and illustrations of systematic checks in vari-

ance and regression calculations. Although possibly deliberate (though not because of expediency), these omissions definitely lower the value of the manual to the field forester. Invalid inference may result from the authors' overlooking split plot compulsion in locality tests (p. 159 and 173), and from their implication that the usual confidence interpretations are valid for all possible intra-group t tests following a significant F test (exemplified by attaching significance to all possible differences greater than a least significant difference). Of course, Nair's and Tukey's papers on the subject were not available in 1947. The average forester will probably prefer to use the 1946 revision of Snedecor's *Statistical Methods* rather than *The Silvicultural Research Code* Vol. 2, which was prepared before the revised Snedecor was available. Those foresters, however, with a statistical phobia who are engaged in routine field tests of clearly formulated null hypotheses may find its concrete forestry illustrations and detailed calculation layouts helpful, despite its lack of provision for systematic checks. Its emphasis on orthogonal design (balance, replication, and a minimum of randomization) is healthy, and its casual approach to prerequisites for validity of illustrated techniques will do no great harm where situations resemble the models reasonably closely; in any case, this risk of misapplication is a danger which must be accepted by all manuals which exclude underlying mathematical bases from their scope.

Nature 163:344–5 Mr 5 '49. J. Wishart. * It is undoubtedly a convenience for sylviculturists to have their own all-embracing text, although as a matter of fact the only feature of the work under review that is peculiar to sylviculture lies in the numerical data and the actual experiments chosen for purposes of illustration. Generally, the volume is an expository presentation of those parts of the theory and application of statistical methods that are needed in the domain of field experimentation. * the selection of the material and the general presentation are on the whole sound, while a welcome feature is the considerable detail given to all the calculations; so much so, indeed, that the impression may have been left that computation is more complex than it really is, and the so-called "short-methods" not very short after all. Part 1—general principles—covers the standard methods needed for estimation and tests of significance up to analysis of covariance, with an added chapter (the longest in the book) on the fitting of simple curves, which is mathematical rather than statistical, and which could with advantage have been integrated with the general study of regression. Part 2 deals with the design of field experiments, describing the ordinary arrangements up to simple factorial designs, including split plots, and giving consideration to experiments repeated in space and time. With some unnecessary repetition from Part 2, Part 3 rounds off the work with nine full-scale examples. It would have been a convenience to readers to point out that variance-ratio tables are available, with all the other tables required, in a single book, "Statistical Tables," by Fisher and Yates. The main points of criticism are a need in some places for integration of alternative methods, a faulty comparison of a total and partial correlation coefficient on p. 57, and some confusion regarding the use of interactions in space-time experiments (for example, p. 177). But, in any event, sylviculturists will be safer with this book than with some of those given in the list of references, and the authors are to be commended for a useful compilation which will have a general value outside the forestry service.

[137]

★GRIMSLEY, GLEN. **A Comparative Study of the Wherry-Doolittle and a Multiple Cutting-Score Method.** American Psychological Association, Psychological Monographs: General and Applied, Vol. 63, No. 2, Whole No. 297. Washington, D.C.: the Association, 1950. Pp. vi, 24. Paper. $0.75. *

[138]

★GUILFORD, J. P. **Fundamental Statistics in Psychology and Education.** New York: McGraw-Hill Book Co., Inc., 1942. Pp. xi, 333. (London: McGraw-Hill Publishing Co., Ltd.) * For revised edition, see 139.

Am J Psychol 57:117–21 Ja '44. Joseph Zubin. * The contents generally follow the orthodox pattern * A new note is struck by such chapter-heads as Testing hypotheses, Prediction, and Errors of prediction. The author has a readable style. Psychologists who have had to learn statistics through Yule and Pearson cannot but envy the happy lot of the student of today whose road to knowledge is paved so smoothly. Here and there, it is true, the author is carried away by his facile pen. For example, he suggests that, if the price of a boat is marked $15,600, the student ought to "conclude that the cost was anywhere from $15,500 to

$15,650." But such lapses from realism hardly interfere with the reading of the book. Some of the quotations and the choice of examples are quite provocative of thought. His dilemma regarding "vague and right vs. precise and wrong" could well hang on the walls of every statistical laboratory. The examples are drawn from a variety of problems met in education and psychology and should strike a responsive chord in students in both fields. * The latter parts of the book, however, especially the new materials, are not integrated as well as the earlier chapters. One wonders whether in those sections the publisher's claim that the "treatment presupposes no previous knowledge of statistics" is justified. The book is primarily concerned with the statistics of continuous distributions, especially those of the normal type. This approach is suitable for students of social and educational psychology. For students in such fields as experimental and the abnormal, where distributions are often non-normal, and where a considerable fraction of the data is not necessarily quantitative, the text will not be so helpful. * it is somewhat surprising to note that even at this late date the virtues of physical measurements are still praised and looked up to as the model for psychological measurement. Such questions as whether a score of 50 points means twice as much as a score of 25 seem to the reviewer to be in the same category as the mind-sharpening but futile questions that used to appear in arithmetic books before arithmetic became functional. The author avoids some of the pitfalls that less expert textbook writers have fallen into. For example, in dealing with the proper selection of a measure of central tendency, he points out that there are at least two considerations. First, as to which measure would be more reliable on a sampling basis. Secondly, which measure would answer best the question that the investigator is examining. The discussions of this point are placed under the heading "when the mean is misleading," which is unfortunate since the median and mode can be and often are also misleading. In the discussion of measures of variability, only reliability seems to be stressed, the purpose of the measure being utterly neglected and a measure frequently useful—the average deviation around the median—is not mentioned at all. A pitfall which the author fails to avoid deals with the treatment of the 2×2 table. Most authors neglect to point out that the method of the critical ratio of percents and that of χ^2 lead to the identical results when the treatment is carried out adequately with due reference to the testing of a definite hypothesis, such as the null hypothesis. In fact, the value of the critical ratio will be identical with χ. Since the author treats the same problem with the two different methods on successive pages, it is surprising to note that he fails to point out the similarity of the results. And it should be pointed out, too, that he has so selected his data that the results are identical only in the particular example which he chose. If the student were to follow the directions given (165) for computing critical ratios of percents for a 2×2 table his results would be comparable only by accident with those obtained by χ^2. The selection of data in this way leads to an obscuring of the differences that ordinarily occur, and in the final analysis creates more confusion than integration in the student. The centile or C-scale, which the author regards as an improvement over the T-scale, is merely a cruder type of T-scale, and seems hardly worthy of the three pages it occupies in close proximity to a presentation of the T-scale itself. One comforting feature of the book is the introduction of postscripts at the end of each section indicating the dangers and hazards of each technique. In only two sections did the author fail to do this, and perhaps forgivably so. In the treatment of χ^2 he indicates the need for the Yates correction but does not indicate the limiting conditions under which its use is mandatory. Furthermore, he fails to mention Fisher's exact method, which needs to be used all too often in small sample experiments. In the treatment of analysis of variance no warning is given concerning assumptions of normality, of independence of observations, and of equal variances in the subgroups. A puzzling point in this connection is the failure to attribute the equation for the variance of a composite group (145) to Yule, in whose text the above equation has appeared since the 8th edition (1927). In introducing certain new materials the author has leaned heavily on the recent work of Guttman, which appeared in the monograph entitled *The Prediction of Personal Adjustment*. The incorporation of new methods has advantages but it also has its drawbacks. Some of the techniques are still, even according to Guttman, in their preliminary formulation and hence one should go slowly in introducing them into an elementary

text. Furthermore, the example of the 2×3 table giving the analysis of the answers to a questionnaire item (178 ff.) would, in the classic tradition, first be examined for the presence of an association before prediction is attempted. The entire discussion of prediction is on an unrealistic basis and seems to be introduced more for pedagogic than practical reasons. The prediction of weight from sex, for example, seems to the reviewer to be of not even hypothetical value, since in actual research no one would undertake such a procedure. Furthermore, if there is any point to the determination of the relationship between sex and weight, the biserial or point-biserial correlation coefficients are readily available. These coefficients give not only a measure of the degree of relationship but also an indication of its statistical reliability, while the method utilized by the author gives no indication of reliability. A simple analysis of variance or some other simple technique could be readily utilized for this purpose. The total neglect of association measures in this section seems to the reviewer unwarranted. Similarly, in the discussion of critical scores, a concept which H. M. Johnson has popularized, the author adopts Guttman's suggestion for selecting as critical that point at which the two contrasted groups are equal in frequency, *i.e.*, their point of intersection. For continuous smooth curves, this method is certainly sensible. For discontinuous, irregular curves it leaves much to be desired. The inspectional methods now used for such purposes, accompanied by chi square tests or analysis of variance to determine the point at which maximal differentiation is obtained, still are the most valuable. Guttman's principle of "maximum probability" is erroneously introduced under the title of "maximum likelihood." Were it not for the fact that there is considerable literature in which the differences between these two methods are described, the error might be understandable. The method of "maximum probability" as Guttman defines it is quite similar to Markoff's method of the "best unbiased estimate." This method selects as a parameter to represent a given aspect of a distribution (for prediction or for descriptive purposes) that one whose estimate (statistic) would have the smallest probable error in the observed sample. Thus, the mean of a sample is the *best* estimate to use for predicting the weight of a randomly selected individual in the sense that the standard error of prediction will be a minimum about the mean. The method of maximum likelihood, on the other hand, is based upon the premise that the best parameter is that one which will maximize the probability of obtaining the observed sample. Thus, the standard deviation is a maximum likelihood parameter in the sense that of all the possible estimates of variability that might have been selected, the size of the standard deviation in the given sample is the one which would make the observed sample the most likely to occur. In some instances, the two methods may give rise to the same solution, but this is not a necessary result. Consequently, the confusion between the two terms is unfortunate. As a whole the book is a brave attempt at injecting new trends into elementary statistics, and in view of the difficulty of such an undertaking, it is a commendable effort. If the author is not entirely successful it is only because of the heavy hand of tradition and because of the paucity of the new materials that can be handed on to an elementary student at the present time.

Am Sociol R 9:342 Je '44. Thomas C. McCormick. * especially complete in its treatment of correlation * investigators in psychology and education will find it a handy reference volume. Its chief merit lies in an unusual clarity and accuracy of exposition. In content it scarcely differs from previous texts except for the addition of sections on analysis of variance, small sampling, and the testing of "null" hypotheses * The discussion of analysis of variance, however, is too brief to be of much practical value. In view of the fact that measurements in psychology and education are conventionally made with scales so crude that the equality and even the meaning of their units are in doubt, it would seem wise in those fields to avoid small sampling as much as possible, and when used, the propriety of applying to them the mathematical refinements that constitute Fisher's contribution is debatable. Because of the present prestige of the Fisher methods, however, a new text could hardly be published in any field of statistics without including them. On the other hand, the book contains no definition of mathematical probability, and does not mention the elementary theorems of probability that underlie the whole theory of sampling and statistical induction; and it provides no instructions on how to obtain a sample of any kind in practice.

* Only an occasional technical error was noticed *

J Am Stat Assn 38:266–7 Je '43. Martin A. Brumbaugh. * the outstanding feature of the book is the uniform clarity of presentation. There are certain points at which the reviewer feels that the fetish of brevity may have been pursued at the expense of clarity and completeness, but such lapses are negligible in comparison with the overall precision of expression and adequacy of treatment. This matter of brevity is most prominent in the last two chapters of the book. The chapter on multiple and partial correlation would be more satisfying if an explanation were included of the meaning of multiple and partial regression equations. Some explanation is also needed of why the successive steps are taken in the Doolittle Method of solution. The chapter on reliability and validity of tests is an excellent critical discussion of the theoretical problems involved in evaluating test results. It seems to imply more practical experience with tests than the beginning statistical student would ordinarily be presumed to possess. At the end of each chapter a set of exercises is appended. These exercises are well designed to reinforce the student's understanding of the principles set forth in the chapters, and are adequate for homework assignment or for a laboratory of moderate length. The attitude of students toward courses in statistics has in many cases become extremely adverse because the authors of textbooks have succeeded only in introducing mystery into the subject. This book takes the mystery out of the subject by its clear and rounded exposition, its judicious choice of illustrative examples, and its general adherence to the point of view of the beginning student. The book is indeed a valuable teaching medium.

[139]

★GUILFORD, J. P. **Fundamental Statistics in Psychology and Education, Second Edition.** New York: McGraw-Hill Book Co., Inc., 1950. Pp. xiii, 633. $5.00. (London: McGraw-Hill Publishing Co., Ltd. 30s.) *

Brit J Ed Psychol 20:147 Je '50. * A very useful feature is the series of tables in the appendix * The book would be a useful addition to the library of any psychological laboratory. But as so often in American books, references to the work of some important English statistical psychologists are, unfortunately, lacking.

For reviews of the first edition, see 138.

[140]

★GUILFORD, J. P., AND LOVELL, CONSTANCE. **Elementary Statistical Exercises.** Beverly Hills, Calif.: Sheridan Supply Co., 1946. Pp. 64. Paper, lithotyped. $1.00. *

[141]

★GUILFORD, J. P., AND MICHAEL, WILLIAM B. **The Prediction of Categories From Measurements: With Applications to Personnel Selection and Clinical Prognosis.** Beverly Hills, Calif.: Sheridan Supply Co., 1949. Pp. v, 55. Paper. $1.40. *

J Consult Psychol 14:159 Ap '50. Laurance F. Shaffer. * Previously applied in the main to the prediction of "succeed-fail" in training or in industry, the methods have interesting possibilities in clinical research involving the prediction of "well-sick," "improve-regress," and the like. *

Psychometrika 15:328–9 S '50. Hubert E. Brogden. * provides a clear, explicit, and comprehensive discussion of the problems and possible solutions involved in predicting a membership in dichotomous categories and in setting critical scores for prediction purposes. The content is principally concerned with possible answers to the two questions posed early in the discussion, namely: (1) What is the probability that an individual with a known score on the continuous independent variable will be in a designated category of the (dichotomous) dependent variable? (2) Given the probability of an individual's being in a designated category of the (dichotomous) dependent variable, what should be the critical, or cut-off, score on the continuous independent variable? * The authors appear to favor the multiple correlation solution proposed by Wherry to the more widely publicized discriminant function for multiple prediction of a dichotomy. In considering possible answers to the second question, techniques are presented for determining the critical score that will yield any desired probability of success (or membership in a category). This in a sense gives a general solution to the critical score problem in that it allows choice of the proportion of failure that can be tolerated. The answer to the problem of the optimal critical score is sought in Guttman's principle of equal likelihood. Considerable space is devoted to demonstrating the adequacy of this principle, and to a somewhat elaborate consideration of the manner in which critical scores satisfying this principle vary with variation of such parameters as the percentage in a given category of the dichotomy, the difference be-

tween the mean predictor scores in the two categories, etc. This reviewer regards the solution deriving from the principle of equal likelihood as inadequate, and questions, consequently, the rather considerable emphasis and favorable treatment accorded it. Guilford and Michael, apparently, base their support of this solution upon their demonstration that critical scores satisfying the principle of equal likelihood minimize errors; that is, minimize the total of the predicted "failures" who would have succeeded and the predicted "successes" who would have failed. The reader will note the implied assumption that both types of errors are of equal importance. This assumption appears totally unwarranted to this reviewer. Generally speaking, the simpler solution of setting cutting scores as a function of the ratio of number of vacancies to number of applicants would seem much more satisfactory. It would seem evident that few hiring agencies would choose to disregard the benefits deriving from an advantageous selection ratio in the interests of reducing the proportion of rejected individuals who would have been successful. Critical scores based on the principle of equal likelihood would often lead to such a choice. In general, however, the presentation is excellent. A number of charts and nomographs are presented which will be found useful to those with problems in the areas discussed by the authors.

[142]

★GUMBEL, E. J. **The Statistical Forecast of Floods.** Columbus, Ohio: Ohio Water Resources Board, State of Ohio, December 1948. Pp. 21. Paper. Gratis. *

[143]

★HAAVELMO, TRYGVE. **The Probability Approach in Econometrics.** Supplement to Econometrica, Vol. 12, July 1944. Chicago, Ill.: Econometric Society, University of Chicago, 1944. Pp. viii, 118. Paper. $1.75. *

Am Econ R 36:161–3 Mr '46. R. G. D. Allen. * Haavelmo's monograph....is not easy reading even for a mathematician and the non-mathematical economist is likely to be scared off at a first sight of its pages. Patience is well rewarded, however, for Mr. Haavelmo's method of approach, whether accepted or not, should be known and appreciated by every economist. By astute and selective reading, and without going into the fine mathematical details, an economist should be able to get a general idea of Mr. Haavelmo's thesis and to profit from the many acute observations he makes on the side. * Mr. Haavelmo has useful things to say about the relation between economist and statistician, too seldom the same person. *

Econ J 56:265–9 Je '46. Richard Stone. This publication....should be read by everyone interested in statistical economics. Since the discussion between Keynes and Tinbergen in this *Journal* on the logic of econometric research a number of articles have appeared with the object of expounding and justifying the procedures used in this field. This paper is the most comprehensive exposition of all, and combines a clear statement of the logical foundations of econometrics with an account of the author's brilliant contribution to that subject, which is having such a revolutionary effect on the procedures used in the estimation of economic relationships. In particular, it may be recommended to those who are sceptical of econometric work, for, as Koopmans has remarked, "the meaning of Haavelmo's work is that economic statistics has now caught up with economic theory. It has now become clear that methods of statistical estimation, even of a single equation of economic behaviour, must in some way take account of the fact that the variables entering that equation are part of the wider set of relevant economic variables which are determined by a complete system of simultaneous equations." The greater part of the exposition of this paper is intelligible to those without special mathematical equipment, despite the fact that mathematical notation is used freely and some parts of the argument are of a purely formal character. * Chapter IV contains a brief description of the Neyman-Pearson theory of testing statistical hypotheses * It is helpful in enabling the economist to see how a theory must be formulated if the statistician is to get profitably to work. It brings out clearly that the economist must specify the set of *a priori* admissible hypotheses before a test is constructed. * Chapter V follows out the implications for estimating the coefficients of economic relationships of the fact that each relation is part of, and influenced by, a system of stochastic equations. This means that there are factors operating to cause disturbances which are not explicitly introduced into our theory, and, further, that economic relationships do not exist on their own, but are part of a system of relationships. It is here that Haavelmo has made an important original contribution to the theory of estimation by showing that, except in special cases, unbiased estimates of the parameters in equations which form part

of a system of the above kind cannot be obtained by considering each equation in isolation. This discovery opens up a new method of estimation which requires that the system of equations be written down in advance, even if we are only interested in one relationship, and considered as a whole. The difficulty of putting this principle into practice in the present state of knowledge calls for an examination of the circumstances in which the bias of the single-equation approach is especially serious, and of short cuts which can be adopted through the use of incomplete systems of two or more equations. * Chapter VI deals briefly with some of the problems of prediction. In his conclusion Haavelmo states as his belief that "if economics is to establish itself as a reputable quantitative science, many economists will have to revise their ideas as to the level of statistical theory and technique and the amount of tedious work that will be required, even for modest projects of research. On the other side we must count the time and work that might be saved by eliminating a good deal of planless and futile juggling with figures." This is my belief also, and I look forward to the day, already overdue, when it finds recognition in the syllabuses for degrees in economics. In conclusion, attention may be drawn to work on another aspect of the estimation problem dealt with in Chapter V which is going on currently. In Haavelmo's scheme we concern ourselves with disturbances in the equations of a system, but neglect the sampling problems arising from errors of measurement in the variables. This latter question has been attacked recently by Tintner, though in his case errors are dealt with to the neglect of disturbances. Haavelmo's estimation problem is, I think, novel in a way in which Tintner's is not, but both writers have put statistical economists very much in their debt.

J Am Stat Assn 40:393–4 S '45. R. L. Anderson. * This paper is a very important contribution to economic statistics, since it points out how the various probability schemes which have been so useful to the biological statistician can be used with few alterations by economists. Coupled with the results of Mann and Wald and those now being prepared by the Cowles Commission for Economic Research at the University of Chicago, this paper can be used as a basis for the development of stochastic economic theory. * The economist must reconcile simplicity with autonomy in the formulation of his constant relationships. Haavelmo might have added that there is need for a good sampling technique to test the constancy and repeatability of results. The design of the experiment and the theory to be tested are interrelated. Since most economic data are fixed, the author might have added that the design is often restricted to a good sampling program. It is fruitless to devise a test of a given theory unless a suitable design can be devised utilizing existing data. Haavelmo stressed the fact that existing data can not be used to test all types of theories. Much of the paper is devoted to the problem of formulating a general stochastic approach which could be used to fit economic theory into the framework of the Neyman-Pearson theory of testing hypotheses. The author shows how to set up random elements in economic formulations; these have been called "disturbances" by some economists. Economists are usually faced with the fact that the disturbances are not independent of the systematic variables. For example, the fact that one miscalculates his savings today affects his investments tomorrow; the miscalculation may be random in some sense, but it does affect the plans for the future. Haavelmo's emphasis on the interdependence of the various parts of the economic process is one of the most important contributions he has made to realistic economic statistics. The treatment of the Neyman-Pearson theory is quite general and is well illustrated by a problem in trend fitting. The discussion of the type I and type II errors is excellent as is the example of the use of the power function in connection with the trend fitting problem. The author emphasizes that a general framework of admissible hypotheses should be set up before an experiment is made. The data of a given experiment should not be used in setting up these admissible hypotheses, but these data can be used to decide which theories from the admissible ones should be tested. However, I do not believe Haavelmo would exclude the use of results from a given experiment to reform the set of admissible hypotheses to be used in future experiments. In addition to pointing out the need for considering all equations simultaneously when estimating the parameters of a given process, the author develops a method of testing for the uniqueness of these estimates. He has extended the Gramian criterion for linear independence to solve this problem. It might be mentioned that the Cowles

Commission group has called this problem one of "identifiability" of results and has developed a different approach to the solution of the problem. To the reviewer, the "identifiability" concept seems somewhat clearer, since it tends to connect the problem to actual economic processes. For example, when we use historical price data to estimate the parameters of a demand equation, what are the requisite features of this equation which guarantee that the resultant estimates actually identify it as a demand and not a supply or some other equation? Finally, Haavelmo offers suggestions on how existing statistical theory can be used to make valid predictions and on how to compute confidence limits for these predictions. Although this problem is much more complicated for economic than for biological prognostication because of the interdependence of the sequences used in the process under consideration, a solution is shown to be possible.

Math R 6:93–4 Ap '45. A. Wald. * Econometricians will find the book stimulating reading and helpful in clarifying the nature of the probability approach. Of special interest is the clear recognition of the fact that in estimating unknown coefficients in a simultaneous system of stochastic equations one has to consider the joint distribution of all the observable variables as implied by the whole system and one must not fit each equation separately. The discussion in chapter 5 adds to the clarification of the problem of indeterminate parameters much discussed in econometric literature.

R Econ Stat 28:173–4 Ag '46. Edwin B. Wilson. The author's contention seems to be that when dealing with an econometric problem, *i.e.*, one which involves the statistical treatment of econometric data, some hypothesis about the behavior of the so-called errors is implied and that it is better that the investigator should know what the hypothesis is and should state it as part of the formulation of his problem than that he should ignore it. From an ideal point of view this is undoubtedly true, but a rather wide acquaintance with the application of mathematics and statistical techniques to problems in some fields other than econometric inclines me to the belief that somehow or other investigators in astronomy, physics, engineering, biology, psychology, and medicine have come most of the distance they have so far come without paying much explicit attention to this matter which the econometricians are urged to make a foundation stone of their thinking and working. If I am right, the question must be raised as to whether there is some particular reason why the backward science of econometrics must be more critical with respect to its probabilistic hypotheses than other sciences need be. Maybe yes, maybe no; I see nothing in Haavelmo's brochure which answers such a question. The work is difficult reading for a variety of reasons. First, the English is, naturally, somewhat foreign. Second, the author's approach is extremely abstract and metaphysical; his first chapter of eleven pages is entitled "Abstract Models and Reality," and his second (and longest) chapter entitled "The Degree of Permanence of Economic Laws" seems to be written quite as much from the point of view of the philosophy of scientific method in general as from that of economic analysis in particular. In the third place, when the author does take up an illustrative example or application of his abstract considerations, it is a hypothetical or abstract illustration, hardly a true concrete application. Finally, when he takes up probability theory itself, he must needs go into its most modern formulation in terms of "an absolutely additive and nonnegative *set-function*," "Lebesque-measurable functions," etc., instead of being content with the classical formulation, which satisfied Maxwell, Boltzmann, Gibbs, and Jeans as a basis for their work on the theory of gases and statistical mechanics. There may be some good reason why this high degree of abstraction is necessary; ideally, I suppose, for a final presentation of a scientific philosophy, the more abstract, the better; but pedagogically I fear that the author's approach is suicidal. If he is interested in showing what he has learned about modern probability theory, about the Neyman theories of hypothesis-testing, about the problems connected with Frisch's confluence-analysis, and about the metaphysics of scientific theory he has done a good job; I do not see how anybody could deny that. Granted that the author and I have very similar ultimate purposes in seeing economic thinking better controlled by analysis of the facts of the economic world, and the facts themselves better collected under control by economic thinking, I have to state that hopelessly concrete-minded persons like myself would presumably have gotten much more, and gotten it more easily, if the author had taken some important, particular, concrete problem in

econometrics and worked it through, with full attention to those matters he considers important, as he went along; especially instructive would it have been to have taken some real problem which somebody had worked through to a misleading conclusion because of ignoring the author's philosophy and to work it through with the proper attention to the probabilistic approach so as to arrive at the right conclusion. For many of us, several illustrations of these sorts would be convenient to put into the hands of our classes so that our graduate students might grow to be better econometricians. However, it is only fair to the author for me to admit that there may be few persons so hopelessly concrete-minded as I, and that he may know far better than I the audience he has in mind and how to address it in an effective manner. There is a small group of econometricians who are well trained in mathematics and who apparently choose to write for one another rather than for economists (or even econometricians) in general. I believe they have something important to say—important not alone for the further development of a purely mathematical dialectic but for economics in the large. Furthermore, I believe that not much will be accomplished by them in the development of economics until and unless economists in general can understand why their contributions are important. Economics is not yet advanced as a science to a point where we may take on faith what any small group of investigators says we must accept. Let me illustrate by an anecdote. Some 15 years ago I was at a scientific meeting with Colonel M. C. Rorty, one time chief statistician for the American Telephone and Telegraph Company and a President of the American Statistical Association. He had had an engineer's training, knew considerable about mathematics and physics, and had a keen interest in the philosophy of science. He attended a session at which one of the most eminent of econometricians read a paper, and he remarked that it consisted in applying highly refined mathematical techniques to statistical materials that he (Rorty) knew were scarcely worthy of elementary methods, and that therefore nothing of value was accomplished. I do not say that Colonel Rorty was right; that judgment is quite beside the point; the point is that Colonel Rorty, who could have turned considerable effort and money into applying the author's methods, was not convinced that he should do so, but quite contrarily was convinced he should not do so. Assuredly, this did not get the author's methods ahead; the more his methods were worth while, the greater was this loss.

[144]

★HAGOOD, MARGARET JARMAN. **Statistics for Sociologists.** New York: Henry Holt and Co., 1941. Pp. viii, 934. $4.50. *

Am J Sociol 48:263–5 S '42. Clark Tibbitts. [Joint review of *Statistics for Sociologists* and *Elementary Social Statistics* (see 212) by Thomas Carson McCormick.] * two textbooks ....for....students of sociology and social work. They, and the first one in particular, could be used, also, without much supplementation, for similar courses in public health, medical economics, and public administration. * [Hagood's book] is an exhaustive, nine-hundred-page text covering numerous ramifications of each technique presented. A diligent student with little opportunity to attend class could master a great deal of the content by applying himself closely to this presentation. The other book is only one-third as long and, although compact, leaves more for the instructor to supply in his lectures. * The longer presentation of Hagood may seem detailed, laborious, and repetitious of the classroom lectures and, hence, dull to the student who is only mildly interested in this subject. At the same time it is probably much to the liking of the more serious student. Perhaps McCormick's book comes closer to meeting the needs of both groups. The good student will get the supporting material from the lectures, while the student seeking credit only has fewer pages to read. There is evidence that both authors used their texts in mimeograph. Presumably each thought he was successful, or he would not have published his material. The rest of us can use one book and then the other to determine which is better adapted to our needs. * McCormick had a one-semester course in mind and, therefore, omitted intensive discussion of small sampling theory. Hagood, including more than enough (her own statement) for a two-semester course, is able to incorporate a more thorough discussion of sampling procedure. She has a useful discussion of index numbers, while McCormick omits the subject altogether. The omission is difficult to explain in view of the increasing interest in living-cost studies and because of the usefulness of the technique in making comparisons. The longer text incorporates, also, a one-hundred-and fifty-

page section devoted to population analysis. Although this involves a little repetition of material presented earlier, it may be useful, as Hagood suggests, for instructors who wish to add a third course in this specialized field. In this section Hagood employs a device which McCormick uses more extensively, namely, that of starting out with a simple problem, developing its ramifications, and introducing new techniques as the development proceeds. This device has the twofold merit of showing the interrelationship of several summarizing measures and of introducing new ones with very little shock to the student. The Hagood volume contains several discussions of what are called descriptive and inductive statistics. By the former is meant summarization and correlation between characteristics of particular samples; by the latter, the estimation of universe parameters from samples. The author calls the second type of analysis "generalization." This seems to be a rather new conception of generalization, since it appears to preclude the drawing of scientific conclusions from limited universes and since it implies that the estimation of a population average from a sample constitutes a basis for prediction. In the opinion of the reviewer the author does not make her position clear and, consequently, imposes a considerable burden on undergraduate students. McCormick concludes each chapter with a set of exercises for laboratory work. These have been worked up in such form as to illustrate nearly every point made in the text. They call for a good deal of thought on the part of the student. Both writers include topical bibliographies at the ends of the chapters. The references are up to date and specific, although neither mentions the Arkin and Colton handbook on graphs and charts. Likewise, Hagood's failure to cite Lundberg's *Social Research* in connection with designing a problem and collecting data must be regarded as an unfortunate oversight. The introductory chapters of both texts cover the planning and execution of a statistical project, collection, analysis, and presentation of data. Space does not permit exhaustive coverage in either case, but the material is compact and valuable. Hagood's statement on developing a blueprint for a study and McCormick's on the use of the schedule are outstanding. * Any teacher of elementary statistics looking for a suitable text should expect to be well satisfied if he chooses either of these two. It is to be hoped that McCormick will publish a second volume based upon his experience in teaching advanced students.

Am Math Mo 52:454–5 O '45. Abraham Wald. * most of the sociologists have little mathematical background * Consequently, proofs and derivations of formulas are not given, but the meaning of statistical procedures and interpretation of the results are stressed throughout the book. The discussion of statistical methods and procedures is subdivided into two logically distinct parts, descriptive statistics and inductive statistics. * The understanding of descriptive statistics requires, of course, less intellectual effort than that of inductive statistics and, therefore, such a subdivision may have some advantages from the pedagogic point of view. On the other hand, it seems to the reviewer that the treatment of descriptive statistics as an independent logical unit has some drawbacks also, since the various "summarizing measures" can be justified, in general, only on the basis of their usefulness for purposes of statistical inference. * Throughout the book the author takes great pains to explain the meaning of the various statistical procedures and to state the conditions under which they are applicable. While as a whole the author was successful in this effort, especially in explaining the meaning of tests of significance and estimation by confidence intervals, the discussion is perhaps not everywhere entirely adequate. In the chapter on regressions there is no method given for setting up confidence limits for partial regression coefficients, although exact procedures for this purpose are available. The reviewer also noticed a few statements which are not entirely correct. For example, the definition of an unbiased estimate as given on page 388 is not correct. The statement that the sample standard deviation, using the number of degrees of freedom in the denominator, is an unbiased estimate of the population standard deviation is also incorrect. One can only say that the sample variance is an unbiased estimate of the population variance. In spite of these shortcomings, the book as a whole is certainly interesting and useful reading for sociologists who want to learn about statistical methods. The reader will also welcome the numerous illustrations and examples taken from fields of applications of interest to sociologists.

Am Social R 7:440–1 Je '42. William M. Fuson. Dr. Hagood has performed a notable

service to all sociologists * Hagood's contribution lies in the simplicity and clarity of her description of the complicated settings in which statistical methods are or can be useful to the sociologist, so that even the mathematically unsophisticated (and these comprise 90 percent of all) can safely find their way. The student who deplores both the prevalent uncritical use of statistics and the incomplete analysis of statistical data will find powerful support. Of outstanding value should prove (1) the systematic statement and illustration of the processes involved in statistical induction and in the testing of various hypotheses, and (2) the systematic presentation of the interrelations of the older correlation analysis and the newer analysis of variance culminating in the analysis of covariance. Also useful should be the discussion of confidence limits, the statement of the logical role of the null hypothesis, and the outline of aspects of association to be statistically investigated. The major weakness appears to lie in the exposition of the chi-square test, which is incomplete, although of special relevance to current sociological data. Finally, mathematicians will find the book wordy, rhetoricians will find it repetitious * Part I, "Quantitative Methods in Sociology" (100 pp.) presents a well-balanced statement of the role of quantitative methods and then sketches the procedures involved in collecting and presenting data. * Part III, "Inductive Statistics" (180 pp.) is a fine presentation of sampling theory and its implications for sociological research. *

Ann Am Acad Pol & Social Sci 221:244–5 My '42. Hugh Carter. * The theoretical framework of the volume is modern * A noteworthy feature....is the full discussion of the applications of the various techniques to sociological problems. * This textbook is a teachable one; graduate students who have had some contact with it comment favorably upon its clear and stimulating presentation. Its usefulness could be increased by bringing together in one place every important formula employed, and in a few instances by a more schematic, step-by-step presentation of the procedures to be followed by the student. The charts are excellent, and an appendix contains tables frequently used as aids to computation.

J Am Stat Assn 37:148 Mr '42. Elbridge Sibley. Students of sociology will find in this book an introduction to the statistical tools of their trade rather than an exposition of statistical theories *in vacuo* or in any other medium. * contains many lengthy computations whose rationale is surely beyond the comprehension of most students of freshman college mathematics * although the student is repeatedly and wisely admonished always to consider the basic assumptions of each method that he is tempted to use, his attention is likely to be distracted by occasional digressions from discussion of first principles into minutely detailed instructions for the use of calculating machines to compute various functions on a mass-production basis. Aside from such shortcomings—probably unavoidable in a text which aims to do so much for novices—the book is not only sound and up-to-date but extremely comprehensive. It should appeal to students who are above the average in intellectual maturity and scientific curiosity. Parts of it, especially those dealing with the newer concepts relating to sampling and analysis of variance and co-variance, should be required reading for many social researchers whose statistical training was derived from the standard textbooks of no more than a decade ago and who do not yet realize that Fisher and others have outlawed inverse probability. * A systematic collection of the formulae scattered through the text would have enhanced the book's usefulness for reference.

Rural Sociol 7:112–4 Mr '42. C. Horace Hamilton. * Hagood has written a comprehensive advanced text for an entire year of study in social statistics * an excellent introduction to research method and procedure * an up-to-date, comprehensive, and well-written text. New developments and techniques are explained and illustrated with many applications to sociological research. The treatment of analysis of variance and its application to sociological research is noteworthy. * The first part....presents in about 100 pages a compact but well-rounded discussion of quantitative methods in sociology. Especially noteworthy in this discussion are the chapters on the plan and execution of a quantitative research project and on the presentation of results. Rural sociologists doing or supervising research work will find the entire first part worthy of review if not careful study. * Part III, Inductive Statistics, presents the logic as well as the mathematics of induction. No better treatment considering the amount of space available can be found anywhere. * Of considerable interest to the rural sociologist, is

Part V, which covers the field of population statistics. No other modern text treats this field so comprehensively if at all. Research workers as well as students will find many helpful techniques of tabulation and analysis explained simply yet fully in this part. Needless to say, however, the limitations of space and the purpose of the book prevented the inclusion of some advanced techniques which have been fully described in sources referred to by the author. *Statistics for Sociologists* meets a real need in the teaching of statistics. It must be emphasized, too, that research workers—both tiros and professional—will find this book to be most useful. It is more than a text in statistical methods: It is a text in logic and in research method as well. One may well predict that it will find a wide field of service for a long time to come. *

[145]

★HAINES, GEORGE H. **Workbook for Business and Economic Statistics.** Dubuque, Iowa: Wm. C. Brown Co., 1949. Pp. ii, 118, plus 79 leaves of blank forms. Paper, spiral binding. $2.25. *

[146]

★HALD, A. **The Decomposition of a Series of Observations Composed of a Trend, a Periodic Movement, and a Stochastic Variable.** Copenhagen, Denmark: G. E. C. Gads, 1948. Pp. 134. Paper. 8d.kr. *

J Am Stat Assn 44:317–20 Je '49. D. B. DeLury and Boyd Harshbarger. * The decision on the usefulness of the model in dealing with economic series must be left to economists. Its value in the design and analysis of field experiments will surely be widely questioned. The agricultural experiment chosen to illustrate an application of these methods is called a "row experiment," in which the plots are placed consecutively in a row and divided into blocks, so that each treatment occurs once within each block. * One could, as the author remarks, employ this model when the treatments are arranged in any manner whatever, but when the "periodic" arrangement is abandoned, orthogonal polynomials are no longer feasible. In this case, regression analysis (presumably using ordinary orthogonal polynomials) or, what amounts to the same thing, a covariance analysis with the position of the plot as concomitant variable, permits the use of the same mathematical model. Even when the treatments are randomly arranged within blocks, control of the error resulting from variation in fertility is possible by these means and such procedures have, in fact, been used a number of times. It is true that the computational labor is considerably greater when orthogonal polynomials, of the sort developed in this book, are not available, but then, when random arrangements are used, there is good reason to expect that such refinements will not be needed and that a simple analysis of variance will suffice. On the other hand, if one adopts a periodic arrangement of treatments in the hope that fertility variations are expressible in terms of a polynomial of low degree, his computational program is dismal indeed if this hope is not fulfilled. Furthermore, it is not clear to the reviewer that randomization can be dispensed with without assurance that variation in fertility is completely accounted for by the fitted polynomial (a viewpoint probably held also by the author, see p. 91), but presumably it never is. Whether or not this mathematical model is suitable for routine use in field experiments, it seems likely that there are many situations in which it is quite appropriate and a table of orthogonal polynomials to facilitate the computations it entails is a useful item of statistical equipment. It is to be hoped that a more complete table than the one included in this book will soon be issued. Part I, devoted to theory, includes a survey of standard regression theory and applies these classical methods to the problem at hand. * The methods used in this section are direct and the exposition is clear and concise. Part II presents three worked examples, the fitting of a time series, the analysis of a row experiment and a re-working of the data of an industrial example reported by H. E. Daniels. * Part II contains also a short but excellent discussion of some of the theoretical considerations on which experimental design is based. This work is well put together and written in a concise and straightforward style that makes for easy reading. It can be recommended to those who (*a*) would like to have a concise, accurate statement of the methods and principal results of regression theory; (*b*) are interested in the theory of moving averages; (*c*) may find appropriate the mathematical model to which the book is devoted (*e.g.*, in engineering research); (*d*) are perplexed about the old controversy over systematic and random arrangements, even though the concept of randomness is not dealt with as discerningly as one might wish.

[147]

★HALL, MARGUERITE F. **Public Health Statistics.** New York: Paul B. Hoeber, Inc., 1942. Pp. xxiii, 408. For latest edition, see 148.

Am J Pub Health 33:608 My '43. W. Thurber Fales. * Unfortunately, there are so many loose and inaccurate statements both as to the subject matter of public health statistics and in the exposition of statistical methods that the book cannot be recommended either for the classroom or the reference shelf. Space will permit only a few examples of the many misleading sentences which challenge the critical reader continuously. For instance such statements as "The country is divided into census tracts, each tract having a supervisor and assigned enumerators," in the description of the census on page 89, or "The Life Table Standard Million reflects the natural growth of population measured by excess of births over deaths" (page 139), are inaccurate. These and many similar sentences represent carelessness in expression or superficial knowledge on the part of the author. More serious is the confusion found in the discussions of statistical technics. It is desirable that mathematical concepts be presented in simple language but the argument must remain logically sound. Many of the definitions, notations, and applications of statistical methods are confusing. For example, in Chapter XIV, which describes the short method for the construction of the life table proposed by Reed and Merrell, the notation is badly mixed up. Further the misapplication of the method when the original data are not available to the end of life results in a half year underestimation of the expectation of life at birth with a larger error at older ages. Lack of a fundamental understanding of random sampling, the binomial theorem, and the use of the standard error are each illustrated by the discussion of "Chances with a small sample" on page 348. This section purports to answer the question "What are the chances that 6 out of 7 potential patients actually become ill during a given month?" The remainder of the section is a jumble of words that has little, if any, bearing on the answer to the question posed. One should be able to state the solution quite simply. In fact the solution is given on page 332. Perhaps the difficulty arose first in the meaning of the statement, "in a random sampling of potential patients the chances are even for a person to become ill." Does the author mean more than that each person in a random sample is equally likely to become ill? The probability of becoming ill in a sample chosen at random is not a function of randomness but of the universe from which the sample is drawn. It is this probability or estimate of it that is represented by p in the binomial $(p + q)^n$. The vexing problem of medical care would indeed be insolvable if one half of a physician's panel were ill each month. This, unconsciously, is the author's postulate in trying to answer the above question. Readers will find these sections and many others confusing and of little assistance in the sound application of statistical methods to the problems of public health.

J Am Med Assn 121:90 Ja 2 '43. * This book has combined a common sense view on the interpretation of public health statistics with a clear and concise presentation of the algebra involved. *

J Am Stat Assn 38:253–4 Je '43. Clyde V. Kiser. * The introductory chapter contains a conventional but good discussion of history, principles, and limitations of statistical methodology. This is followed by three useful chapters on principles of computation and handling of mass data and tabular and graphical presentation of the materials. From this point the book can be said to fall into two major divisions, vital statistics and general statistics, although not so labeled. The vital statistics section includes Chapters V–XIV (pp. 88–259) * Chapters XV–XXI (pp. 260–372), devoted mainly to general statistical methodology * The author probably had good reasons for the tandem arrangement of the materials for vital statistics and those for general statistics, but the reviewer fails to see what they were. If separation was necessary it would seem that the chapters on vital statistics should follow rather than precede those on general statistics. In the reviewer's opinion, however, better integration of the materials would be in order for a book on public health statistics. As one might expect, the present arrangement resulted in virtual duplication of the discussion in several instances. * With commendable simplicity of language and detail she leads the reader through the step-by-step procedures in specific computations. Dr. Halbert L. Dunn correctly states in the foreword, "She has discovered the knack of making probabilities, chi-square rates and index numbers into everyday county, city, and state health language." This characteristic will doubtless enhance the value of the volume as a handbook for use in health departments. In the reviewer's opinion, however, the volume does not measure up so well as a textbook. For this pur-

pose one would look for adequate discussion of underlying theory as well as for clarity in the exposition of technique. Unfortunately, the discussion of theory tends to be sketchy. * the author tended to devote much more attention to the mechanics of computation than to the meaning of the statistical measures considered. On several occasions the reviewer was somehow reminded of the lines, "Theirs not to reason why, Theirs but to do and die." Despite the above characteristics there is ample evidence of the author's own well-balanced point of view regarding the place of statistical technique in public health work. She emphasizes strongly the limitations of statistical methodology and the necessity of knowing at first hand the characteristics of the basic data and the conditions under which they were collected.

Q R Biol 19:71–2 Mr '44. * There are only two or three....[elementary statistics texts] addressed to the workers and students in public health. The present book is designed to meet the needs of such workers, but unfortunately it fails to do so not because of the scope of the work but because of the countless errors in its execution. These are not a question of mere looseness of statement, or oversimplification, but are in large part straight errors of fact as to source material, mathematical definitions, and interpretation of statistical constants. * the entire discussion of such important topics as life tables, probability, and correlation, contain so many misstatements and misinterpretations that it is impossible to represent them in a short review. A thorough rewriting of the book is necessary before it could be recommended to a person turning to it for factual information or instruction in method.

Social Service R 18:118–9 Mr '44. Wayne McMillen. * some social workers....who have a general knowledge of statistical methods have never been introduced to the specialized application of the method in the public health field. Dr. Hall's book provides an excellent means of remedying this deficiency. It is difficult to believe that any clearer exposition of the subject exists in print. The book covers all the basic problems in the field with exceptional thoroughness and clarity. It is a masterpiece of expository writing. For the social worker the most valuable chapters in the book are vi–xi inclusive. The chapters deal with population data, methods of estimating population, the standard millions, the various rates based upon vital events, and related applications of these procedures. The other chapters, for the most part, are concerned with methods and problems that are more likely to be encountered in standard courses in statistical methodology in schools and universities. Even these chapters, however, are well worth reading, for they contain new material and are interestingly and effectively presented. Of special interest are the chapters on tabular and graphic presentation. * Her chapters on "Measures of Central Tendency" and "Variability" are perhaps less detailed than those in other texts. Of course these important basic methods of summarizing data have been very ably set forth in numerous textbooks. In few, if any, however, has the application of the statistical method to public health data been equally well presented. This book, of course, is primarily for students in schools of public health administration. It is not suitable for students in other fields except as a supplementary text. * The student of social work needs to understand budget-control charts, stability quotients, ogive curves, and other derivations that are useful in his field. These are covered more completely in other texts now available. But a student in any field, when he reaches the point of mastering vital statistics, will be well advised to consult this volume. He will find here a thorough, scholarly, and lucid exposition of the major problems and methods in the field.

[148]

★HALL, MARGUERITE F. **Public Health Statistics, Second Edition.** New York: Paul B. Hoeber, Inc., 1949. Pp. xxix, 441. $7.50. *

Am J Pub Health 40:217–8 F '50. Paul M. Densen. The changes....consist primarily of the addition of new material * The original text.... has remained largely unchanged as has the general plan of organization. This is regrettable for, as reviewers of the first edition have pointed out, the author's desire to simplify the presentation of statistical ideas has been permitted to interfere with the logic of the argument, resulting in many unsound statements which have not been corrected in the second edition. * The value of....[the] additions would be greatly enhanced if the basic concepts upon which they depend had been reexamined and clarified. For example, fundamentally the life table depends upon the concept of a rate as a probability. It is difficult for this reviewer, therefore, to understand why the chapter on "Rates" follows the

chapter on "Standard Millions" in which the life table is introduced. Further, on page 172, the statement is made that "a rate refers an event to that part of the population which is exposed to the risk of occurrence of that event, *i.e.*, those persons who really experience the event." If this definition of "exposed to risk" were actually the case, every rate would have a value of 100 per cent. Again, on page 223, it is stated that the birth mortality index, as the sum of the stillbirth and neonatal mortality rates, "measures the chances in 1,000 live births that an infant has in being born alive and then surviving the first month of life." Such statements are misleading as to what is meant by "exposed to risk" and fail to express the basic notion of a rate. In the new chapter on applications of life table techniques, it is indicated on page 272 that the procedure of following a cohort through life stresses "the constancy of age selection." It is true that such constancy is present in the data cited, but it would be much more apparent if the experience of a series of cohorts was shown graphically as in the original paper on this subject by W. H. Frost—to which, incidentally, no reference is made. Reviewers of the first edition have discussed in some detail the logical difficulties encountered in the chapters concerned with the point binomial and measures of reliability. These have been carried over into the second edition * Because of the difficulties indicated above, the book is not recommended for use either by the student or by the active practitioner of public health seeking a guide to the application of statistical reasoning in this field.

Q R Biol 24:387 D '49. Margaret Merrell. The first edition of this book (1942) was reviewed in this journal [see 147] * It was pointed out then that the book could not be recommended because of its numerous errors of fact in citing source material, as well as errors of definitions, theory, and application. It was hoped that the second edition would represent a complete rewriting, but unfortunately the revision has been only slight, and the errors of the first edition are almost wholly conserved. Of the nine errors cited as illustrations in the previous review, not one has been corrected. One, indeed, has been omitted, due to the deletion of the particular discussion in which it occurred. The appearance of this sort of a second edition is to be regretted.

For reviews of the first edition, see 147.

[149]

★HALL, RAY OVID. **Handbook of Tabular Presentation: How to Design and Edit Statistical Tables: A Style Manual and Case Book.** New York: Ronald Press Co., 1943. Pp. viii, 112. $3.50. *

Accounting R 20:252 Ap '45. Dale Yoder. * The author has done an unusually fine job in pointing to the most common deficiencies in tabular presentation as well as the most effective means of presenting data in tabular form. He has written a book that is excellent both from the reference viewpoint and from an instructional point of view. His continual use of examples makes his discussion of both desirable and undesirable practice unusually effective. The job is done thoroughly, too, and covers minor as well as major features of statistical tables. Illustrations are drawn from a wide range of sources. The only criticism this reviewer finds appropriate concerns the format of the volume. Its usefulness might have been increased by holding pages to the more common textbook size. That result could have been attained without injury to the contents.

J Am Stat Assn 39:259–60 Je '44. Leon E. Truesdell. For many years there has been an outstanding need for an adequate handbook of tabular presentation. Dr. Hall's book is in the first place too short for adequate coverage of the field, with only 13 pages of general text and 25 or 30 more devoted to the discussion of specific examples. In other respects, too, it falls short of meeting the current need—or the expectations aroused by its title page. It contains rather frequent recommendations of procedures that run counter to current usage. * In a number of instances the author is apparently under a misapprehension on points of fact * The supplementary material is not well arranged or adequately labeled. The changes recommended in the comment on the specimen tables are for the most part improvements, though in some cases they result in presentations quite as illogical as anything in the original table * Throughout, the book mingles specifications for the physical make-up of tables that are to be printed in type and tables to be written on the typewriter for photographic reproduction, whereas one of the first requirements in a set of instructions for this phase of table-making should be a recognition of the fact that two distinct sets of techniques are required for these two methods of printing. With the exception of a brief generalized preface, the book is confined

mainly to statements on specific mechanical points. It is unfortunate that the author did not see fit to devote more time to an opening discussion which would bring the materials into better perspective. In its present form the book reads like a series of items from a notebook carefully kept but not well coordinated, or like a book of exercises designed to test the mastery of a comprehensive volume which unfortunately is not existent. It is replete with sententious phrases, some of which one cannot but admire even though he does not always agree with the import. In short, it may be said of the whole book that, while it is interesting to read and stimulating to one already familiar with current usage in the construction of statistical tables, and while many—yes, even most—of the recommendations with respect to table form are good, there are so many variations from this rule that the book cannot safely be taken as a reliable guide for the inexperienced maker or editor of statistical tables.

South Econ J 10:316–7 Ap '44. Dudley J. Cowden. * A careful study of the principles and cases found in this book will help anyone to make better statistical tables. Perhaps the advice that can be most profitably followed is that one cannot expect to have a good table until he has drafted it, studied it, and redrafted it several times. * Although this is a very useful book it is subject to a number of shortcomings. (1) The author appears to be primarily interested in the mechanics of table construction. Although he mentions the terms "general-purpose table" and "special-purpose table," there is little if any recognition of the relationship between the object of a table and its design. Often the same material can be presented in several different ways, depending on the purpose in view. (2) There is no section devoted to the body of a table, though that is where the data are found. (3) If there were a treatment of material according to subject matter (such as classification, arrangement, ruling spacing, typography) as well as according to parts of table, it would be helpful. As it is, to learn how to rule a table, one must ascertain from the various sections how the stub should be ruled, how columnar captions should be ruled, and maybe he will discover somewhere how the body should be ruled. (4) Terms are not usually defined; even the terms listed are without definitions. (5) Although Dr. Hall criticizes textbooks for not explaining why various techniques are recommended, he is not always careful to make explanations supporting his own preferences. (6) Devices advocated to make the table less monotonous in appearance sometimes seem to the reviewer to give the appearance of ginger-bread work. (7) If the redrafts of tables were set up in finished form, as well as in typewritten skeleton form, one could better judge the effectiveness of the changes indicated, and whether the table is pleasing in appearance.

[150]

★HAMPEL, LOUIS F. **Workbook in Business Statistics.** Chicago, Ill.: Richard D. Irwin, Inc., 1942. Pp. viii, 171, plus 72 leaves of graph paper. Paper, lithotyped. * For latest edition, see 151.

[151]

★HAMPEL, LOUIS F. **Workbook in Business Statistics, Revised Edition.** Chicago, Ill.: Richard D. Irwin, Inc., 1947. Pages not numbered. Paper. $2 50. *

[152]

★HANSEN, MORRIS H.; HURWITZ, WILLIAM N.; AND HOLMES, IRVING. **Notes on Precision of Sample Estimates: Technical Notes on the Formulas Used to Evaluate the Precision of Data.** Washington, D.C.: Government Printing Office, 1945. Pp. 283–91. Paper. $0.10. *

[153]

★HARSHBARGER, BOYD. **Rectangular Lattices.** Virginia Agricultural Experiment Station, Memoir 1. Blacksburg, Va.: the Station, October 1947. Pp. iii, 26. Paper. Gratis. *

[154]

★HARTKEMEIER, HARRY PELLE. **An Introduction to Managerial Business Statistics.** New York: Thomas Y. Crowell Co., 1943. Pp. xiv, 207. Paper. $2.00. *

Accounting R 18:283 Jl '43. G. R. Davies. * a valuable addition to the new field of applied statistics. The author is a capable mathematician who is also familiar with the problems of industry which calls for statistical treatment. * an excellent introduction to the use of chi square is presented * A minor criticism might be suggested with respect to the lack of problems arising from the possible skewness of the data, but on the other hand this aspect of the subject might well be left for consideration in more advanced phases of the work. On the whole the "Introduction" should find a wide field of usefulness in preparing students for urgent statistical problems of industry.

J Am Stat Assn 38:382–3 S '43. Donald R. G. Cowan. * At the end of each chapter many useful work tables and charts are to be found as well as sets of practical business problems. * Unlike many other introductory texts, it does not discuss in detail such topics as the

planning of statistical investigations, collection of data from various sources by different methods, tabulation, ratios, charting, index numbers or the different measures of central tendency, dispersion and correlation. * Apparently, it is the author's intention to treat index numbers and other topics in a series of separate volumes of which this is the first. The author's criticism of advertising, page 26, seems to be irrelevant, unjudicial, and based on an extremely small sample. Within the limited range of the subject matter of this book, the author has succeeded in explaining the practical applications of some phases of statistical theory which are usually very difficult for the layman to understand and apply. It should fit well into the curriculum of a business school which endeavors to develop the management point of view. Business executives who possess a good educational background should read this book because it indicates how these methods may be applied profitably to the solution of many of their management problems.

J Pol Econ 52:380 D '44. Howard L. Jones. * The format is interesting. * The text is usually clear and simple, in non-technical language, with a minimum number of formulas. At times, however, the presentation is inadequate or objectionable. There is a careful explanation that probabilities based on the normal curve do not apply exactly to a discrete distribution; but other possible departures from normality, such as skewness, are ignored. While it is evident that the author uses the symbol σ_M to represent an estimate of the standard deviation of sample means, his assertion that "more than 5 per cent of the area under the distribution of means based upon 15 observations lies beyond $\pm 2\sigma_M$" may cause confusion, nevertheless. The formula $\sigma_\sigma = \sigma/\sqrt{2N}$ is given without qualification as to size of sample. The steps in testing a null hypothesis and the conclusions to be drawn are very well outlined in the chapter on this subject; but in several places in the book the conclusions are ambiguously or incorrectly stated. For example, the statement that "a business statistician who uses the 5 per cent probability point as a criterion in solving practical problems would be right in 95 per cent of the decisions he makes if he solves a large number of problems which yield values that fall approximately at this point" is poorly conceived. The use of the *t*-distribution to establish significant points on production control charts is technically incorrect for sample standard deviations, and also for sample means when the variance of the controlled product is specified, although the resulting inaccuracies would be negligible in large samples. Most objectionable are the author's eccentric views about the statistician's place in the business world. We read, for example, that "accounting is nothing but classification, which is the simplest kind of business statistics summary or report known," and that "most of the problems of production and business management can be solved by the application of statistical methods." Such views are not widely held even among statisticians, and their exposition should not be required reading for college students. Professor Hartkemeier has introduced several ideas that should prove helpful in teaching elementary statistics, but considerable revision is needed to make his book suitable for the purpose intended.

J Royal Stat Soc 110:369 pt 4 '47. H. O. H(artley). The title of this book is entirely misleading; in fact the author gives an elementary discussion of a few standard statistical tests, *viz.* the *t*-test for the difference between two arithmetic means, the *F*-test for comparing two standard deviations, the χ^2-test for contrasting frequency distributions, and a brief description of control charts for mean and standard deviation. The text is preceded by an introduction in which generalities far beyond the actual scope of the work are discussed. The beginner is, therefore, given the impression that the above tests are capable of dealing with such weighty matters as Analysis of Time Series and Index Numbers and provide a complete tool for correlation problems—a definite case where some little learning may prove dangerous. Although the introduction of the concept of variability is fairly lucid, the bulk of the text is an amazing jumble of quite elementary computing instructions expounded at length, alongside with philosophical discourses on the concept of a null hypothesis in tests of significance. A number of examples, all on commercial data, are worked in detail, numerous others are set as "problems," and half the booklet consists of preprinted computing forms on which students and "business statisticians" alike are supposed to do their homework! Certain of the methods advocated are inefficient or faulty. To name two examples: In the computational instructions for forming the sample standard deviation the author first introduces the method of forming

individual deviates from the mean, forming their squares and then adding them on an adding machine; later the original data are squared, but the possibility of forming the sum of squares directly on a calculator appears to be ignored, at least all the computing forms show a column for the individual χ^2. In the control chart for the sample standard deviation the author computes control limits from $t \cdot s/\sqrt{2n}$ (n = sample size), which appears to be based on a fundamental misinterpretation of the t-distribution.

Nat Math Mag 17:371 My '43. W. D. Baten. * two dozen pages [Chap. 2] contain statements about the most fundamental ideas in statistics. Usually at least two full terms are required to present the necessary material for students to understand the material in [Chap. 2]....Students and teachers using this book will have to secure other statistical texts to understand the material covered; for they cannot possibly comprehend these fundamental statistical concepts from what is given. Chapter 3 presents a good discussion pertaining to the null hypothesis. At the end of this division are some questions which have no relation to the subject matter presented. Here it is assumed that the student is familiar with correlation, fiducial limits, index numbers, sampling theory, time series and information which can be obtained by a thorough course in statistics. The next chapter deals with computing procedure and machines without introducing the reader to any of the modern calculating machines. Most of this section is devoted to rounding off figures before and after computing * From the last sentence, it appears as though this book is to be followed by three other statistical books. It is hoped that they clarify most of the material mentioned in the first volume.

Trans Actuarial Soc Am 44:440 O 13–4 '43. A clearly expressed non-mathematical explanation of the techniques required in applying small sampling procedures to business problems *

[155]

★HARTKEMEIER, HARRY PELLE. **Principles of Punched-Card Machine Operation: How to Operate Punched-Card Tabulating and Alphabetic Accounting Machines.** New York: Thomas Y. Crowell Co., 1942. Pp. xv, 269. Loose-leaf. $5.00. *

Accounting R 17:417–8 O '42. William Cooper. * The book is confined almost entirely to a discussion of tabulating and accounting machines, other items such as punches, sorters, verifiers, as well as more highly specialized equipment are, for the most part, ignored. As a training manual for machine operators the book is excellent, but it is doubtful that the book succeeds in its major objective. * The purpose of the book....seems to be to develop the principles and fundamentals of machine operation, but it is difficult to reconcile this....with long descriptions of the wiring of plugboards and the use of digit selectors. Critical discussion of the use and limitations of the machines is lacking. Even the obvious volume limitations surrounding the use of the machines are not mentioned. Where a simple distribution and continuous use are present, other devices such as keysort cards or, perhaps, the use of an IBM service agency as substitutes for machine installations are available. But competing services and competing equipment, such as Remington-Powers machines, are not mentioned. The book is confined to a discussion of IBM equipment. "Since it [IBM equipment] is operated by electricity rather than by any mechanical means, flexibility is an inherent feature of this electric tabulating machine" (p. 7). Is this a causal statement? It seems dogmatic since no attempt is made at comparison and justification. In many processes Remington equipment is both faster and more flexible than IBM's. The subtle and important limitations implied in the philosophy underlying the accounts draw no breath in these pages, although perplexingly present at every step in the machine process. Where general-purpose statements are prepared, the machines may be worse than useless. The wise accountant, at least in a large organization, will recognize that such statements can have only limited value as answer-givers but can be very useful in suggesting questions to the executive, questions of detail which can only be answered by resort to the books. The same process in machine accounting leads back to the cards where the information can be obtained only by long, tedious, and forbidding work. Even in special-purpose statements the same limitations are present in greater or less degree. The book suffers further from a lack of critical discussion of techniques. The use of [illegible] verifications, and other time-and-money savers receive no mention although undoubtedly of interest to accountant and executive. The problem of planning the flow of work is omitted, and the same fate is meted out to the problems revolving around the efficient designing of cards—strange omissions

in a book devoted to "fundamentals." Some day, perhaps a study will be made on the psychological effects of punched-card machines. The esthetics of the machine, the whirling noises and fluttering cards, with the neatly ordered columns of figures as the end-product, seem to have a fatal attraction for the human mind. Many an office or shop is cluttered with machines busily engaged in turning out reports that could just as effectively and even more quickly be done by the use of adding machines or comptometers.

J Am Stat Assn 37:400–1 S '42. Francis McIntyre. * the reviewer is not aware of the publication, prior to Dr. Hartkemeier's monograph, of any text purporting to present an elementary treatment of the general problem of machine tabulation. Certainly the manuals which accompany the equipment are entirely inadequate for instructional purposes. * Out of the 153 pages devoted to the introduction and to numeric equipment, approximately 30 are actually textual; the rest consist of photostat copies of wiring diagrams and of the reports prepared on the tabulator from the various wiring diagrams displayed. Perhaps another 15 pages of text are devoted to the description, in part III, of the alphabetical accounting machine. This more modern apparatus, which the reviewer believes ought to be the almost exclusive subject of a text on the use of punched card equipment, is treated not as the only tabulator with which the modern student of punched card methods is likely to come in contact but rather as an incidental stage in the historic development of the numeric equipment. Most of the ordinary wiring problems are well discussed and there is a good section on the use of punched cards in obtaining sums of squares and cross products. While Dr. Hartkemeier has performed a real service in meeting a long felt need for a text on punched card machinery, several possibilities for improvement suggest themselves. The types of IBM equipment discussed constitute a small proportion of that company's offerings in the punched card field. The summary punch, the reproducer, the gang punch, the collator, the multiplying punch, the interpreter, the various models of hand-operated numeric and alphabetic punches, and the mark-sensing reproducer receive little or no mention in this text. Since no discussion is given of competing equipment, there is no opportunity to point out the types of applications in which rival lines have a material advantage, such as the punching of cards for which a portion of the material is to be repeated from card to card or the listing of material requiring alphabetic characters throughout the line of printing. It would have been helpful if more attention had been paid to possible fields of application of the techniques described. Except for the section on progressive digiting (for the accumulation of sums of squares and products) the illustrations are confined to elementary accounting problems. The reference system by which diagrams and forms are located is not well conceived. The reader may find it confusing to locate diagram 12 on page 61, diagram 12–405 on page 189, and diagram 13 on page 62. The small figures which show the position of the pin in the clearing collar (on page 12) were omitted in earlier printings but this has been corrected in later runs. While the loose-leaf format simplifies the extraction of an individual wiring diagram for comparison with the relevant text and also makes it easier for the student to turn in the blank diagrams supplied with the text after completing them, a number of copies have appeared with defective rings in the loose-leaf binder, which have made the use of the volume somewhat awkward.

[156]

★HAYS, SAMUEL. **An Outline of Statistics, Third Edition.** London: Longmans, Green & Co. Ltd., 1947. Pp. vii, 254. 8*s.* 6*d.* (New York: Longmans, Green & Co. $2.25.) *

J Am Stat Assn 43:155–6 Mr '48. Harold Nisselson. * Roughly two-thirds of the text is devoted to a nontechnical discussion, in the traditional spirit, of descriptive methods in statistics. Of the remainder, half is given over to a consideration of published sources of statistics on England and the United Kingdom, and the balance to a set of routine exercises (with answers). The principal revisions consist of a new chapter dealing with rounding errors, an appendix on quality control, and the inclusion of postwar sources of data. Since the book is almost pocket-size, the amount of space that could be devoted to any one topic is fairly limited. This is reflected in the progressively sketchier treatment of later topics; in particular, time series, correlation and index numbers. However, the style is much more agreeable than this brevity would indicate. The remaining comments apply to the book as a text in statis-

tics, rather than its adequacy for the examinations cited. The chapters on official and other published sources of data for England, an additional one on statistical measures (unit costs, turnover, *etc.*) in common business use, are the most valuable sections of the book and should prove very useful. By contrast, the technical material is far less satisfactory. In general, the approach to statistics is one of merely summarizing a set of data. * There is almost no mention of the role of sampling variation in interpreting statistical data, and the choice of the few instances where such reference is made is quite unexpected. Thus, a formula is given for the probable error of a mean or total due to rounding of the individual figures involved, but there is no mention of the probable error of a sample mean or total as an estimate of the corresponding quantity in the population sampled. (The probable error due to rounding as given is incorrect, and the statement is also made that the probable error is "the most likely value of the error to occur.") Again, a two-page appendix explains the probability that a population proportion lies in a specified range based on the proportion observed from a sample; and an unsatisfactory cookbook rule is given for judging the significance of an observed correlation. The examples cited here are typical of a number of misstatements and unguarded remarks on methodological material which appear at all levels of sophistication. For teaching purposes the unconventional terminology is awkward: for example, "coefficient of dispersion" for the coefficient of variation, "ratio of variation" for the regression coefficient, definition of the first moment of a set of numbers as the mean deviation and the second moment as the standard deviation. Moreover, even for a one-semester introductory course, extensive supplementation by lectures would be necessary. In future editions, the usefulness of this book could be greatly enhanced by pruning or eliminating entirely the chapter on rounding errors, and, if necessary, issuing the exercises separately. The space gained in this way could then be devoted to developing and illustrating the basic ideas of statistical inference, and the relations between a sample and the population on which it is to provide information.

J Am Stat Assn 43:156–7 Mr '48. Edgar Z. Palmer. * The book gives evidence of careless preparation. It is stated that a death rate of 12.5 means a value anywhere between 12 and 13 (p. 22); a frequency polygon is smoothed by the use of a weird collection of curves joining the tops of the bars (p. 62); the third moment measure for skewness is given in terms of the cubes of the deviations, without indication of summation (p. 98); moving averages, plotted at the *ends* of their periods, are supposed to illustrate the smoothing process (p. 106); a square root sign appears without a figure under it (p. 205). Formulas are a crude combination of words and symbols, and fractions are mixed with decimals in a confusing manner. Sampling and quality control have been relegated to two appendices, the former topic including only the sampling error of a proportion, and the latter introducing for the first and only time the sampling error of the mean. It is probable that for the quality of student for which this is intended it is quite teachable. The writing is clear, and illustrations of computations, tables, and graphs are generous. The only interest for American readers is in five short chapters on the sources of British statistics, including one chapter each on vital, employment, overseas trade, and price data.

[157]

★HENDERSON, DONALD E. V. **Opportunities for Statistical Workers, Revised Edition.** American Job Series of Occupational Monographs, No. 5C19. Chicago, Ill.: Science Research Associates, Inc., 1944. Pp. 51. Paper. $0.75. *

J Am Stat Assn 40:530–1 D '45. Lester S. Kellogg. * Restricted to statistics in economics and the social sciences * From the cover—showing a girl operating a Felt & Tarrant comptometer—to the last page of text this monograph is obviously directed to the statistical worker. It is not geared to giving information for use at the professional level. The treatment will stir the imagination and desire of many a high school reader because of the elusive and almost esoteric description of the job and characteristics of the statistician. It will also confuse him. He will finish reading with scarcely any knowledge of what kind of work he will do if he becomes a statistical worker or a statistician. To define a statistician as "a person who is able to use figures *intelligently*" does not distinguish him from an accountant, an engineer or any one of several other specialists who use figures frequently. * Through the use of several questionable illustrations and lack of precision in expression, many misrepresentations are created and erro-

neous notions are perpetrated. * material on vocational guidance in statistics is essential but that it is also essential that the prospective statistical worker be given a more objective picture of what he should anticipate and that he be made aware that statistical worker, as described in this monograph, is synonymous with clerk. * The profession itself has done literally nothing to clarify the content of its field or to establish any kind of standards for its work. * Until the professional societies provide definition and classification of their work and their own statement of standards, other publications on the subject can only be improved by being successively subjected to the critical review of general and professional readers.

[158]

★HENDRICKS, WALTER A. **Mathematics of Sampling.** A summary of a course of lectures given during the 1947 Statistical Summer Session at Virginia Polytechnic Institute. Virginia Agricultural Experiment Station, Special Technical Bulletin. Blacksburg, Va.: the Station, February 1948. Pp. ii, 45. Paper. Gratis. *

J Am Stat Assn 44:144–5 Mr '49. T. A. Bancroft. Although the material for the most part is not new....it presents....a welcomed addition to the unfortunately small amount of published material available in this rapidly expanding field of statistics. The booklet should be of value as a reference for workers engaged in survey sampling as well as for teachers and students of its theory and practice. * A selected but valuable list of references is given * the value of the booklet would have been greatly enhanced by the addition of sections on: choice of sampling unit, determination of sample size, confidence intervals, double sampling, and variances of totals based on various methods of estimation. Although the title....contains the word "Mathematics," no attempt has been made to give either rigorous detailed mathematical proofs or to introduce useful powerful mathematical concepts or machinery to shorten such proofs. Instead the heuristic approach has been used, the details of proofs in many cases being suggested rather than explicitly stated. General theorems, probability distributions, and formulas have been advanced as true because of their analogy with simpler cases. The manner of presentation is understandable since the booklet is a summary of a few lectures covering a broad field. * a valiant effort has been made, by the use of these methods, to make the methodology of survey sampling reasonable to workers.... who may have a modest background in the elements of mathematical statistics. * the author has been successful with one important exception * the fundamental assumptions and limitations involved in setting up various mathematical models, especially in the case of the analysis of variance and of such proofs as indicated in formula (52) and the simpler case at the bottom of page 11, should be given. It is true that an indication of the fundamental assumption of linearity in the analysis of variance model is given in equation (50), but in the reviewer's opinion a greater understanding would have resulted from beginning with the usual assumptions, *i.e.*, $x_{ij} = u + f_i + e_{ij}$, *etc.*, and with detailed definitions, even though the derivation in the latter case is longer. No mention seems to have been made of the formulas for the variance of a product and the variance of a quotient. For the sake of comparison, it would seem desirable to give a proof of the usual formula found in the literature for the variance of the mean of a sample from a finite population in addition to the one given in the booklet. There are several typographical errors. Also the reviewer differs with the author on several points of notation. *

[159]

★HENDRICKS, WALTER A., AND SCHOLL, JOHN C. **Techniques in Measuring Joint Relationships: The Joint Effects of Temperature and Precipitation on Corn Yields.** North Carolina State College, Agricultural Experiment Station, Technical Bulletin No. 74. Raleigh, N.C.: the Station, April 1943. Pp. 34. Paper. Gratis. *

[160]

★HERDAN, G **Quality Control by Statistical Methods.** London: Thomas Nelson & Sons Ltd., 1948. Pp. xii, 251. 21s. *

Iron & Steel 21:468 N '48. * Such subjects as control charts, probability graphs, sampling inspection, analysis of variance, and correlations are clearly explained, and no worker, whether engaged on inspection or research, need hesitate to consult this work. The graphs are frequent throughout the chapters and are clearly drawn and worded. *

J Am Stat Assn 44:569–70 D '49. Paul Peach. * Herdan....discusses not only the usual material of quality control literature....but such less customary subjects as correlation, analysis of variance, and inverse probability. He devotes a whole chapter to the use of probability graph paper, a tool that certainly deserves to be introduced to industrial workers. His is, I believe, the first text on statistical quality control to mention the important notion of components of

variance. * There is perhaps not another book in the statistical field that touches upon so many topics in so little space. Elementary books are presumably written for the instruction of students * The student who picks up Dr. Herden's book with any such expectation had better be prepared to take a substantial consumer's risk. Naturally, no ordinary book of 250 pages can include adequate expositions of all the topics Dr. Herdan has introduced. I don't believe anybody will learn to fit the least squares straight line by studying pages 115–118. The Latin square on page 102 is almost void of explanation or context. The discussion of acceptance sampling is based mostly on the work of Dodge and Romig; but there is only half a sentence about the AOQL concept. The professional statistician learns from these pages that Dr. Herdan knows about linear regression and Latin squares; the beginner can learn, I fear, nothing. The book suffers further from a neglect of common standards of literary craftsmanship. Both the writing and the typography are frequently obscure and confusing, and sometimes we find downright misstatements that are obviously the result, not of ignorance, but of carelessness. On pages 3 and 4 we find what purports to be the equation of the normal curve, but so carelessly set up that no novice could be expected to read it rightly. In the discussion of the test for the significance of the difference of two means, some of the formulas are right, some wrong. In the chapter on probability graph paper the probability density function and the ogive are persistently confounded. Even in his literary references Dr. Herdan fumbles. * One wonders how Thomas Nelson & Sons came to publish this book, what authorities served as their referees, whether the comments of these authorities were transmitted to Dr. Herdan, and what was done with the galley and page proofs. Something must have been neglected somewhere. At all events, the resulting book has in my opinion no possibilities for the instruction of students.

Sankhya 10:164–5 Mr '50. Abraham Matthai. * The book is written in an unusually impressive style of which captions like "the rail lines of chance," "the shorthand of inspection" are indicative, and is interspersed with novel methods and interpretations. The method given of working with $\sqrt{x_i}$ for a Poisson population is elegant and serves to bring the qualitative chart to the same level with quantitative charts as regards sensitivity. This suggests to one the possibility of using means in the case of the number defective (defectiveness greater than 10%) and the fraction defective charts also, with the transformation sin $-1\sqrt{p}$ to make control lines simpler. A notable omission is of the fraction defective chart and the book therefore not only does not give details about a widely applicable chart, but also does not provide a method for unequal subgroup sizes. The book is almost without blemishes. * though brief and not exhaustive, [it] is well planned and retains considerable unity in development. Altogether it is a handy, thought-provoking, useful manual which merits the attention of students and practitioners of quality control.

[161]

★HILL, A. BRADFORD. **Principles of Medical Statistics, Third Edition.** London: Lancet Ltd., 1942. Pp. vii, 189. For latest edition, see 163.

Am J Pub Health 33:900 Jl '43. Paul M. Densen. * differs in no material respect from the previous edition * For the medical man with little or no knowledge of statistics, Dr. Hill's book serves as one of the best introductions to the subject. Even for those who have had some statistical dealings its clear exposition of the logical principles involved in the ordinary statistical procedures deserves a careful reading.

Brit Med J 4278:13 Ja 2 '43. * We congratulate both Dr. Hill and his readers on a notable success.

For reviews of earlier editions, see 38:B635, 2:148–9.

[162]

★HILL, A. BRADFORD. **Principles of Medical Statistics, Fourth Edition.** London: Lancet Ltd., 1948. Pp. xi, 252. For latest edition, see 163.

Am J Pub Health 38:1461 O '48. Hugo Muench. * a thorough revision and expansion * The core of the book is unaltered. The presentation is still designed to give the student a clear idea of the simple, essential tools necessary for the statistical attack on quantitative data in medicine and public health. The careful reader will learn to use these tools; what is more important, he will know why he is using a particular one, and its limitations. He should also find it more difficult to draw wrong conclusions from apparently correct procedures—probably the most frequent and damaging fault of statistical analysis. The bulk of the new material is devoted to the expansion and clarifi-

cation of points which have proved to be troublesome. A whole new chapter is devoted to "The Average," and a second chapter on "Standardized Indices" has been added. Considerable additions have been made to the discussions of distributions, the characteristics of rates, and the use of "significance" tests. The inclusion of an occasional word or phrase gives evidence of heated arguments which must have taken place in classes, or outside.

Brit Med J 4568:207–8 Jl 24 '48. Major Greenwood. A book on medical statistics which passed through three editions between 1937 and 1942, was reprinted in 1945 and again in 1946, and now appears in a fourth and revised edition must have qualities which make praise from a critic superfluous and blame futile. Prof. Bradford Hill set himself the task of explaining to a clinical reader the principles of statistical reasoning without boring or puzzling him with algebraical formulae, and he succeeded so well that other medical consumers, or at least users, of statistics begged to be helped. The author has added sections of more interest to workers in social and preventive medicine than to clinicians, but has done this so skillfully that the personal charm of the first edition has not been lost. *

Eug R 40:93–4 Jl '48. Major Greenwood. * In 1937 "doctors" needed first-aid, which Professor Bradford Hill provided. His book could be read, and was read with pleasure, by persons whose mathematics went no further than what Karl Pearson once described as the average equipment of a public school boy—a fading memory of a "formula" for solving quadratic equations. There is indeed very little algebra in Professor Hill's book. A reviewer of the first edition said that "arithmetic guided by logic" was a fairly accurate definition of statistical method; it certainly describes Professor Hill's practice. * The three chapters on fallacies and difficulties are particularly good; all the arithmetical examples will appeal to "doctors" the public primarily had in view, although the author has been led, by the requirements of workers in public health, social medicine and industrial medicine to make additions (the fourth edition is about one-third larger than the first) which are less directly interesting to clinical workers. A good and popular manual such as this eventually, and inevitably, suffers as well as gains from revision. One must set off a loss of individuality against a gain of completeness. * authors of good, short books may be warned to revise and expand very cautiously. This is a *very* good introduction to statistics for medical readers; may it long continue to be so!

J Am Med Assn 138:250 S 18 '48. * Any one who retains a slight command of his high school algebra, specifically the binomial theorem, will be able to understand everything in this book provided that he is willing to contribute the needed time and effort. * The methods for computing chi square for fourfold tables and of the correlation coefficient for ungrouped and grouped data are well explained. Considerable space is given to death rates and life tables. * a concluding chapter on "Common Sense and Figures" takes much of the wind out of the sails of unbelievers in statistics. A slight expansion of the index with appropriate changes in the text would make the book more useful to readers who wish to know the meaning of "tetrachoric" and "root-mean-square." Some terms like these are not represented in the index, though their equivalents can be located in the text if one already knows what they mean. In general, however, the omission of many important aspects of statistical science is explained by the fact that they simply do not admit of elementary presentation. If this is kept in mind, the book should be extremely useful. In particular, the section on questionnaires will help many an investigator to avoid trouble, and a copy of this book should be available to every one planning clinical research.

J Am Stat Assn 43:492–3 S '48. J. Yerushalmy. Many workers in clinical and preventive medicine have found the previous editions of this book the most satisfactory source for acquiring a working knowledge in statistics and an understanding of the role of quantitative methods in medicine and public health. * Of greatest interest to professional statisticians are the techniques of presentation which accomplish the difficult task of making statistical methods palatable to a nonmathematical audience. These techniques....derive their effectiveness from a sound evaluation by the author of the intellectual level of the readers for whom the book is intended. It is apparent that Professor Hill addresses himself to an audience of intelligent and capable persons in their own fields of endeavor, even if they are lacking in mathematical training. Consequently he does not "talk down" to them; rather he introduces the statistical concepts in the frame-

work of medicine and public health with which his readers are familiar. He thus succeeds in developing the statistical techniques without the use of mathematical symbols and formulae in such a way that the rationale behind them is comprehended. The concepts become acceptable as logical entities although no mathematical derivations are presented. One minor exception to the generally lucid and comprehensive method of presentation may be mentioned. In discussing the standard error of the difference between two sample proportions Professor Hill presents the usual two formulae, one in which an estimate of the universe proportion is obtained from a combination of the two samples, the other in which individual proportions of the two samples are used in the determination of the standard error of the difference. The explanation of the later technique, however, is presented in terms of two different estimates of the standard error of the proportion in the universe (pp. 111–112). It would probably be more easily acceptable to the reader if the hypothesis of a single universe was not retained in the second approach. In this fourth edition Professor Hill has substantially elaborated and strengthened many of the weaker points of the previous editions. Tabular and graphic presentation and the description and calculations of averages is more adequately covered. Sampling is discussed more adequately and the concept of normality is presented more clearly. The development of the life table and its functions is particularly lucid. The chapters on sampling, averages, proportions, differences, and chi square are enriched by numerous examples, many of them in the field of public health. There are also additions in the number of the very instructive examples of fallacies, difficulties, and problems of selection. In spite of the additions and elaborations of so many topics, Professor Hill succeeded nevertheless in his objective to have the book "kept within limited bounds and confined to 'arithmetic guided by logic.'"

J Am Stat Assn 44:146–7 Mr '49. Margaret Martin. News that....Hill's excellent book....is again available, in the form of an enlarged fourth edition, is indeed welcome. * The clarity of the presentation, the emphasis on the meaning and interpretation of statistical results, and the inclusion of numerous examples illustrating the dangers of careless statistical thinking account for the popularity which this work has enjoyed since its first appearance as a series of articles in *The Lancet* in 1937. Medical students, physicians, and other workers in the medical fields who wish to gain an understanding of the principles of elementary statistics will find it most helpful and stimulating. On the whole the selection of material....is excellent. * it would be desirable to have included a table of probabilities for the normal curve to be used in significance tests, especially since such a table is given for chi-square; that in the discussion of significance tests for proportions, more detailed consideration might have been given to the conditions necessary for reasonably reliable application of normal curve theory and to the correction for continuity; and finally, that follow-up studies in which cases are under observation for fractional parts as well as for whole numbers of years might have received more complete treatment. On the other hand, the calculation of the average length of after-life in a study in which life experience is not complete for all patients (p. 173) does not seem to be particularly useful and might, in fact, lead to misinterpretation. A few minor errors have been noted. *

J Inst Actuaries 74:164–5 pt 1 '48. R(onald) G. B(arley). * this excellent introduction to statistics has been substantially expanded and is now one-and-a-half times the size of the first edition, published in 1937 * this book may be read with profit by students of the Institute examinations. This recommendation need not be confined to "those students who come absolutely fresh to the study of statistics"; in spite of the elementary treatment, the emphasis throughout on the proper limits of interpretation will help any student to keep his feet firmly on the ground whilst engaged in attaining the more advanced theoretical standard required by the examinations.

J Royal Stat Soc 111:164–5 pt 2 '48. P. D. O. * Hill's textbook has come to be, for workers in medical fields, the normal approach to a knowledge of statistical methods. * The author has not extended the book beyond the limits of large-sample theory, although it might be thought that readers capable of using a χ^2 table would not be confounded by a table of t, especially as Professor Bradford Hill has shown his peculiar talent for revealing the common sense that lies behind unfamiliar arithmetic. The beautifully clear approach to the problems of sampling and sampling-error has been made more complete by a section on the Normal distribution, the absence of which from earlier

editions was a remarkable feature of the book. A small improvement that could have been made is the transference to this part of the book of the introduction of $n - 1$ instead of n as the divisor when an estimate of the standard deviation is made from a sample. Appearing as it does now in the chapter on methods of calculating the standard deviation this modification can be confusing, and the reader may be left without a clear conception of the idea of estimation. It is not uncommon to find that $n - 1$ has been used when a standard deviation is employed in its purely descriptive sense as a measure of spread in a population, and although the error itself is trivial, the underlying misconception may not be. In an extension of the chapters on χ^2 a valuable warning is given against a too-sanguine interpretation of what appears to be a logical order in the percentages found in a contingency table, which from a χ^2 test was found to be non-significant. The incorrectness is pointed out of the popular device of multiplying the chance of finding an explicable order—steadily increasing or decreasing percentages, for instance—by the chance given by the χ^2 test, but the explanatory paragraph which follows will not bear examination. A rigorous proof would be outside the scope of the book, but explanation is not really necessary; the warning would in itself be sufficient. The magnificent collection of common fallacies and difficulties, which occupies three chapters of the book, has also been enlarged in this edition. The more timorous reader, after studying these chapters, might perhaps feel that the danger of reasoning fallaciously from numerical data is too great; part of his apprehension might disappear if a system of classification of the sources of fallacy could be evolved and included in the book. The present concluding chapter does not entirely fulfil this purpose. The absence, from these chapters on fallacies, of the summaries which are so useful a feature of all other chapters leads us to hope that perhaps Professor Bradford Hill has considered the possibility of classification, and that it may be realized in a later edition. A similar summarizing list, of the various devices for standardizing, and of the standardized indices in common use, would also add greatly to the value of the chapters which describe these, in their rather bewildering profusion. It would have the additional advantage that, if the book were constantly used for reference, the medical worker would as constantly be reminded of the need for sound logic and clear thinking in treating numerical data, the principles which this excellent book is concerned to instil.

For reviews of earlier editions, see 161, 38:B635, and 2:148–9.

[163]

★HILL, A. BRADFORD. **Principles of Medical Statistics, Fifth Edition.** London: Lancet Ltd., 1950. Pp. ix, 282. 10*s.* 6*d.* * [This edition includes "the addition of some paragraphs and the amendment of others * The main addition....lies in the inclusion....of twenty-five exercises...."—Preface to the Fifth Edition.]

J Am Med Assn 144:78 S 2 '50. * this volume has come to be regarded by many as a classic. The present edition has been only slightly altered from the fourth. The major addition has been the inclusion of a set of 25 practical exercises * By means of lucid explanations, practical examples and a minimum of mathematics, the author leads the student through a variety of experimental and statistical problems and points out not only the "how" but also the "why" of their solution. The subject matter is carefully chosen for its applicability to medical problems. * The meaning of frequency distributions is clearly explained * The chapter on averages....is a fundamental and readable discussion * The many problems of sampling....are adequately discussed and well illustrated by practical problems. Two common statistical tests are thoroughly presented, namely, the chi square test and the coefficient of correlation. Of importance to those interested in public health and vital statistics are the chapters on life and survival tables and the calculation of standardized indexes. Common statistical fallacies are also thoroughly discussed. * a very useful glossary of definitions and a set of practical exercises to which the answers are furnished. Although there are bulkier and more exhaustive texts on medical statistics, there appears to be little doubt that this volume of Dr. Bradford Hill's is still the most useful and most readable for the general medical worker. * should be required reading for every medical student and medical research worker.

For reviews of earlier editions, see 161–2.

[164]

★HODGES, J. L., JR. **The Choice of Inspection Stringency in Acceptance Sampling by Attributes.** University of California Publications in Statistics, Vol. 1, No. 1, pp. 1–14. Berkeley, Calif.: University of California Press, 1949. Pp. ii, 14. Paper. $0.25. *

[165]

★HOEL, PAUL G. **Introduction to Mathematical Statistics.** New York: John Wiley & Sons, Inc., 1947. Pp. x, 255. $3.50. (London: Chapman & Hall, Ltd. 28s.) *

Am Math Mo 55:39–41 Ja '48. C. C. Craig.

The reviewer's opinion that the minimum of mathematical preparation for a satisfactory introductory course in mathematical statistics is a year of the calculus is widely shared but so far no really suitable textbook for such a course has been available. It is with considerable anticipation, therefore, that he noted that Hoel's new book is intended to fill this need, particularly in view of the author's known competence in this field. But a rapid inspection of the contents reminds one of the difficulties one faces in planning a first course in mathematical statistics. (1) Is this first course also to be in most cases the terminal course? If it can be generally admitted that any real statistical competence is not likely to be gained in a one-year course, then an author can more easily avoid spreading himself too thin. (2) Is one to concern himself chiefly with the mathematics of statistics which can be so formal as to be almost meaningless or is the science of statistics also to be a matter of principal interest? The reviewer has always found the formal mathematics in elementary statistics the easier half of what is to be taught; to give the student an orientation in a new discipline is more difficult. (3) The students electing such a course vary not only in their mathematical preparation and maturity but also even more widely in their previous acquaintance with the uses to which statistical methods may be put. The most enthusiastic students are commonly those who have already acquired a considerable practical acquaintance with the methods taught but who are now satisfying a most laudable desire to gain some real understanding of them. These and not average students who have just completed a calculus course are the ones to whom the more purely mathematical type of course should be taught. It appears to the reviewer that Hoel's book is best adapted to students with mathematical maturity beyond that usually conferred by a calculus course and with some previous acquaintance with statistical methods. The first seven chapters cover what has heretofore commonly been the material for an introductory course but the mode of treatment is a distinct departure. Not many words are wasted, for the job is done in 127 pages. Little is actually omitted that ought to be included and there are frequent numerical illustrations which indicate the importance and nature of the applications. What is said is almost all accurate and one can take little exception to the mathematics. But the discussion is always brief and the mathematics neat. Brevity with clarity is a merit of an elementary textbook provided it is taught by an instructor who can amplify the discussion and provide additional examples. But pedagogically speaking, mathematical elegance ought sometimes to be eschewed in favor of the direct attack. The obvious case in point here is the early introduction of the moment generating function and its free use. This gets in a concise and pleasing way many results, and the student of mathematical statistics should not go for long without making its acquaintance; but had not beginners better first calculate the variance of a normally distributed variable or of one obeying a binomial distribution law by direct integration or summation? Finally in these seven chapters actual computing methods are treated very briefly indeed in spite of the fact that there is much to be taught about computation and that no one becomes a competent statistician without having a great deal of computation behind him. The remaining five chapters include an introduction to the small sample significance tests and to χ^2 tests which have now become standard. The exposition is still brief but it is still a long step beyond what has heretofore been available in an elementary text in accuracy and mathematical soundness. The reviewer does not see why at least the geometrical proof of the independence of the mean and variance in samples from normal and the development of the approximation which leads to the χ^2 test of goodness of fit could not have been attempted in view of other derivations that are included. The reviewer does have differences with the author with respect to the Student-Fisher t test. On page 143 it ought to be stated that this test does not remedy the defect of the large sample test. In fact for small samples the defect cannot be remedied; instead in strict accuracy we are forced to use a different test. Again in both numerical illustrations, on this page and on page 146, the regions of rejection are both taken as one-sided, which is only correct if it were decided in advance of performing the experiment that the alternate hypotheses admissible were also one-sided, which seems very debatable. In addition some

rather recent material is included. Linear discriminant functions and the theory of runs are introduced with developments that seem really substantial for college juniors. Non-parametric tests, interval estimation (confidence intervals), sampling inspection methods including sequential analysis, stratified sampling, some of the Neyman-Pearson theory of significance tests, and a little about maximum likelihood methods are all included briefly, some of them so very briefly in comparison with what would be required to give any real comprehension of them, that it makes their value to the student doubtful. Very few typographical errors were noted. The book suffers from the very common inconvenience of requiring the reader to search for the page on which, say, (3), Chapter V referred to is to be found. At the end of each chapter references are given to other, fuller, or more mathematical treatments of material in that chapter. Good lists of problems follow each chapter, and the instructor will find often included as exercises nontrivial derivations of theoretical results which supplement the text. I think it is evident that the reviewer's chief concern is that Hoel's book may prove a little more mature and to treat too much material a little more concisely than is best for beginners fresh from a calculus course. A really experienced instructor could undoubtedly amplify and supplement the text and have in his students' hands a basic reference book that is much more sound, more complete, and more modern than anything that has been available at anywhere near the proper level. The book does represent a very long advance in the right direction.

Gen Elec R 50:58 My '47. A. V. Feigenbaum. * thoroughly modern * Hoel has done a competent job of combining the more effective large-sample techniques of classical statistics with the powerful small-sample methods that have developed recently as part of the modern rebirth of statistics. The very virtue of the book as one of the few up-to-date textbooks on elementary statistics is also the characteristic that will probably limit its use. There are some large gaps between general statistical theory and its three largest modern applications—in business, agriculture, and industry. Because Professor Hoel makes no effort to close these gaps, his book may have relatively small utility as an application manual away from the classroom. The book is at its best in its treatment of several phases of modern statistical theory, particularly the development of the design of experiments and of small-sample distributions. The sections on tests of significance are excellent, suffering only in that the illustrative examples are both few in number and standard in nature. * All in all, *Introduction to Mathematical Statistics* is a comprehensive, well-written presentation of some of the more effective statistical concepts which are at the core of much of modern industrial and business statistics, and should enjoy a wide college and university popularity.

J Am Stat Assn 42:324–7 Je '47. J. H. Curtiss. * After a careful reading of Hoel's book, the reviewer is willing to state that, in view of its general excellence, its publication is rather more than just a welcome event: it is the most important happening in the field of undergraduate statistical textbooks in several years. * A novel feature of the [eighth] chapter is the presentation of the derivation and applications of the distribution of the range. * [The title of Chapter 9] is "Non-Parametric Methods." However, the teacher had better be prepared to answer some fairly sharp questions from the brighter members of his class as to exactly what is meant by the title. As far as can be gathered from the first page of the chapter, the author means "methods that do not require any knowledge concerning the form of the basic distribution function." After expounding on the usefulness of such an approach, he goes on to say, "Methods on the type just described are usually called *non-parametric* methods because they do not involve the estimation of parametric values of a distribution function." Then as the first example of such methods, he derives Tchebycheff's inequality and shows how it can be used to test hypotheses about the population mean, given the population standard deviation! Wilks' distribution-free tolerance limits are next discussed; but these too can be fitted into the parametric viewpoint. It is not until the theory of runs is taken up that the discussion becomes really "parametric-free." Serial correlation as a measure of randomness is treated briefly at the end of the chapter. It would seem that the entire chapter might be better entitled "Distribution-free Methods," although the serial correlation material seems to be no more distribution-free than the central limit theorem which appears much earlier in the book. The tenth chapter contains standard material on the application of the χ^2 approximation to the mul-

tinomial distribution. A commendable amount of attention is paid to the binomial and Poisson indices of dispersion. In the final thirty pages of the book, the author starts to skip very lightly and rapidly over some important modern material, apparently with the idea that a speaking acquaintance at this stage of the student's development is better than no acquaintance at all. He introduces the reader to the Neyman-Pearson theory, to maximum likelihood estimation, likelihood-ratio tests (incidentally deriving Bartlett's test on the way), the technique of setting sample sizes to insure a given power, Dodge-Romig principles of inspection sampling, stratified sampling, and sequential analysis. The reviewer sympathizes with the author's point of view in presenting this survey. There is, however, a disadvantage of such superficiality that the author may not have considered. A student who has had a course using this textbook is able truthfully to say on a job application that he has studied design of experiments, sequential analysis, *etc.;* and such a statement might be quite misleading to a prospective employer. In his use of the moment generating function as the principal tool for proving the standard classical asymptotic theorems and deriving the exact distribution of $\bar{x}$ and s^2, the author follows in detail (perhaps unconsciously) the recommendations made by the reviewer some years ago in an article on the subject in the *American Mathematical Monthly* (48:374–86, 1941). It was gratifying to find a correct mathematical explanation of the effect of always putting the larger variance over the smaller one in F and to observe that the author avoided the usual incorrect statement about kurtosis. These are just examples of a much more general proposition: Here at last is a text at the undergraduate level which is almost always right and which is written by an author who clearly knows what he is talking about, and a good deal more, too. There is indeed an absolute minimum of incorrect or loose statements. On page 13, it is announced that "For a set of data that has been obtained by sampling a particular type of population called a *normal* population, it will be shown later that the interval $(\bar{x} - s, \bar{x} + s)$ will usually include about 68 per cent of the observations," which is hardly true for small sampling; but trivial deviations from rigor like this are almost never encountered. Any really serious adverse criticism which the reviewer might have would center about the treatment of regression, the omission of point estimation theory, and the handling of some of the proofs. Regression is approached via the idea of the association between two correlated random variables. The difficulty is that the descriptive material does not seem to be tied in well enough with the succeeding theoretical material. It is not made really clear in the systematic formal treatment of regression and correlation that the "relationship" between the variables that is being estimated by the least square line is the locus of the means of the X-arrays of Y. Fifty pages later, when a small sample treatment of the standard error of the regression coefficient is given, it is brought home to the reader that this is the case and that moreover, the values of X are considered as "fixed" and X need not be a random variable to start with. But the vagueness of the initial presentation is not thereby dispelled. The reviewer was particularly sorry to see transformations, especially the logarithmic transformation, applied on pages 90–91 to regression systems without any discussion at all of the question (all important because unweighted least-squares methods are apparently being recommended) of the effect of the transformation on the dispersion within arrays. It also seemed unfortunate that discriminant functions should be handled entirely descriptively, since the validity of the discrimination is of central interest. The other two points of criticism will be dealt with more briefly. The idea of *unbiased* estimate is touched on in one place, and the maximum likelihood method is presented with no discussion of the properties of the results obtained by using it. No general discussion of point estimates is ever given. Hoel's complete preoccupation with testing hypotheses reminds the reviewer of the opposite example of Colonel Simon, who devotes his *Engineers' Manual of Statistical Methods* almost entirely to point estimation techniques, paying little attention to the idea of testing hypotheses. It would seem that a book which sets out to be as forward-looking as this one can hardly afford to ignore Fisher's rationalization of the most common way of stating an inference from data. As for the matter of the mathematical proofs, here only a tentative and very cautious statement should be made. It seemed to the reviewer that some of the longer demonstrations were a little confusing and needed some polishing up, but probably the reviewer could do no better himself than the author has done. Refer-

ence is made particularly to the discussion of change of variables on page 132 (which can perhaps be handled more neatly via the cumulative distribution function), and the derivation of the distribution of the range on pages 161–164. By the way, it was puzzling to encounter the following sentence while wading through that demonstration: "Since u and v are arbitrary, they may be treated as statistical variables." In general, the text is written in an entirely competent mathematical style which will please members of mathematics departments who have obligations in mathematical statistics. At the same time, the exposition is firmly based on the applications. The reader is made constantly aware by concise paragraphs of explanations and by examples and exercises simulating real life that the mathematical theory is being set up to provide a set of models for a particular class of physical situations and that the selection of the appropriate model is quite as important as being able to manipulate it once the choice has been made. Undoubtedly there will be further editions of the book, incorporating refinements and meeting some of the criticisms stated above. Also, more highly polished competitors can be expected to appear in the future. The significance of the present edition is that it sets an entirely new standard of mathematical and statistical competence for textbooks on intermediate mathematical statistics. It is almost certain to have a far-reaching and elevating effect on expository writing in mathematical statistics for undergraduates. Other writers of textbooks in this class will have to try to do at least as well, and that will be quite an assignment.

J Am Stat Assn 42:327–30 Je '47. Wilfrid J. Dixon. * This book is well titled. It contains only an introduction to the field of mathematical statistics but does introduce the student to a wide range of the problems of mathematical statistics. The mathematical development makes extensive use of moment generating functions, which so abbreviates the development of the distribution theory that the student is able to see the results of the problem at hand before he has lost himself in the development. Further, the book is definitely a mathematical statistics book in that problems of application of theory to practical situations are given secondary place. There is, however, a wealth of problems giving numerical practice with the theoretical results obtained. The author states that the book is intended for junior and senior science students. The reviewer believes that many such students will need an introductory course in statistical method, since the introductory material on descriptive statistics is condensed to 20 pages (Chapters 1 and 2). * A discussion on sampling covers single sampling, stratified sampling, and sequential analysis. Here, as throughout the book, only a bare introduction is given to these topics. A saving feature, however, is the many annotated references at the end of each chapter to which the interested student may refer. There are also many very good exercises, some numerical and others extending the theory already introduced. One wishes when he sees a book so ably done that the author had included much more material presented in the same excellent manner not only covering more completely the topics presented here, but additional topics as well. This book, although intended only as a survey course, points the way to a more detailed study at this level of mathematical maturity, including extensions of nonparametric methods and analysis of variance beyond the simplest problems. Much stress is placed on efficiency and "best" procedures to use all the information available from a set of data. The reviewer believes that it is also important to know how less efficient procedures may be used for a quick appraisal of data. Also very useful "inefficient" statistics for the estimation of mean and variance are available. * An error was noted on page 166. The circular definition of the mean square successive differences is given in place of the noncircular form. There are many points of similarity between this book and *A First Course in Mathematical Statistics* by C. E. Weatherburn. These two books require approximately the same mathematical maturity. Both make use of generating functions, Hoel to a greater extent than Weatherburn. The similarity in topics covered is best described by stating the major differences. Weatherburn gives a more extensive treatment of analysis of variance including analysis of covariance, but includes very little of the material in Chapters 9, 11, and 12 of Hoel.

J Bus 20:176–7 Jl '47. Frederick Mosteller. The author says: "This book was designed to serve as a textbook for a two-semester course in mathematical statistics for which elementary calculus is a prerequisite." The reviewer feels that for this purpose the text is quite satisfactory. * It is agreeable to see the method of

maximum likelihood treated in a book at this level. Numerous references appear at the end of each chapter, but what makes the references useful is the helpful comment attached to each describing its content. * the student is not advised about common transformations of data such as the logarithmic, square root, and arc sine transformations. The omission of the logarithmic transformation seems surprising in view of the considerable attention given to skewed distributions in early chapters. Little or no attention is given to importance of differences, although plenty of attention is given to statistical significance. This preoccupation with significance and kinds of errors leads to oversimplification in discussion of an industrial example (p. 202), when the author does not consider either costs of making changes in a production process or the advantages which will accrue from such changes. For example, a proposed improvement for which the estimated savings are $200 per month should not be adopted, no matter how statistically significant the results of experiments, unless all the costs associated with the improvement amount to less than $200 per month. Overlooking such costs leads the author to the generalization that it is usually more serious for an experimenter not to detect a real improvement than to make the mistake of advocating a new process that in reality is no improvement. The truth is that no such generalizations can or should be made. It is said that "Tchebycheff's inequality is not of much practical value except for very large samples," but no reason is given why it is ever practical or impractical. The author is to be congratulated for this addition to statistical textbooks. The publishers are maintaining high standards in their "Wiley Mathematical Statistics Series."

J Inst Actuaries Students' Soc 8:117–9 O '48. E. J. * There undoubtedly exists a real demand for books which will cater for the special needs of the student whose mathematical background goes no further than the elementary calculus. Hoel's book was written with this end in view. Actuaries will be particularly interested to learn that this work is included in the course of reading suggested in the syllabus of the joint examinations of the Actuarial Society of America and the American Institute of Actuaries. * The material was selected to give the beginner a fairly broad introduction to both classical large-sample and modern small-sample methods, the book being written on the principle that in dealing with such a rapidly developing subject it is more useful to survey a wide stretch of the field somewhat briefly than to concentrate heavily on a few topics. There is, of course, much to be said for and against each of these alternatives. By choosing the former the author has been able to include quite a wide range of subjects, considering the limited space available, but inevitably the treatment is, in places, brief in the extreme. An excellent set of references, in which each title is introduced with a few helpful comments, is, however, given at the end of each chapter. * Throughout the book the author has not hesitated to state and use without proof theorems essential to the development of the subject but which require advanced calculus for their derivation. * emphasis on the practical use of the theoretical results is much in evidence throughout the text and is an excellent feature of the book. In addition, the exercises of both numerical and theoretical types given at the end of each chapter should be very useful to the student. * Chapter VIII is a particularly important and interesting one. * In the twelfth, and final, chapter the statistical design of experiments is considered from the point of view of validity of the results and efficiency. Although interesting, this chapter is highly condensed and the sections on analysis of variance, sampling inspection, stratified sampling and sequential analysis give no more than a bare outline of these subjects. This book is written in a refreshing style calculated to foster a real interest in the subject of statistics. In the reviewer's opinion it can be highly recommended to any beginner who wishes to acquire a sound grasp of the principles underlying modern statistical methods. It would, of course, be easy to list a number of topics omitted by the author but which, one feels, might usefully have been included in the text. It would be even easier to express regret at the very brief treatment accorded to some subjects, such as the analysis of variance. However, it must not be overlooked that this book is intended only as an introduction. The reader who decides to pursue his studies further will find that the practical approach and sound principles inculcated by this work will stand him in good stead. Hoel's book follows so closely on the publication of *A First Course in Mathematical Statistics* by C. E. Weatherburn....that a few words of comparison will not be out of

place. Whilst both works cater for the same type of reader there is an important difference in approach. The emphasis in Hoel's book is on statistical methods whereas, to quote from Weatherburn's preface: "The subject treated in the following pages is best described not as Statistical Methods but as 'Statistical Mathematics, or *the mathematical foundations of the interpretation of statistical data.*" The result is that Weatherburn's discussion of the standard probability distributions, regression, correlation and such fundamentals is, on the whole, more complete than that to be found in Hoel's book. On the other hand, Hoel provides the better introduction to modern statistical methods. In the opinion of the present reviewer the beginner would be well advised to make a study of both books.

J Royal Stat Soc 110:145–6 pt 2 '47. J. O. I(rwin). * an excellent introduction to the subject intended for a first "two-semester" course for American students. It will, however, be very useful to English students who know some calculus but not a great deal. * There is a very short section on analysis of variance, and a short account of some methods in stratified sampling, sampling inspection and sequential analysis. This part of the book is stimulating rather than sufficient. There are very useful references and examples at the end of each chapter, and the author can be congratulated on producing a very useful, readable and concise text-book.

Nature 160:625 N 8 '47. David G. Kendall. * an excellent work * In spite of the restrictive effect of the present licensing system, means should be found of introducing the book widely in Britain. Placed in the hands of any intelligent mathematical undergraduate, it will give him in a few weeks not only familiarity with the broad outlines of the subject but also a real understanding of the types of problems with which the research worker in this field is contending. The first six chapters cover the usual introductory material, in a manner at once accurate and attractive. There follow brief accounts of a variety of more advanced topics * Up-to-date references, exercises both realistic and interesting, the usual tables (together with a very useful one of squares and square-roots) and a satisfactory index complete the work. Of course it is easy to ask for more; one would have liked to see some mention of cumulants, of the characteristic function, of Fisher's exact test for 2×2 tables, and a more adequate account of maximum likelihood estimation. But the author was probably wise in not overloading the book; it will leave many readers full of a most healthy curiosity.

Q R Biol 23:406–7 D '48. Margaret Merrell. * there has been a real scarcity of introductory textbooks dealing with the mathematics of statistical methods. Hoel's book meets a very real need and meets it exceedingly well. The book forms an excellent companion to a competent subject-matter textbook such as, for example, Hill's *Principles of Medical Statistics.* * The biologist with a limited amount of mathematics at his command will not find this a formidable book, and will be helped by the liberal use of illustrative examples from biological and other fields. The fact that the book developed out of Hoel's experience in presenting the subject to science majors, and that he wrote with an awareness of the needs of applied statisticians has made this a singularly successful presentation for the scientist. The author of any such treatise is faced with a very difficult problem in the selection of material. Here again one is impressed with the skill shown in planning the book. A good balance between classical large sample theory and small sample theory has been achieved. Recent developments in such topics as sequential analysis, discriminant functions, non-parametric methods, and the testing of hypotheses are introduced. * Exercises at the end of each chapter add to the appeal of the book, both for undergraduate teachers and for the many scientists who try to get an understanding of statistical theory through their own study. For such students, it should be recognized that this book is not a substitute for a subject-matter textbook that gives thorough consideration to the problems inherent in the collection of data, the types of errors likely to be encountered, and interpretations relevant to a particular field. Thus scant attention has been given to the labeling of axes in terms of the data presented, or in attaching units to arithmetic results; and only superficial interpretations are attempted. The arithmetic examples serve their purpose, however, in making the mathematics more easily read and understood. The book can be heartily recommended to the growing group of biologists who are thinking in quantitative terms.

R Scientific Instruments 18:785–6 O '47. S. S. Wilks. During the last ten or fifteen years

rapid progress has taken place in the field of statistical inference; *i.e.,* the application of the mathematical theory of probability to all kinds of statistical problems. This relatively new branch of applied mathematics for putting statistical analysis on a rational basis is called *mathematical statistics.* Until fairly recently most of the activity in this field has been of a research nature, the results being presented in research journals and most of the teaching being done at the graduate level. However, there are many signs of effort now being made to organize many of the results and teach them at the intermediate and upper class levels in college. In the present book the author has successfully prepared such material, with elementary calculus as a prerequisite. In the present book the usual material on descriptive statistics, *i.e.,* the arithmetical and graphical description and analysis of frequency distributions of observed data, is condensed to about twenty pages. This work does not involve any probability considerations. In the older statistics courses it has been customary to spend at least one semester on descriptive statistics. This diminishing attention to all kinds of descriptive statistics is characteristic of the modern trend in mathematical statistics in which the emphasis is placed on probability interpretations of statistical analysis. * The moment-generating function, a very effective device for obtaining moments of distributions, is introduced early and used widely. * The author's treatment of regression methods, and multiple and partial correlation is fairly standard. One relatively new multi-variate statistical method which has never appeared before in an intermediate textbook is discriminant analysis. * Some of the more novel material for a book of this level consists of a chapter on non-parametric methods and one on the testing of statistical hypothesis. Non-parametric methods are becoming more important because they enable one to make certain inferences with only a bare minimum of assumptions. The author's treatment of these methods is very meager in the opinion of the reviewer. Actually, the only really non-parametric material included is a section of the theory of tolerance limits and one on the theory of runs and their applications. The author devotes one chapter to the statistical design of experiments, but he hardly does more than introduce the student to the subject. Part of the material that would normally be included in this chapter was inserted in an earlier chapter under applications of the Snedecor F ratio. The presentation there is inadequate for a clear understanding of the use of raw-column layouts in the design of experiments. No mention is made of the Latin Square and related experimental designs. The book is written with satisfactory mathematical rigor considering the fact that only a first course in calculus is prerequisite. The author does a good job of emphasizing in the practical problems how the mathematics serves as a model for interpreting the analysis. * In conclusion, this book marks an important step in the statistics textbook field. * it is the first satisfactory textbook to bring a substantial part of modern mathematical statistics down to the intermediate college level. It can be made more satisfactory in subsequent revisions by including more material along lines suggested by the reviewer earlier in this review.

Sankhyā δ:389 Je '48. T. Choudhury, Despite the existence of a large number of text books on elementary statistical methods, the need is there for a really good one. On the one hand, theories of statistics are to be deduced through mathematical symbols and reasoning, and on the other, the symbols are to be interpreted in non-mathematical language in the light of the real world. The combination of these two aspects is seldom found in any text book. Then again the approach to statistical problems, which can easily be made through common sense, is sometimes made only through a jugglery of mathematical symbols, leaving non-mathematical readers confused. Mr. Hoel's book will, to some extent, remove these deficiencies and lead the reader to real problems without compelling him to part with mathematical understanding. * recent developments have been described in brief, and the reader can obtain an up-to-date view of statistical theories in this book. In finding out the distributions of statistics, the author has used characteristic functions uniformly, and has made the reader's understanding easier. The exercises and references....will be found useful for better understanding and further reading of the subject. Most of the exercises and examples relate to industrial problems, and from this point of view, it will be useful for industrial statisticians.

Sci 107:510–1 My 14 '48. Churchill Eisenhart. * Noteworthy features of this book are: (1) Its broad coverage of the ideas and techniques of statistical inference, especially those

found to be most effective in industrial experimentation, quality control, and acceptance inspection. Thus, in addition to treatment of the material found in most elementary statistics texts, the reader is introduced to such topics as discriminant functions, statistical tolerance limits, and testing for randomness by runs and serial correlations. (2) The effective use made of moment-generating functions to obtain elementary proofs of many of the basic theorems of modern statistical inference. Granted certain fundamental properties of these generating functions, the proofs given are not only complete, but throw light on the character of the approximations involved, if any. (3) The collections of well-chosen exercises at the end of each chapter which provide the reader with opportunities for trying out the methods to which he has been introduced. A major shortcoming of the book is its failure to make the reader feel "at home" in the application of the methods presented. It falls in that intermediate zone between a purely formal mathematical treatment, on the one hand, and a manual of procedures, on the other, where it is difficult to strike a satisfactory balance between mathematical rigor in the proofs and stimulating illustrations of the scope and power of the applications. The author has tended to favor rigor of development, at the expense of giving the reader a "practical feel" for the applications. As anyone who has made the attempt knows, the latter is more difficult to achieve. As W. Edw. Deming has so admirably put it, "it is fairly easy to write mathematical books and papers, and even easy to make the exposition clear, but....it is quite a different matter to try to explain *how to use theory in practice*. This is *very difficult*." Also, the reference material cited is insufficient and inadequately tied in with the text material. For example, in connection with discriminant functions, B. L. Welch's "Note on Discriminant Functions" (*Biometrika*, 1939, 31, 218–220) is not cited. This important note relates the problem of constructing an optimal "discriminant function" to Bayes's Theorem and to the Neyman-Pearson likelihood ratio test for choosing between one of two admissible hypotheses, and is essential to an adequate background of the subject. In addition, the reader is occasionally left without further guidance; thus, on page 15 it is stated that the measure of skewness a_3 "can be zero without the distribution's being symmetrical," and a similar caution is given in connection with a_4 as a measure of peakedness. However, the reader is given no hints on the nature of these exceptions, to enable him to judge whether they are "pathological" or not, nor is he told where such exceptions are discussed in the literature. Explicit citation in the text of especially pertinent references given at the end of the chapter would be very helpful in numerous instances, as would also the referencing of such material in the index under author and subject. This reviewer obtained the impression, as he read along, that he was being "talked down to." Instead of a feeling of being guided through new vistas by an enthusiastic statistician engaged in a bit of proselyting, or the feeling of being "shown the way" to a new "religion" by a penetrating thinker with wide experience, he felt that the narrator was condescending to tell him a few of the things regarded as commonplace by those "in the know." As a textbook for a first course in mathematical statistics, its mathematical level is likely to render it unsatisfying to students of mathematics, and its atmosphere of noncontact with practical applications may limit its effectiveness among practical workers who seek on-the-job guidance. There is, however, at present no other book of comparable size that provides such a broad introduction to statistical inference.

Social Forces 26:360 Mr '48. Daniel O. Price. * should prove very valuable to those applied statisticians interested in the fundamental methods of mathematical statistics.

Trans Actuarial Soc Am 48:376 O '47. * an intermediate textbook considerably more advanced than a large number of elementary textbooks but not nearly so advanced as the mathematically mature works of Cramér, Kendall, or Wilks. It is rather unique in this respect. The proofs are as rigorous as could be expected in a book designed for readers with only a moderate mathematical background. Good numerical examples are used frequently and are very helpful. It is well documented with references to more advanced works by which the reader can pursue any individual subject as far as he likes. This book appears to be pitched at about the right level for most actuaries who are seeking to learn a practical amount of mathematical statistics without devoting the tremendous amount of time which would be required to master an advanced treatise. It now appears in the recommended course of reading for Part 3 of the Joint Examinations.

[166]

★HOGBEN, LANCELOT. **Chance and Choice by Cardpack and Chessboard: An Introduction to Probability in Practice by Visual Aids, Vol. I.** London: Max Parrish & Co., Ltd., 1950. Pp. 417. 50*s*. (New York: Crown Publishers. $12.50. *)

[167]

★HOGBEN, LANCELOT. **An Introduction to Mathematical Genetics.** New York: W. W. Norton & Co., Inc., 1946. Pp. xii, 260. $5.00. * (London: George Allen & Unwin Ltd. 25*s*.)

J Am Stat Assn 42:184–5 Mr '47. C. W. Cotterman. The author of *Mathematics for the Millions* here lends a helping hand to the hundreds of geneticists who have experienced difficulty in understanding the mathematical writings of a few of their colleagues. The subject of the present volume is the mathematics of Mendelian populations * In large part, this material has not previously been summarized in book form in the English language. The book is an expansion of a series of lectures presented to graduate students of genetics at the University of Wisconsin in 1940. It has the logical arrangement of a mathematics text and is provided with numerous exercises and answers which increase its usefulness as a manual for self-teaching. Particularly valuable in this respect are three introductory chapters on basic algebraic series, first steps in finite differences, and binomial series, in which the author gathers together various algebraic devices that have been found to be most useful in statistical genetics. * It is unfortunate that the author did not apply his skill to the exposition of a wider variety of statistical methods from the works of other authors. For example, he sets forth a method which he devised for the correction of ratios derived from selected human families, but he does not correctly state its limitations, nor does he describe a more generally serviceable method due to Fisher. Indeed, none of the latter author's important contributions to statistical genetics are mentioned in the very inadequate lists of references which are provided at the ends of chapters. Metrical characters are not discussed, hence the general problems of analysis of variance and correlations between relatives are not developed. However, the very simple and widely useful coefficients of relationship and inbreeding due to Wright should at least be mentioned in an introduction to mathematical genetics, and their use would have simplified the sections on assortative mating and consanguinity.

Sci 106:45–6 Jl 11 '47. Kenneth Mather. * The third part consists of two appendices, one on tests of significance and the other on statistical estimation. These topics are dealt with in a more mathematically thorough than a practically comprehensive way. The most valuable method of testing significance in genetics is by the use of χ^2. Yet this is not granted any mention. Again, the method of maximum likelihood is presented without any account of its value in dealing with fragmentary and combined data. It is impossible, of course, to deal adequately in 43 pages with the statistical methods used in genetics, whether from the mathematical or the analytical point of view. Such a brief account should be omitted if space forbids a more comprehensive survey. The space gained by an omission of the appendices might well have been devoted to developing further the mathematical treatment of genetical situations, which forms the main theme of the book. As we have seen, the topics taken up are discussed thoroughly, but their range is limited. Neither Fisher's treatment of the theory of selection nor Wright's of the composition of populations is included. Admittedly, both are necessarily complex but cannot be neglected on that account. * To achieve genetical understanding we must work out the properties not only of single genes, but of systems of genes—genes which are not separable in analysis, but which can reinforce and balance one another in variation. Prof. Hogben, like Mendelian genetics itself, takes us only part way, because, as we saw, he deals with genes only one at a time. He shows us how to cope with the problem of red and white cows in our herds of black and white Friesians. He does not tell us how to cope with the problems of their milk production. The student will find that this book well repays study. There are a few misstatements of genetical fact, as when it is said that in *Primula* species individuals homozygous for the thrum gene are nonviable, and a few of mathematical scope, as when it is stated that the recombination value can be estimated from F_2 data only when it is the same in both sexes. Nevertheless, this book is unique in the genetical ground it covers and in the attempt to explain the mathematical methods used. Having mastered it, the student will have a deeper insight into the formal properties of mating systems and the formal workings of selection, the principles of which, as Prof. Hogben suggests, are basic to

the application of genetics in agriculture and human affairs. Before he can cope with the problem of applied genetics, however, the student will have to learn how these principles are used in a wider variety of situations, in some of which genetical complexity at present precludes mathematical rigor.

[168]

★HOLZINGER, KARL J., AND HARMAN, HARRY H. **Factor Analysis: A Synthesis of Factorial Methods.** Chicago, Ill.: University of Chicago Press, 1941. Pp. xii, 417. $6.00. (London: Cambridge University Press, 1943. 30s.) *

Am J Sociol 48:261–3 S '42. Chester E. Kellogg. * here at long last is a book no part of which is a battleground for hobbies. * the authors have given us a thoroughly objective, impartial presentation of the techniques which have seen most actual service in research: the basic Spearman search for the general factor; the Holzinger bi-factor method, representing the various methods adding group factors to the general factor; the principal-factor solution, using the revised form of Hotelling's method of approximation; Thurstone's centroid method, and a variant called the "averoid method." All these are discussed as simply various ways of determining the placement of the number of orthogonal axes required to account, within the limits of sampling errors, for the communality variance of the measures in question. Exposition is much abridged and simplified by setting down systematically in Part I the material basic to all the methods * This book is not to be recommended to students who do not like mathematics. Those who do, and who have a good working familiarity with elementary analysis and statistical methods, will be able both to appreciate the beauty of a masterly exposition and to acquire facility in the use of the factor techniques.

Char & Pers 10:253–5 Mr '42. Charles M. Harsh. * Part I presents the statistical and geometric formulations of the factor problem and describes the several preferred types of solution, with a lucid discussion of the bases of preference. The language is concise, definitions are clear, and formulae are well explained. But a sound statistical background is required. Not even Part I can be read intelligently without the fundamentals of matrix theory presented in Appendix A. A more generous use of figures might have simplified the geometric formulation for many readers. Part II develops the methods of solution for the Bi-Factor, the Principal-Factor, and the Centroid solutions. * Of special interest is the development of sampling error formulae for factor coefficients and for residuals from a general factor extraction. These sampling error estimates apply strictly only to triad solutions and the closely related Bi-Factor solutions, but may be used as rough approximations in multiple-factor solutions. Considering the difficulty of calculation, these sampling formulae are of more interest as statistical exercises than as practical aids. The authors admit the danger of estimating probabilities from the use of these standard errors, since it is not known that the factor loadings are distributed normally. To the reviewer the formulae would seem of doubtful value for testing the significance of differences between factor loadings in two populations. Such a test requires a formula for the standard error of a difference, yet there is no way of estimating this because we do not know the correlation of factor loadings in the two populations, although the loadings are undoubtedly highly correlated in that they are derived from similar correlations of similar tests in both populations. Convenient tables of sampling errors are presented in an appendix, but these are approximations involving only the average intercorrelation of the original matrix, thereby losing much of the accuracy of the original formulae. The standard error of residuals should be useful in testing the adequacy of factorization of a matrix. Part III shows how orthogonal and oblique multiple factor solutions may be obtained from Centroid or Bi-Factor solutions. Part IV presents several methods of estimating factors and, finally, suggests an order of analysis for determining what solution to use. The detailed procedures for computing factor patterns are clearly outlined in the appendices, with numerical examples that could be followed without reading Part II. * While the authors were so systematically relating the American factor methods, it is to be regretted that they did not show how Burt's method and the inverse factor method of Stephenson are related to these. (Thomson and Burt must get credit for being more internationally minded.) An understanding of methods involving correlation of individuals would seem quite important in the designing of factor studies in any of the social or biological sciences. But despite this omission Holzinger's and Harman's book

should be required reading for both prospective and habitual factor analysts.

J Abn & Social Psychol 37:567–8 O '42. J. P. Guilford. The authors' stated purposes include "a general treatment of factor analysis including an objective basis for comparing various forms of solution" and to supply "the methods of analysis in a very simple, readable form for the worker who is not concerned with the rigorous foundation." In the opinion of the reviewer, both objectives have been adequately accomplished. * Having previously championed one particular factorial theory and method of solution, the authors now present in a rather unbiased manner most of the current theories and procedures. * the authors make no final choice among factor methods or factor patterns. In general, they leave the investigator to choose for himself that pattern which seems best to picture the phenomena of his immediate problem. No criteria are set up for deciding whether nature, psychological, biological, or social falls into one type of factor pattern or another. There is, however, a strong payment of respect to the mentor, Spearman, and in speaking of preferred types of orthogonal solutions in Chapter V, the simple Spearman pattern with one common factor comes first and the Holzinger bi-factor pattern comes closely behind. Both patterns are regarded by many critics as being very arbitrary and as having little to recommend them except their simplicity. Other "preferred" patterns include the principle-factor and the multiple-factor types. The principle-factor solution yields bi-polar factors (both positive and negative factor loadings), whereas the multiple-factor solution by rotation of axes aims at unipolar factors (only positive factor loadings). It is pointed out that almost any type of solution leads to psychologically meaningful, or otherwise significant factors. It can be admitted that human imagination is sufficiently elastic to reading meaning into many really meaningless "factors," yet it is hard to see how bi-polar factors have any reasonable interpretation when dealing with a pattern of abilities. Negative contributions of abilities to performances would seem to demand too much, even of human imagination. * One weakness of all factor methods—the lack of standard errors or their substitutes—has often been deplored, and rightly so. With the exception of Spearman's tetrad differences no factorial constant has previously been provided with a sampling formula. In this volume the authors derive methods of estimating standard errors of factor loadings (factor coefficients) and of residuals. The limited applicability and the lack of ease of computation of these statistics, however, leave much to be desired. The authors' solution of the question of how many factors to extract and the knotty problem of unknown communalities rests on the advance determination of the number of factors in the common-factor space. This in turn depends upon the use of Holzinger's B-coefficient, or coefficient of belonging. This coefficient, empirically developed, requires a large amount of subjective judgment to apply, lacking criteria of significant changes in size. Their method for estimating communalities in advance also depends upon the assumed number of common factors. Knowing the number of common variables in advance would, of course, solve the troublesome question of when to cease extraction of factors. Even knowing the communalities in advance, or having good estimates of them, solves the same question for then one would cease extractions when communalities are exhausted. But, unfortunately, the dependability of the B-coefficient is not sufficiently demonstrated. In view of the lack of any other adequate index of the number of common factors, however, the B-coefficient may be included among the things which point to the rank of the correlation matrix. Those familiar with the British contributions to factor methods will be likely to miss the mention of a number of variations more popular in the Isles. This statement applies particularly to the work of Thomson, Burt, and Stephenson. Those who follow the Thurstone procedures closely will fail to find mention of some of the refinements in computational techniques which have appeared since Thurstone's *Vectors of Mind.* With these deficiencies having been mentioned, however, one can still say that the present volume is the most comprehensive and satisfying exposition of its subject that has yet appeared. Nowhere else can one find an account so complete and in terms that are bound to gain and hold scientific respect for methodological advances in a statistical field which now extends its usefulness well beyond the boundaries of psychology.

J Am Stat Assn 37:292–3 Je '42. M. A. Girshick. Although factor analysis had its greatest development in the field of psychology, its application to many other branches of the

social and physical sciences is becoming so widespread that a book dealing with the general aspects of this subject is not only timely but highly welcome. The book under review is a valuable contribution for several other reasons: First, the authors have made a determined attempt to define the scope and limitations of the technique of factor analysis; second, they have synthesized the major known methods of factorial decomposition; and third, they have developed the subject matter with great clarity and with much detail so that the book can be followed without too much difficulty by people with limited mathematical training. Except for a few minor omissions, the book is self-contained. Not only does it cover all of the important aspects of factor analysis that have been considered in the past few decades in the literature, but each topic is thoroughly digested with detailed numerical examples, detailed methods of computation, and complete proofs given either in the body of the text or in an appendix. From the point of view of the uninitiated, the mathematical and geometrical treatment in this book of the subject of factor analysis is the best that has yet appeared. The main contribution of this book, however, lies not so much in the algebraic and geometrical treatment as in the handling of the subject matter as a tool of research. * Insofar as factor analysis is a tool of statistical analysis, the problem of the significance of the results obtained from a sample of observations assumes great importance. Unfortunately the problems involved in the development of tests of significance are rather complicated, and, to date, only scanty progress has been made in this field. The book, for example, contains several approximations to the standard errors of the quantities involved and some indications of tests of significance are given. However, these are at best rough and cannot be relied upon always to give satisfactory answers. Thus, at the present stage of development, an investigator must depend to a large extent on his own judgment and a knowledge of the variables analyzed. The same holds true in regard to the problem of estimating communalities. These communalities are in a sense the cornerstone of the whole technique of factor analysis as developed in this book, and several methods are described for their estimation. If used with discrimination and mature judgment, these methods will lead to fruitful and sensible results. This fact is well exemplified by the manner in which the authors themselves have handled them. However in the final analysis, the methods proposed are mostly based on rule-of-the-thumb criteria and will remain as such until factor analysis passes from a tool for hit-and-miss experimentation to a tool for testing well-thought-out theories concerning the structure of the variables analyzed.

Math R 4:18 Ja '43. C. C. Craig. * a clear exposition of the theory of factor analysis * It gives relatively little space to the interpretation of the results in any particular field of psychology which is admittedly a matter for caution. The student with more than a minimum of mathematical preparation and a knowledge of mathematical statistics will find this work a clear and felicitous road to a good grasp of its subject, but I am more uncertain of the ease with which a mathematically uninitiated worker in psychology, say, will use it as a laboratory manual. To this second class of readers I believe that the directions will appear somewhat economical of statement and that the discussion will seem somewhat mathematically sophisticated. There are four principal sections. In the first the underlying mathematical framework and the basic statistical tools are set forth. In particular, the useful and enlightening geometrical interpretation of the whole theory is especially well explained and is well used throughout the remainder of the book. It is emphasized that there is no unique resolution into factors and a list of standards is set down for assistance in choosing a mode of factorization. In part II orthogonal solutions obtained directly, uni-factor, bi-factor, principal-factor and centroid, are derived and the numerical steps in carrying them out are illustrated. The preliminary estimation of communalities is important here and several methods for accomplishing this are given. A variant of the centroid method is shown which may be tried if good estimates of the communalities are not available. Some of the desirable sampling formulae are developed and discussed though as it is stated the existing theory is far from being satisfactorily complete. Perhaps a somewhat fuller explanation of the shortcomings of the formulae given would have been desirable. * The scientific caution and restraint shown by the authors throughout is commendable. The claims of factor analysis as a tool for scientific investigation are fairly stated and not overstated. The book as a whole is an excellent and valuable job.

Psychol B 39:261–2 Ap '42. Paul Horst. For a book on factor analysis the present volume is remarkably free from emotional bias or pet theories. This is in part due to the fact that the authors consider factor analysis as a statistical method generally applicable to all problems where a large number of quantitative variables are involved, rather than merely to the restricted fields of psychology and education which have been primarily responsible for the development of the factor methods. All of the leading factor techniques are given competent treatment with no attempts to disparage or champion any individual method. Very little of the controversial exposition which has characterized several of the preceding volumes on factor analysis by other writers is to be found in this volume. * It would, of course, be possible to suggest various other alternative procedures for carrying out the computations in connection with the methods of factor analysis described, but it is not to be expected that all practical or useful variations could be included in a volume even so complete as this one. One omission, however, was a little surprising to the reviewer. The authors, in discussing the transformation of a given pattern to a principal factor solution, indicate the formal solution based on a characteristic equation. Numerical illustrations are given in considerable detail. The authors fail, however, to point out that the characteristic equation in this connection is entirely analogous to the one obtained in the direct principal axis solution and that the same iterative procedure which they suggest for the direct solution is applicable when transforming a given pattern to a principal factor solution. As a matter of fact, the formal solution is almost prohibitive if the number of factors is more than five or six. Some contributors to the development of factor analysis methods will recognize solutions and procedures which the authors have not explicitly attributed to them, but in so rapidly expanding a field, it is not to be expected that such an ambitious synthesis as the authors have attempted can hope to allocate credit to the satisfaction of all. Investigators who have struggled with an extensive variety of factor configurations will recognize the limitations of the technique of beta-coefficients in certain special cases and may well wish for a discussion of other possible alternative methods for the preliminary grouping of variables. However, the authors have turned out a thoroughly professional job. Whatever may be said of the individual merits of previous volumes on factor analysis, the present volume is undoubtedly the most useful contribution as a general textbook and reference work which has yet appeared on the subject of factor analysis.

Sch R 50:537–9 S '42. Truman L. Kelley. The subtitle of Holzinger and Harman's book, "A Synthesis of Factorial Methods," well describes the purpose of the authors. Their intent has been accomplished to a degree and with a thoroughness not equaled in earlier works. This review deals with certain assumptions in the Holzinger-Harman point of view, certain mathematical standards and novel practices, and certain more general issues. To the reviewer the most serious assumption is also the most deeply ingrained, namely, that only communalities of tests should be factorized. With utter fairness of intent the authors modify the analytical problem attacked by Kelley and Hotelling so as to make it a problem which seems real and important to them—that of factorizing communalities —quite unaware that as a consequence they have really destroyed the fundamental problem and have thrown out of vision and out of consideration certain crucial statistics which Hotelling developed and Kelley incorporated in his own methods of factorization and discovery of consociated mental factors. In all cases the factorization of tests is academic to an extreme degree, as the person selecting the tests to be analyzed has, known or unknown to himself, largely dictated the outcome. He dictates it still further when he asserts that he will analyze only communalities. But the minds of subjects are not thus subject to his whim. If children's minds function in dimension x, not represented by communalities and (though with less likelihood) not represented by specific features of any of the tests employed, the experimenter has not made an analysis of the way the minds of his subjects operate. At best, he has only analyzed tests—an outcome with some value though trivial in comparison with the analysis of mental life. The reviewer believes that the authors should redirect their energies to this more human, more social, and more psychological problem. The authors have a fondness for bifactor analysis and have worked heroically to secure belongingness coefficients and standard errors of coefficients of factors (test loadings). The reviewer questions the value of these. The statistical technique based on the use of judg-

ment to discard certain evidence, as is their procedure in discarding certain triads $\left(\frac{r_{12}\, r_{13}}{r_{23}}\right)$, when "based upon insignificant denominators" (p. 79), just is not a statistical technique. The same, of course, is true of any procedure involving the use of judgment to determine the size of the communality variance. These are not cited as mathematical blemishes, for the authors are well aware of the mathematical difficulties involved, but they are mentioned as logical shortcomings. Problems should not be set in these terms, for they are unsolvable. Except for certain points mentioned later, the authors are keenly aware of the difficulties of securing, and of the necessity for securing, standard errors of their outcomes. This is the most refreshing and surprising feature of the study. It is refreshing because its dearth has been so grievous in much earlier work, and it is surprising because herein the authors provide the point of view and some, at least, of the tools for the annihilation of their own techniques. It is but a short step from, say, awareness that the standard error of a communality is, of logical necessity, unavailable to the conviction that the thing is not worth thinking about, but it is a step the authors have not taken. They have built so soundly, so far as they have gone, that the reviewer warmly commends their treatment and asks them and their readers to pursue it just a little further. The authors have used inconsistent data. In three tables the correlations and variances shown in the following excerpts are found. All the correlations .58, .45, .84, .881, and .730 are inconsistent with the variances, for of course a covariance must be less than the root of the product of the variances. That the authors have either overlooked this elementary fact or considered it unimportant is distressing to a mathematician, who must refuse to take the first step

EXCERPT FROM TABLE 7.6

Variables	2	6	8
2	94		
6	.58	.28	
8	45		12

EXCERPT FROM TABLE 7.8

Variables	1	2
1	.52	
2	84	1 00

EXCERPT FROM TABLE D

Variables	2	3	5	7
2	.897			
3	.881	.833		
5			.870	
7			.730	.521

in any development undertaken with such data. It is true that, with all the methods they illustrate (including in this respect an inaccurate illustration of the Hotelling method), the variances are derivatives and not arguments. But this does not alter the fact that the standard errors of all the statistics which they themselves consider crucial—coefficients of variables in terms of factors and coefficients of factors in terms of variables and variances of communalities—are, in essential part, functions of variances. It would be easy to conclude that on this account all their results are suspect. But the reviewer believes that, in spite of the uncertainty that attaches to the crucial quantitative statements of standard error, the fundamental analytical pictures they give are sound. The authors have spent much time in solving the problem which R. A. Fisher has shown is impossible of solution—the problem of the standard error of factor coefficients. Fisher has shown that the standard error of a multiple-regression coefficient is indeterminate; that is to say it is incapable of determination unless all the other regression coefficients are known. This indeterminateness is even more strikingly true of a factor coefficient unless all the other coefficients are known with certainty, and of course they never are. This raises the fundamental issue for all factor analysts to ponder: Why think about these loadings since they are essentially indeterminate? This is not the place for the answer to this query, but it is appropriate to suggest that a search for the standard errors of these coefficients is not a step in the solution of the problems of the factor analyst. The authors frequently refer to certain factors as "insignificant." In fact, they seem to believe that, in general, the number of factors will be considerably less than t, the number of tests employed. "Insignificant" in the mathematical sense is synonymous with the idea that the magnitude in question may be a chance deviate. Consider the jth factor ($j < t$ and also $j < N$, the number of cases) having the variance v_j. What is the probability that this value v_j is a chance deviate from zero? The standard

deviation of v_j helps us not a particle, for the distribution of v_j is skewed, with zero as the lower limit. In other words, there is no probability whatever that the observed value v_j is in truth a chance deviate from a true value of zero. With utter certainty we can assert that the true value of the variance of the jth factor is greater than zero. The authors seem to fail to realize this. If by "insignificant" is meant "not very large," their conclusions are probably sound, but such a meaning would be taking undue liberties with a mathematical concept. In their introduction the authors illustrate the breadth of the field—economics, business, physics, *etc.*—to which factor-analysis methods apply. They have rendered a service in making it very clear that the purposes and the methods of factorial analysis are not limited to a clique of self-centered psychologists working on hypothetical problems in a narrow field of human life. In connection with *a priori* postulations the authors refer to the uni-factor form (one in which each test measures one and only one factor) as the ideal form. The factor analyst starts with material whose complexity and dimensions he does not know (for, if he does know them, there is no problem), and he should obtain new information as to this complexity and dimensionality. If with this added information he can now construct new tests which are in truth uni-factor measures, he has obtained the final utilitarian goal. To postulate these uni-factors at the start of the investigation denies the virginity of the data. The uni-factor form as an end product does in truth seem ideal, but as an initial postulation it may well be vicious. The first mathematical appendix, which contains a treatment of matrices, is a well-selected and happy minimum for the student of factor analysis. The general tone of the book is admirable. No difficulties which the authors sense are glossed over. There are a fine appreciation of different points of view and a careful presentation of them. The book seems to the reviewer to be an important steppingstone to the as yet unattained goals of factor analysis.

Sci 95:504–7 My 15 '42. Harold Hotelling.

* to identify....fundamental "factors," to specify them as definite functions of the test scores, and, above all, to give them names, requires something on which different workers have not been able to agree. A large number of schemes for the statistical treatment of such problems has been proposed. The volume now at hand is a compendium of most of them, with a good account of their bases and mutual relations, including the rotations of axes involved in getting from one to another. The introductory chapter includes an excellent discussion of certain relevant phases of scientific method in general. Matrix algebra and n-dimensional geometry are essential in this subject, and the reader is provided with introductions to these and some other mathematical topics in special sections. An extraordinarily clear elementary treatment is given of rotations in n dimensions. Correlated as well as uncorrelated sets of "factors" are discussed, there is a chapter on the estimation of the values of the factors for individuals in terms of their test scores, and some essential indeterminacies in the problem are duly indicated. There is an appropriate emphasis on the criterion of "parsimony," that is, on the desirability of using the smallest possible number of variates to describe a phenomenon. However, this criterion is apparently overlooked in the preference shown for types of solution involving not only general factors common to several tests or all of them, but also individual factors specific to each test and not entering into any other. Thus the whole number of factors used is actually greater than the number of tests, though the original object was to represent a large number of tests by a small number of factors. This subject of "factor analysis" has received much attention from psychologists in recent years, and is altogether fascinating. Its potential applications go far beyond the domain of . . . . It is in fact a branch of the theory of multivariate statistical analysis, which is in turn a branch of the theory of statistics, and has applications in the most diverse fields in both natural and social sciences. Unfortunately, this logical position has frequently been overlooked by workers in factor analysis, who have treated it as a branch of psychology, and have therefore not thought it necessary or worth while to keep in touch with the rapid advances that have been taking place in multivariate analysis and in general statistical theory. The result is that factor analysis, after a brilliant start years ago, has come to be surrounded by an aura of obsolescent statistical methods, concepts and terminology. Its isolation from the main body of statistical theory has left factor analysis in a state which can not exactly be described as stagnation, since there is so much activity, but also can not be regarded as

wholly healthy. The work of R. A. Fisher on the theory of estimation, and that of J. Neyman and E. S. Pearson on testing hypotheses, have rendered obsolete the criteria for selection of a statistics used in most textbooks on statistics and by most factor analysts. The sampling distribution appears instead as the fundamental basis from which must be derived the choice of a statistic and the method of testing a hypothesis, governing the whole investigation from start to finish. Factor analysis persists in the old habit of regarding sampling distributions as luxuries to be considered after everything else is done, if at all. Modern statistical theory aims at getting exact sampling distributions, sometimes succeeds and, in case of failure, examines a variety of approximations with a clear consciousness of the distribution that is to be approximated. In this whole comprehensive treatise on factor analysis there is not one exact sampling distribution, nor any more modern basis for the sampling theory than the Pearson-Filon paper of 1898. Criteria such as those of maximum likelihood, minimum variance and uniformly most powerful tests lead modern statistical theory to recommend as the bases of calculation functions found by applying the methods of the calculus to the determination of maxima and minima of well-defined functions of the observations. Something of this concern with maxima and minima appears in factor analysis, but is much obscured by the injection of hypothetical "communalities" and the like into the data in such a way as to vitiate accurate statistical discrimination between rival hypotheses. One bit of fallacious reasoning seems in the past to have affected a good deal of thinking about factor analysis and multivariate statistical theory in general, and to have given the subject a directive impulse that still persists. If p measurements are made on each of N individuals drawn from a normally distributed population at random, and are plotted as coordinates of N points in p dimensions, the swarm of points tends to have a sort of ellipsoidal shape. If $p=3$, for example, the typical ellipsoid along which the density of probability for these points is a constant may have any shape from that of a sphere to that of a pancake or a needle. In the last cases the distribution may be thought of as approximating a distribution in two dimensions or one. The problem has therefore been propounded more than once of finding a sampling distribution for testing by means of a sample the hypothesis that the distribution is really of fewer dimensions than the number p of variates measured. Such efforts are completely futile. If all the points of a population on which three variates are measured lie in a plane, then every sample from this population lies in the same plane. Conversely, if a sample of more than three points is coplanar, we may conclude that the population is coplanar because in the contrary case the probability of coplanarity of the sample would be zero. Hence there is no problem of a sampling distribution here. But factor analysts have written as though they thought that the deviations of actual observations from the values they compute on hypotheses of smaller dimensionalities could be ascribed to sampling errors. A dubious passage on pages 21–22 of the current volume is perhaps in this category, though another interpretation may also be possible. The reasoning in this passage is, on either interpretation, unsatisfactory. When it is realized that no deviations from coplanarity, however small, can be explained as sampling fluctuations, it is necessary for the factor analyst determined to represent a number of variates by a smaller number of factors to find some other yardstick for these deviations. One such yardstick, which I suggested in 1933, is provided by the errors of measurement estimated by the reliability coefficients of the tests. Many psychologists, however, have felt that to judge hypotheses by a comparison of the main effect considered with mere errors of measurement is too much like letting the tail wag the dog, and have not used this standard. In order to explain the manifest fact that the dimensionality of the set of observations is actually the number of variates, and no less, they have resorted to highly unsatisfactory "communalities" associated with "specific factors" whose existence does not seem particularly clear on *a priori* grounds, and which is not tested by the statistical methods used. Another possible yardstick which I also suggested in 1933 is in a theory of the variates themselves as a random sample of a hypothetical aggregate of variates endowed with a probability distribution. This theory has not been developed since then, though it must be essential to the vital problem of finding factors that shall in some sense be invariant when the set of tests used is replaced by a new set. This last question is mentioned, far too briefly, on pages 107–8 of the present volume. On page 112 a solution is

obtained for the coefficients of a general factor in terms of the observed correlations. This appears to be only one of infinitely many solutions of this problem, all satisfying what Fisher calls the criterion of consistency. It provides for the coefficient a statistic that is a function of all the observed correlation coefficients, and in this sense uses all the information in the sample; but it is not clear that it uses all the information in the sample in Fisher's sense of having minimum standard error. Once this problem of obtaining a consistent statistic with minimum standard error is understood, its solution should not be outside the range of reasonably possible straightforward mathematical research; and it is just possible that the solution might turn out to be that given. A related point is that the "least square" criterion on page 115 might well be replaced by minimizing another quadratic form whose matrix is the inverse of the covariance matrix of the triads. The achievements of factor analysis so far seem to be in the nature of promise, and of challenge to further research in mathematical statistics. Complete methods have not yet been achieved which can be recommended to workers in the empirical sciences without reservation, or with the expectation that they will permanently be regarded as the best possible. Empirical problems, especially in psychology and neighboring fields, will certainly play a part in shaping the direction of research necessary to put the required methods into final form. But the research will necessarily be a matter of mathematical statistics, for which no combination of psychology and matrix algebra, even with the addition of the other subjects conventionally taught in university mathematics departments, can be adequate unless the progress already made in mathematical statistics itself is utilized.

Social Forces 21:118 O '42. Margaret Jarman Hagood. * a sociologist should not bother with this book unless he is going to have considerable time to study it through carefully. On the other hand, no sociologist whose research involves considerable quantitative analysis can any longer afford to remain ignorant of the developments made by the factor analysts. And no other existing book offers such systematic treatment and exposition of this most important area of recent development in statistics. Traces of the psychological controversies which accompanied the birth and infancy of factor analysis remain in this book, but on the whole, the authors seem to have tried hard to free the several methods presented from such bases of evaluation. Sociologists will find little guidance in the application of the methods expounded to their own problems. But once they have mastered them, they should have no trouble in seeing many areas for profitable exploration with the newly acquired techniques. Such work must necessarily precede a final judgment on the utility of factor analysis in sociological research, but at present there is no evidence that it should not supply as fruitful a tool for sociology as it has for psychology. Therefore, the book offers a challenge to the more adventurous in method, a challenge, however, that will be met only by the more industrious.

[169]

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[177]

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[178]

★JEFFREYS, HAROLD. **Theory of Probability, Second Edition.** London and New York: Oxford University Press, 1948. Pp. viii, 411. 30s.; $9.00. *

Biometrika 36:236 Je '49. F. N. David. * On reading the book one cannot help being sharply aware of the breadth of reading and the width of scientific knowledge which is the author's, but the reviewer, at any rate, remains unrepentantly unconvinced by the subject-matter. Prof. Jeffreys' approach to the theory of probability....may be summed up by quoting the idea so often expressed in this book—"no probability is simply a frequency." This is a perfectly legitimate point of view, even if it is not shared by many whose business in life is the provision of an objective criterion in the shape of a probability figure which is to serve as a guide for future action on the part of others. In practice, the writer suspects, Prof. Jeffreys would calculate a probability in the same way as other persons who follow (say) the frequency approach to the subject, but in theory it would be possible for two persons following Jeffreys to obtain different values for the same probability. For the author writes: "Our main postulates are the existence of unique reasonable degrees of belief, which can be put in a definite order." It does not seem possible so to standardize degrees of belief that the order will be the same for each and every person, and it would appear therefore that the uniqueness can really only apply to the single person. Actually the calculation and interpretation of a probability is a compound process. By some objective standards a numerical figure is reached, and should be reached, by a logical process which in its application leads all persons to the same conclusion. It is in the interpretation of this numerical figure that the subjective factor will enter, the final judgement being the result of a complexity of impressions in the interpreter's mind, varying from his psychological make-up to the consequences involved by the taking of a wrong decision. For each person this interpretation must inevitably be different. Prof. Jeffreys writes at length both on theories of testing hypotheses and of estimation. His ideas on the Neyman-Pearson concept of a power-function seem a little hazy, but much of what he has to say is both pertinent and interesting. It is, however, a little disconcerting to be told by the foremost exponent of inverse probability and the applications of Bayes's theorem that there is general agreement between himself and Prof. R. A. Fisher. Many of us first disentangled ourselves from Bayes with the help of R. A. Fisher's papers on inverse probability—I think in particular of "Uncertain Inference" (*Proc. Amer. Acad. Arts Sci.* 1936)—and are inclined to find relevant the remark and the quotation made by Coolidge: "We use Bayes's formula with a sigh, as the only thing available under the circumstances: 'Steyning tuk him for the reason the thief tuk the hot stove—bekaze there was nothing else that season.' " But it may be that until the statistical theory of estimation is placed on more secure foundations, the battle of Bayes will have to be fought by each generation. This book is not suitable for students starting to read probability and statistics. It may profitably be read by those of some maturity, for Prof. Jeffreys's ideas and examples will materially help in the interpretation of statistical theory no matter what school of probability the reader favours.

J Am Stat Assn 44:453 S '49. Herbert Robbins. * The whole theory, based on Bayes's principle of inverse probability, lies entirely outside the modern development of statistical inference in the work of Neyman, E. S. Pearson, and Wald. Its relation to Fisher's work is more obscure; according to Jeffreys his results are in general agreement with Fisher's, although the underlying reasoning is not always the same. Perhaps the most striking feature of Jeffreys' work is that his methods for testing hypotheses or estimating parameters take no account of the cost to the experimenter of accepting a false hypothesis or using an er-

roneous estimate. For example, a null hypothesis is to be rejected when the ratio of its posterior probability to that of the composite alternative is too small, the prior probabilities being determined by a set of conventions into which the cost of making errors does not enter. This procedure, which is based on an axiomatic concept of probability that has nothing to do with relative frequency, is not supported by any operational justification. Within Jeffreys' theory one cannot ask, let alone answer, whether the procedures are better or worse as operating rules than others which might be put forward as alternatives. This was indeed the situation in statistical inference thirty odd years ago. Whatever one's views on the foundations of statistical inference, one cannot fail to profit by the mathematical ingenuity, keen physical intuition, and common sense which Jeffreys brings to bear on a wide variety of practical problems. Statistical theory will continue in large measure to find the inspiration and motivation for its real advances in the practice of the best statisticians. The appearance of the second edition of a book as provocative and rich in content as Jeffreys' *Theory of Probability* is a welcome event.

Math Gazette 32:304 D '48. M. G. Kendall. Mathematicians who learnt their theory of probability from textbooks of algebra or Whitworth's *Choice and Chance,* and those who have followed up with a reading of the work of modern probabilistes (the French have a word for them) will find little that is familiar in Professor Jeffreys' book. Jeffreys, in fact, is an applied mathematician in the best sense; he is not interested in doing pure mathematics disguised in an "applied" language, but in developing an exact theory of induction with the help of mathematics. The present book is an extension and continuation of the author's *Scientific Inference,* and is one of the most remarkable works on probability since Laplace's *Théorie Analytique,* a masterly piece of constructive scientific thinking which no student of the theory of probability, or of scientific thought in general, can afford to omit from his reading. * His theory of induction is based on an extensive use of Bayes' theorem and the so-called "inverse" probability. To make full use of them he has to develop a treatment of prior probabilities which does not, it is necessary to warn the reader, command universal assent. A few years ago this would have been putting it mildly; few scientific topics are subject to such differences of opinion and such heated controversy as inverse probability. But the dust of conflict is settling and there are hopeful signs that the various viewpoints, if not reconcilable, are at least understood. With one or two exceptions they all lead to the same code of conduct in making inferences from statistical data. This is a standard work, unique of its kind. Even the purest of mathematicians will derive pleasure and profit from it, for it deals with the mathematics of thought itself.

Nature 163:464–5 Mr 26 '49. David G. Kendall. * To many to-day it appears that the classical "calculus of probabilities" needs to be separated into two quite distinct components: (1) *The theory of uncertain inference.* This may be described as an extension of traditional logic; in it a probability-number is a numerical measure of the degree of "reasonable" belief in some proposition, in relation to a given body of evidence. One role of the theory is the provision of a critique of the whole of natural philosophy, and in particular it is relevant whenever a mathematical model is selected for the description of some physical or biological situation, and also whenever a "prediction" made with the aid of such a model is to be interpreted in relation to one's belief about the real world. (2) ***The theory of chance phenomena.*** Not all empirical situations can be appropriately described by mathematical theories of the deterministic type used, for example, in classical mechanics, and sometimes it appears more appropriate to employ a mathematical model involving the notions of random variable and random process. Here a probability-number between 0 and 1 is an ideal element of the model which corresponds in the "real" world to the value which an observed frequency-ratio appears to be approaching as the number of trials is increased, while a probability-number equal to 0 or to 1 corresponds to "practical" impossibility, or certainty, respectively. It is these two "conventions of interpretation" which are used to relate a particular model of this kind to the corresponding empirical situation. The decision to construct such a model for a particular situation will, of course, only be made if the observed frequency-ratios do appear to approach stable values. Accordingly, the fact that the model itself admits a representation of an infinite sequence of trials raises an important question of consistency which is answered satisfactorily by the theorem known as "the ***strong***

law of large numbers." It follows, if this analysis be accepted, that the theories (1) and (2) should be developed independently; and that (2) shares with every other branch of natural philosophy its relationship to (1). Moreover, (2) will retain its significance even for those who reject some particular (or every) attempt to give a rigid form to (1). Prof. Jeffreys has provided us with a theory of inference; but he appears to refuse to the mathematical theory of chance phenomena an independent status. This seems to me unfortunate, especially as (2) is more important to the man of science than (1) if he is content to make the inferences relating theory to practice in a manner at once more personal and less formal than that advocated in the work under review. It might be held that while the notion of chance appears to be an essential element in our description of the world, it is really a reflexion of our own ignorance. If this view is correct, the theory (2) must have its place within the framework of (1); but it would presumably still retain a self-contained validity as a mathematical description of what is observed. Epistemology is likely to lag behind the descriptive achievements of natural philosophy, and accordingly the independent development of a theory of chance phenomena would still seem to be worth while. Prof. Jeffreys, however, will have none of this, for he remarks that "the essence of the present theory is that no probability, direct, prior, or posterior, is simply a frequency." Of the new features of the second edition of this book, the most interesting is the author's account of his "theory of invariance." The aim of this is the provision of a universal basis for the formal description of ignorance needed in the treatment of the problem of estimation by the methods of inverse probability. * An extension....to multi-parameter problems is given, but Prof. Jeffreys stresses the need for further investigation. It seems likely that the methods he has introduced here will also suggest interesting developments in other approaches to the problem of estimation * The book concludes with a number of new tables * The first edition contained a very useful appendix on the properties of the factorial (that is, gamma) function; this has been omitted, but an equivalent account has been published separately (in "Methods of Mathematical Physics"). Only to those few who are not familiar with the 1939 edition need it be said that this is a profoundly interesting book of the greatest originality. No one who is seriously interested in the subject can afford not to read it.

Sci Progress 37:348–9 Ap '49. E. S. P(earson). [Not excerpted because of copyright restrictions.]

For reviews of the first edition, see 2:163.

[179]

★JENKINSON, BRUCE L. **Bureau of the Census Manual of Tabular Presentation: An Outline of Theory and Practice in the Presentation of Statistical Data in Tables for Publication.** Washington, D.C.: Government Printing Office, 1949. Pp. xiv, 266. $1.50. *

Am J Sociol 56:128 Jl '50. Ethel Shanas. * should be useful to all persons....who are responsible for the preparation and design of tables. Students who are learning table design may be referred to it for a sensible and clear statement of the function of tables, the rationale of table headings, etc. The author and those persons on the Bureau policy level responsible for it are to be commended for the plan of its publication and the clarity of presentation.

Am Sociol R 15:150–1 F '50. Richard A. Hornseth. * the first reference manual which presents an adequate display and explanation of "good usage" in the preparation of tables for either letterpress or typewriter-offset publication * An important implication of this volume is that table construction cannot be reduced to a few general principles. It requires, instead, a special extension of typographical skills. It is for this reason that earlier manuals which have tended to stress a few principles have been ineffective in improving table form. Style or good usage, as Jenkinson points out, is the set of cues for "normal expectation" on the part of the reader. These cues are still in flux at present because the table is a relatively new form of communication. It is gratifying to see that the Bureau of the Census realizes its power and responsibility to mold table style and sets out to do this with a determined application of intelligence and typographical knowledge. The manual is written in a too elaborate reference style for the casual reader to follow easily. The variety of type sizes and faces, indents, reference numbers, etc., makes the manual a typographical feat in itself. It is surprising, however, that only five misprints could be found. The author is not consistent in the phrasing immediately following the paragraph headings: usually it is a sentence, but sometimes it is a parenthetical phrase, and the reader hunts for

the verb in vain. Those who construct tables for publication will find this manual indispensable because it provides unambiguous guides necessary for good form in every detail of the table. Those who use Census tables will esteem this manual for its instructive explanation of the mysteries of Census table form.

J Am Stat Assn 45:292–4 Je '50. Ray Ovid Hall. The Bureau of the Census turns out tables, as all know, by assembly line methods. * Its staff being the world's most prolific designers and editors of tables, its own official manual of tabular presentation is high authority indeed—a must for all statistical libraries and nearly all statisticians. This large manual is most complete of all in its rich terminology. Even a veteran statistician looking through its fine index will be stumped by such typographical terms for table-parts as: bearoff, read-in, undercut spanner, panel, contracting brace, nonprime column, quasi-banner head, broad-divide table. There are illustrations of more structural-types of table than anyone can easily recall, each with a name. All these Census terms might well be accepted as authoritative, if only as a shortcut to uniform terminology. * There is plenty to quibble about in any manual so detailed on subject-matter so elastic. Thus, p. 73, "No period should appear at the end of the headnote even though the last statement is a complete sentence." That rule has long prevailed in the *Statistical Abstract,* but is it inspired? Again, p. 70, "Headnotes should be used when they are essential to understanding, not otherwise." For sounder guidance I still commend rather seriously a quotation in my *Handbook of Tabular Presentation,* p. 5, "If it has no scale of miles, it is no map; no date, no clipping; and no headnote, no statistical table." There are exceptions but let each bear its own burden of proof. Bad headnoting on the Washington scene is commoner even than bad titling. Yet this manual carries only six pages on headnotes, with only three lines (p. 70) on the duty of table builders to warn table users against "limitations of data." Worse, there is nothing at all on the need for long textual statements preceding most tabular series, to describe the reporting system and to inventory religiously its defects in planning, coverage, and reliability of returns. What reporting system ever was there with no defects? The matter of frankly reporting them, in headnotes or general statements, is not one of tabular form; it is an ethical imperative. Scientific attitude permits no posturing over faulty or dubious results. Perhaps ten Federal agencies, more table-conscious than the rest, have their own pamphlet manuals on tabular presentation, with illustrative tables. Many of these supposedly model tables emerge from systematic scrutiny, amusingly enough, as anything but model. Two were poor enough to be reproduced in my *Handbook,* pp. 101–102, with other inferior tables, as problems in tabular editing. How now are the model tables in this *Census Manual?* Following are thumbnail critiques of the four least satisfactory ones:

P. 14, top: This tiny table of only 16 lines could be improved in nine ways, mostly important. All its figures pertain to "Consumption;" that term belongs hence in title or headnote, not in column heads. All figures are in cords; say this, not in column heads, but in parens above the top horizontal ruling. Stub needs arraying by magnitude. Put subtotals in italics. Put a space break (blank horizontal line) after the "hardwoods" group. Insert column for Net Change. Put the 1944 column to the right of that for 1943. There is spurious accuracy in carrying these measurements to units; round-off to thousands, though still spurious probably. Addends do not equal subtotal for "hardwoods"—an arithmetical discrepancy. P. 17, top: Stub lists of classes of public expenditure: array by magnitude. Pp. 18–19: Columns list lines of business; array. In the former, first column, another arithmetic error. Pp. 20–21: This long employment table lists alphabetically hundreds of industries—with absurd sequences like "belts, biscuits, and blast furnaces." Stub should group related industries and provide for subtotals; fluctuations in subtotals could be highly enlightening. Insert a stub line for GRAND TOTAL. Group-spacing of stub, space breaks, at two points would improve horizontal legibility.

Indispensable as this long manual is for reference, in the Census Bureau or wherever, it rates low as a teaching aid. Principles and purposes are mired in swamps of detail. The book is too long for use in a general course on statistics, which can spare only a few lectures on tables. Good table building is best taught by working with bad tables, revising and revising. There is happily no shortage in these teaching aids; slapdab tables abound in the annual reports of most Federal agencies. This tremendously laborious and highly useful treatise is edited unevenly. Most paragraphs are exemplary in their clarity and terseness, but the dear old bureaucratic gobbledygook is there, too—as on pp. ix and 67. Another defect is that much of the text is in print too small for easy reading.

[180]

★JESSEN, RAYMOND J. **Statistical Investigation of a Sample Survey for Obtaining Farm Facts.** Iowa

State College of Agriculture and Mechanic Arts, Agricultural Experiment Station, Research Bulletin 304. Ames, Iowa: the Station, June 1942. Pp. 104. Paper. Gratis. *

[181]

★JOHNSON, N. L., AND TETLEY, H. **Statistics: An Intermediate Text Book, Vol. I.** London: Cambridge University Press, 1949. Pp. xii, 294. 20*s*. (New York: Cambridge University Press, 1950. $4.00.) *

J Royal Stat Soc 113:250–1 pt 2 '50. S(tefan) V(ajda). * It is for the actuarial bodies to decide what they wish to include in their syllabus, and in this event the selection appears fair enough. It is reasonable to start off with statistics which young actuaries know from their daily work and to show how a maximum of information can be extracted from them. This is well done, even if some readers will find the replacement of the colour of balls in a box by the sex of randomly selected babies of spurious realism. (Incidentally it begs the question whether the sex ratio is, in fact, a probability.) The authors have set out to write a text-book, not a manual, and they are pleasantly unselfconscious about it. Their frequency theory of probability is not over-critical, but it is sufficient for their purpose. Occasionally, perhaps, better ways to the student's understanding could have been found. Is it not confusing to find the regression line of y on x derived in two steps, using least squares only in the second instance, whilst for the regression of x on y both constants are derived by the latter and more natural method (pp. 93–4)? The statement on p. 108, that the correlation coefficient is only zero when "the average value of y for *every* value of x is y" is incorrect. On p. 96 the authors point out that the correlation coefficient reflects a change of the scales used for the variables "while the correlation is, of course, the same as before." Surely that depends on the precise definition of correlation and there is no matter of course about it. This and other similar slips appear to have been transferred from an earlier and less satisfactory book written by one of the authors; it is hoped that such traces of the earlier book will be removed from later editions. The arrangement of the book is sometimes puzzling. The reviewer does not understand why the authors wish section 18 of Chapter 6 to be read not where it stands, but only when "the next chapter has been mastered." Chapter 9, on "Statistical Hypotheses," includes a section on "Estimation," which deals only with confidence limits. Chapter 10, "Simple Statistical Tests," has a first section on time series which looks rather out of place and is apt to lead the student who reads on to think that these must have something to do with tests of quality control. Incidentally, all these tests are based on a normal sampling distribution, with a note on their merely approximate validity. Finally, a few words may be allowed concerning the exercises at the end of the chapters. They are on the whole well chosen, including also material from actuarial examination papers; some questions, however, seem to have been thrown in, rather carelessly, for full measure. Exercise 9.6, for instance, asks for a comparison between confidence limits and limits based on posterior probability. Surely this is far beyond the knowledge of readers who have not looked into a wide range of statistical books. Again, exercise 9.11 quotes a formula for the confidence limits of the "population expected value," and goes on to ask: "would you expect this formula to be reasonably useful for non-normal populations?" Only mature statisticians should tackle such a question, unless the word "reasonably" makes it a leading question and hence prejudices its value as an exercise (and as an examination question as well, for that matter). In judging the book it must be remembered that it forms part of a series of text-books and had to be fitted into a larger frame. The second volume will show how determined the authors are to follow the road of modern statistics as opposed to makeshifts so popular in some fields of applied science. The present volume augurs well and can unreservedly be recommended to many more readers than actuarial apprentices. A great amount of solid work has gone into its writing and even experienced readers will find pleasure in glancing through the more discursive paragraphs, which contain a good deal of sound, convincing common sense.

Nature 166:367 S 2 '50. D. V. Lindley. * The text is well written, and, in particular, the notion of a statistical test is made very clear, though perhaps estimation is too briefly discussed. The exercises are, in general, too difficult, even when some hints and answers are given. The actuarial student will probably be well served by this book. It is difficult to say how well other classes will appreciate the book until we see the second volume. At the moment, the omission of small-sample theory and the preoccupation with some matters make the

work less interesting than it might have been.

[182]

★JOHNSON, PALMER O. **Statistical Methods in Research.** New York: Prentice-Hall, Inc., 1949. Pp. xvii, 377. Text edition, $5.00; trade edition, $6 65. *

Am J Psychol 63:472–5 Jl '50. Josef Brožek. * With Professor Fisher the author spent some time at the Galton Laboratory and profited while in England from close association with Egon S. Pearson and Jerzy Neyman. These stimulating contacts brought Johnson into the very midst of the creative phase of modern statistics. It is fortunate, however, that "His Master's Voice" is reflected more in the content than in the tenor of this exposition. Fisher's *Methods* is perhaps the most influential but certainly one of the least readable of statistical treatises. Johnson strives with greater effort and more success to achieve a clarity of thought. Yet Fisherian passages are not wholly absent. * The illustrative material....is drawn predominantly from the field of education, with some examples from psychology. * It would be a service to the prospective buyer and reader if the field of application had been specified in the title. The opening section....develops the theme of "statistical methods in science and technology." The material is instructive, but the argument lacks coherence. It would have been more logical to start with the general concepts involved in the collection and statistical treatment of data (statistics in the framework of the method of scientific inquiry), and then to indicate the interplay between individual scientific disciplines and statistical theory and practice. Problems of sampling, controlled experimentation, determination and evaluation of the error of measurement, analysis of experimental data, and drawing conclusion (brought into a chapter on statistical aspects of psychological research), are by no means peculiar to psychology. The reader must laboriously piece together an integrated picture of the historical development of statistics, conceived initially as a method of bringing together empirical facts describing the condition of society but becoming in time an essential component of experimental research and an instrument of scientific theory. * emphasis is on a critical use of statistical methods, with three requisites: choose an appropriate statistical tool, be aware of the assumptions, and test the assumptions * economy of scientific work demands that the meaning of symbols be well defined and consistently used. In statistics the situation is distressingly chaotic. * The definition of the degrees of freedom, in the development of the formula for testing the significance of the differences between group-means by means-of-analysis-of-variance, is likely to prove unsatisfactory for many a user of the text. The degrees of freedom for "between-schools mean square" are indicated by r, for "within school means square" by N-q. N is the total number of individuals. The symbols r and q have no direct relation to the material under study and thus lack the real power of symbols. The respective degrees of freedom are indicated (p. 218) as (p-1) and p (n-1). The changing symbolism obviously affects in no way the logic of the argument. It does not add to the didactic value of the book. The work seems to be singularly free of computational errors. * Occasionally an error does creep in and is apt to be disturbing to the reader. Thus the sign of the value g_{25}, an auxiliary statistic in regression analysis, has a positive sign (p. 336f.), while the sign of its equivalent g_{52} is both negative (p. 334) and positive (p. 337). The values should be negative throughout. Among omissions, the most serious is the absence of an exposition and application of the theory of analyzing a variance (a mean of squared deviations) into its components. Some authors consider this to be the very core of the analysis of variance. Brownlee in his *Industrial Experimentation* (1948) has shown that the concept may be made understandable and helpful even in an elementary treatment of statistical methods. In factorial experiments the sequence of the tests of significance is indicated by the estimation equations. In this connection the reviewer would like to point out that Johnson's example illustrating factorial experiments is unnecessarily complex. It will repulse rather than attract students to this important type of experimental design. The preceding critical comments should not obscure the reviewer's overall endorsement of Johnson's *Methods.* It is a thoughtful book and a valuable addition to the large textbook literature on statistics in psychology and education. In intent, approach and presentation, Johnson's volume finds its nearest relative in McNemar's *Psychological Statistics* (1949). It is more advanced and more complete. Where McNemar brings the student to the point of computing the multiple correlation coefficient, Johnson describes in detail the steps

for omitting those prediction variables, one at a time, whose partial regression coefficients are not statistically different from zero.

J Am Stat Assn 44:570–2 D '49. Frederick Mosteller. A great many people have probably been intending to write a modern statistical textbook similar to Johnson's. The notion is to write a rather advanced book suitable for students in education and psychology, suitable in the sense that the emphasis shall not be on the mathematics, but upon methods which are useful in research problems the students will face. People intending to write such a book now have two alternatives: they can either relax and forget about it, or they can raise their sights a good deal higher than they needed to before the publication of Johnson's book. The arrangement of the material resembles that of a handbook, which is rather appropriate in view of the title. This arrangement will facilitate use of this book by active research people who will find the form very convenient. The table of contents is helpful in this connection. The index looks impressive, but the only thing I looked for I was unable to find (see below). The methods used are described carefully, but succinctly, and illustrated by worked-out problems on real data. Methods given are heavily referenced and every effort is made to send the student to original sources. I do not have much hope that students will go to the sources, but do believe that teachers will be grateful for the references because not all who will want to use this book will be prepared to teach from it. This book can be enhanced by instructors able to expand on the material presented. The first 200 pages could easily be inflated to 400 with no padding. * The book opens with a much better than usual discussion of the realm of statistics. To the discussion of general uses of statistics in economic research I would add the possibility of statistical or probability models. In the chapter on probability and likelihood the author is not especially careful about distinguishing between the notions of a probability limit (p. 20) and the usual concept of limit. * [With regards to] testing differences in percentages using *t*....a footnote on page 81 which bothers me....—"The χ^2 test is an exact test for this problem." If no correction is made for continuity the stated formula is equivalent to χ^2, but neither test can be regarded as exact as I see the matter. * The analysis of variance examples are carried out in detail, one example running through 14 pages. The discussion is better than most such. Not enough emphasis is put on the meaning and interpretation of interactions, not enough is said about the limitations of the methods. I doubt that educators are always interested in such questions as: Are the mean achievements of students in the three grades equal, or are the school means on the reading test equal? This is not so much a shortcoming of the book, but a shortcoming of the method as it is now available. This author does give with no heading, and no reference in the index that I can find, Fisher's method for comparing two particular means selected from a set (p. 234). Perhaps the best thing to say is that Prentice-Hall's advertisement for this book is correct in all particulars—except one, I doubt if the author did research with F. A. Fisher (*sic*), although the influence of R. A. is clear.

J Ed Psychol 41:249–51 Ap '50. Jerome E. Doppelt. * Those who are particularly interested in psychology and in education will be pleased to note in the preface that "the book... was developed...primarily for graduate students in education and in psychology." It is also reassuring to find on page 14 the statement that the book "is written for readers without specialized mathematical training." But despite these statements and the fact that *Statistical Methods in Research* is a scholarly work which includes a considerable number of illustrative applications of principles, it is generally not suitable as a text for graduate students in psychology and education. * [Chapter VII], given over to the statistical analysis of data under non-normal assumptions, should be of particular interest to those concerned with data which consist of rankings. Chapter IX is a very good discussion of the various kinds of sampling systems and the types of errors that may be encountered in investigation by sample. * Chapter XII, on the principles of experimentation, is a clear discussion of the self-contained experiment and of the rôle of statistics in the design of experiments. * Although the major topics are presented in logical order, some questions may be raised about the placement and emphasis of sub-topics. Yates' correction for continuity in connection with chi-square is noted very briefly and the reader is referred to a reference. Since this correction is frequently called for in psychological experiments, it is unfortunate that more space is not devoted to it. On the other hand, three tests of homo-

geneity of variability are described and illustrated when one method would seem sufficient. Degrees of freedom are mentioned a number of times in the first five chapters but the concept is not explained until the close of Chapter VI. The analysis of covariance is briefly defined and the problem illustrating its application is much too complex to clarify the use of the method. But these criticisms are relatively minor when compared with the general comment that the book is extremely difficult reading. Psychology and education students who have had no more than one year or one course in descriptive statistics will generally find that they are beyond their depth throughout large portions of the text. Calculus is rather infrequently used but there is great stress on the mathematical formulation and development of statistical concepts. The style in many places is similar to that of highly technical journals. In a book of reasonable size, this style is perhaps unavoidable when the presentation has been based on original and secondary sources of mathematical statistics. But it limits the use of the book to those readers who have a solid foundation in mathematics or to those who have had considerable prior statistical training. It is the reviewer's opinion that *Statistical Methods in Research* will be found most useful as a reference text or as a course text for those with a major interest in statistics. For most graduate students of psychology and education the book would be of very limited value.

J Ed Res 43:309–11 D '49. Arthur J. Riopelle and Lowell M. Schipper. * The first chapter requires 13 pages to convince the student that statistics are important in daily life, science, art and history. Subsequent treatment are less lengthy. For example, in Chapter II (12 pages) among other topics are mentioned: statistical models, interpretation of probability (including Bernoulli's theorem), mathematical expectation, the addition and multiplication law, maximum likelihood, and the binomial, Poisson, and normal distributions. * The direct approach to functions involves a spotty and incomplete treatment of the statistics. Such is Johnson's difficulty. For example (p. 43), t is defined only by an equation. * The tendency to be brief to the point of sacrificing completeness is manifest throughout the book. The following will serve as illustrations. In testing the significance of the difference between the means when the variances are unequal or unknown, homogeneity of the sample variances is tested by the F test, yet no mention is made that this is the two-tailed test. One paragraph (p. 105) is devoted to a discussion of efficiency, consistency, and sufficiency as criteria of good estimates. No mention is made of the desirability of freedom from bias in estimates. When the topic of bias is discussed (p. 188) clear cut distinctions between biased samples, biased estimates, and consistency of estimate cannot be found. On page 281 it is stated flatly that "Replication is the sole source of the estimate of error." Yet on page 290, the first example given, and without explanation, we find that the error estimate is the interaction terms. Yates' correction for continuity is dismissed in one sentence (p. 94). We made no attempt to check on all computations but noted, pp. 39, 40, that the values for the number of standard deviations by which the estimates deviate from the true value are in error. Also, the critical value for $F_{.05}$ which is incorrect should be $F_{.025}$ (p. 82). Fundamentally, our criticism is that the instructor who uses this book as a text will be required to "explain the text" more than he may feel is necessary or desirable for students at this second course level. There are many admirable qualities to this book. The inclusion of a section on non-normal data and their treatments is certainly much needed. Small sections on the sign test, Welch's modification of the Neyman-Pearson L_1 test of homogeneity of variance, and others (indeed, the *routine* testing of homogeneity of variance in the illustrative problems should impress the student with its importance). In addition, sections on the interrelationships between t, F, χ^2, and normal distributions operating characteristics, sequential analysis and other topics clearly indicate an honest attempt to make available the more recent advances in statistical theory and practice. The importance of analysis of variance and covariance in educational and psychological research is made clear in the approximately 110 pages devoted to the topics. The development is difficult and leans heavily upon partial differentiation, but is worth the time spent. The list of additional readings at the end of each chapter is well worth examination by the student and researcher. The references point to further treatments of the topics discussed as well as some not discussed. The research worker who does not have sufficient mathematical background to follow original sources

will welcome this book and its generally careful exposition of the procedures of statistical tests, especially those developed within the last decade or two. The topics covered in this text are sufficiently important as to provide the basis for a well-rounded advanced course in psychological and educational statistics.

J Marketing 14:627–8 Ja '50. Harry V. Roberts. * certainly the reader with reasonable competence in college algebra and the ability to "read" complicated symbolic expressions should have no trouble in following most of the mathematical developments used in the book * One of Professor Johnson's most interesting innovations is the advocacy and illustration of multiple-criterion analyses of variance. The traditional approach is to illustrate a two-criterion problem and state that the extension is obvious. Johnson gives an illustration, complete with computational details, of a five-criterion analysis! * Johnson has obviously done a great deal of practical work and has explored deeply into statistical theory. The list of statistical applications given in the book is unusually extensive and includes many recent developments. In addition to applications treated in detail, many others—such as quality control and area sampling—are mentioned briefly. For the most part the treatment of both theory and applications is relatively advanced. * The difficulty of the problems given at the end of the chapters is sufficient indication that the author presupposes relatively mature students. The book should therefore be most useful to research workers who are already quite familiar with statistics and to students of statistics who have advanced somewhat beyond the elementary level.

Mech Eng 71:929 N '49. Louis C. Young. * a thorough and intensive text * a prior acquaintance with statistics will facilitate a better appreciation of the text. Explanations are in many cases inadequate for satisfactory comprehensions of the method being demonstrated. References to original articles containing the complete exposition are, on the other hand, abundant. The text would be valuable as a guide of source material, if these were its only contents. In addition, the number of applications covered....will make it very convenient in recalling methods and formulas used infrequently. * [the last five chapters are] devoted to analysis of variance and covariance, and closely related subjects, in application to research. The examples used for illustration are progressive in intensity, allowing a good comprehension of both the principles and procedures involved. For those engaged in technical research, this section is of particular value. The principles of experimental design are stated clearly and are correlated with the procedural explanation and examples which preceded them.

[183]

★JURAN, J. M. **Management of Inspection and Quality Control.** New York: Harper & Brothers, 1945. Pp. xv, 233. $3 00. *

Adv Mgmt 10:123 S '45. J. K. Louden. * This book, a pioneer work on management of the inspection function, analyzes and discusses ....[the problem of securing necessary quality at minimum cost] in a practical and refreshing way * the book goes far to fill a noticeable gap in existing management literature. The void in the literature has been present in all phases of the inspection function, with the possible exception of the considerable material written on the Shewhart Control Chart. Even here, the existing literature leans toward the statistical problems rather than towards the management problems of making this new tool effective. * The author, through his years of experience, is at home in the problems of specifications, measurement, accuracy of inspectors, conformance, acceptance and control sampling, organization, and wage determination for inspectors. He divides the subject matter logically and dwells on each point to at least effectively lay a pattern for the reader to follow. While the book is virtually devoid of charts or pictures, the author achieves clarity through skillful diction and through sharply drawn examples from his shop experience. While the book may find its first greatest attraction in the man in the shop, it is in the top management problems on the inspection function, however, that the book may find its greatest influence. * Any pioneer work in an important field is an important book. Fortunately, this volume is most carefully done. It is immediately valuable to top management quite as much as to shop supervisors and engineers. It is further recommended to sales engineers and sales managers whose work requires them to contact customers on matters that may involve quality and adherence to specifications. For the management authors of tomorrow it provides a first reference book on the inspection function.

Ind Qual Control 2:18–9 Jl '45. Martin A. Brumbaugh. * "must" reading for everyone

directly or remotely connected with the operation of a quality control system. It should be read by senior and junior policy making plant executives. Much of the information contained in the book is known to more advanced quality department officials, but here for the first time is set down the complete story of the method of operating the inspection function and its relation to the manufacturing and management functions. Inspection of material is usually considered as an expense of operation. Hence, management is prone to reduce inspection expense as an avenue to lower unit cost of production. The fallacy of this reasoning is nicely exposed by Mr. Juran by showing the extent to which low manufacturing costs are dependent upon good inspection of materials, processes, and products. * Chapter IV on Conformance makes the very important distinction between the fact finding function of the inspector and his judgment of whether the facts do or do not conform to drawing requirements. This chapter will be particularly valuable to readers in plants that have installed the Materials Review System and to those who are "hamstrung" by the existence of a set of unwritten limits or deviations known only to the chief inspector. Chapters V and VI are devoted to Acceptance Sampling and Control Sampling. The point of view of control procedure is stressed rather than the details of acceptance inspection and control chart operation. The discussion of assignable and constant causes of variability is particularly stimulating. * Chapter XI contains an extremely pertinent discussion of the all important question of establishing for inspectors a wage system which is consistent with that in force elsewhere in the plant. Chapter XII goes into the question of determination of the quality of work done by the inspection department. The major emphasis is on check inspection. Perhaps there will be more disagreement on the content of this chapter than any other. Mr. Juran is specific that management should establish a Check Inspection Department which operates independently of the Line Inspection Department. This immediately gives rise to questions of jurisdiction, authority, efficiency, duplication and disagreement. The author discusses these questions ably, but it is this reviewer's opinion that he does not establish the advantage of a separate Check Inspection Department. *

J Am Stat Assn 40:395–6 S '45. A. I. Peterson. * a significant and well-written contribution to the current literature of industrial quality control * Widely experienced in management, the author presents sound principles and a well-rounded evaluation of problems of quality specification, inspection philosophy, lot acceptance sampling, control sampling, inspection organization and lines of responsibility, and last but foremost of the overall management problem. * Although the author conforms admirably to the stated scope of his book, it would have been of great value to have him elaborate upon the engineering phases of process operation and quality control. * provides much needed examination of the overall problem of management. There is still required presentations of the engineering methods of process control. In general, we have a great problem in education and training throughout industry for technical, managerial, and supervisory personnel. Mr. Juran's book should be in every industrial library, and should be collateral reading in engineering schools.

Mech Eng 67:616 S '45. John Gaillard. * deals with matters ranging from those which are the concern of top management... to elementary inspection problems * With all of these matters, the author deals in simple language and in an interesting, informative, and often colorful way. * the executive and the shopman may equally enjoy the book and benefit by the ideas developed in it. In fact, it is hoped that the book may be an incentive for many an industrial executive to focus his attention on the need for systematic organization of quality control in his company. * Rightly, the author stresses the importance of the human element and the necessity of maintaining the maximum possible degree of flexibility in compliance with quality specifications. In this respect, a statement from the chapter on Quality-Mindedness may be quoted here. It says: "The principal force for securing compliance with the specifications lies *not* in the gages, instructions, or other facilities for inspection. It lies in the state of mind of the plant personnel from the top executive down to the man at the machine." As Kipling has said, it is "the everlasting teamwork of every blowing soul" that counts, and whoever wants to build up such teamwork in applying quality control will get some very valuable ideas from Dr. Juran's book.

Mgmt R 34:285–6 Jl '45. Franklin S. Atwater. * On the whole, the book is well organized, and it thoroughly treats the subjects

covered. Noteworthy are the author's repeated references to the similarity between the principles of inspection and public law enforcement which aptly document his discussion of inspection problems. Also, far from being carried overboard by zeal for statistical sampling and control charts, the author readily admits their limitations and ably defines their areas of usefulness. However, in his treatment of some specific inspection problems, Mr. Juran is on somewhat more dangerous ground. For example, he suggests that the purchasing department may properly determine that an inspector should not reject a lot of material received from "a favored supplier" even though the lot clearly fails to meet technical standards. Or again, in the case of border-line material, he recommends as "good policy" that the foremen go through the motions of junking the material, after which he says "there need be no hesitancy in considering the acceptance of usable borderline product." It is to be wondered how a piecework operator who was paid only for the good pieces would look upon such hocus-pocus and the subsequent use of material he produced but for which he was not paid! Finally, the author's suggested tactics for conducting a scrap campaign and introducing quality-control techniques are convincing to the practical shopman until he suggests commemorative dinners, graduation diplomas, and a "gala atmosphere." Nevertheless, the shortcomings of the book are relatively minor, and there should be a place for it in the library of any quality-minded shop executive.

Personnel J 24:239–40 D '45. Everett Van Every. * The personnel-minded reader will find this book interesting because it explores so many simple processes and refines so many simple tasks that he has never analyzed before. Indeed the work is an exhaustive source-book on management principles and practices in what the reader is ready to admit is rapidly approaching a status of inspection and control administration. * Personnel managers who are concerned with perfecting manufacturing processes, and the employee relations problems that accompany such improvements, will find this book as interesting and helpful as will the engineers, planning officials, designers, and those who are directly engaged in inspection and quality perfection.

[184]

★KAFKA, F. **Statistics Without Numbers: A Visual Explanation.** New York: Lifetime Editions, Inc., 1950. Pp. 111. $2.00. *

J Am Stat Assn 45:456 S '50. William C. James. This book undertakes to interpret the basic ideas of the science of statistics by a combination of simple, straightforward text and roughly sketched but nevertheless clear pictographs. The underlying principle is oversimplification. Its appeal is to the unsophisticated consumer of statistics, and this fact is expressly stated in the preface. Any evaluation must take this into account. Nevertheless, many professional statisticians might profitably read the introductory chapter on "What Statistics Can and Cannot Do." Particularly appropriate is the statement: "....Precise looking statistical results may be misleading"; and, again: "The subjective element is very strong and the work of the statistician very often reflects his personality" (page 14). Even after allowing for the acknowledged oversimplification, one still finds occasional misleading statements. The treatment of the variance is an example. The author explains the relatively infrequent use of absolute deviations to measure dispersion thus: "Many statisticians think we should distinguish in our reasoning between differences above and below the average." Then: "The distinction between above and below differences will cease to be a problem if we put all differences upon a higher level." The variance is defined as the mean of these differences at a higher level. In this reviewer's experience, the concept of the variance is one which is least understood by laymen. It would seem that the audience to which this book is directed should have a somewhat more precise explanation of why the variance is preferred to the mean of the absolute values of the deviations. At the beginning of the chapter on sampling, an excellent opportunity is missed to get across the idea that no absolute conclusion about the state of a shipment can be reached from a sample, but that a satisfactory test on a suitable sample from a lot may warrant taking the risk of accepting it. The book should be of interest to a varied audience. It is essentially popular in nature and easily read (it can be read and understood in two hours), but is not intended as a substitute for a textbook. The description on the jacket seems, in this respect, rather to over-reach itself. It suggests that the book might prove useful as a textbook for a

high school course in statistics. As an orientation assignment for the beginner on the first day or so of the course, yes; as a textbook, no!

[185]

★KELLEY, TRUMAN LEE. **Fundamentals of Statistics.** Cambridge, Mass.: Harvard University Press, 1947. Pp. xvi, 755. Lithotyped. $10.00. (London: Oxford University Press, 1948. 55s.)

Am Math Mo 55:593–5 N '48. L. A. Aroian. Whoever has heard Professor Truman Lee Kelley knows how eloquently he speaks for those who enter the field of statistics not primarily from an interest in mathematics or in mathematical statistics but from some contact with an application of statistics to education, psychology, or the social sciences. The text is intended for such students; it makes interesting reading for anyone. * In the preface Professor Kelley states: "An alternative title for the book which would emphasize the point of view is Statistics, Its Philosophy and Method. The endeavor has been to place a great emphasis upon the logic and principles underlying the statistical study of phenomena." On the whole the author has been quite successful in his purpose. He has interwoven and interrelated the various topics and ideas into a closely knit fabric producing an over-all pattern of sound judgment, integrating the practical aspects with the many theoretical considerations involved. The text shows real scholarship and a very wide knowledge of both past and recent results. This has been done moreover with a minimum amount of mathematics. * The highlights of the text besides those already indicated are: a discussion of the purposes and uses of statistics, the treatment of significant figures, the care in determining the size of the class interval and class limits in the frequency distribution, and the introduction of measures of variability before measures of central tendency, a bold and welcome departure. Along with this material the author introduces the standard error of the mean and clearly explains the concept of the number of degrees of freedom. This particular chapter, the sixth, illustrates the expert weaving of many strands into a related whole. * The discussion of the median and the mean is stimulating but, since the concepts of consistency and efficiency are not defined, it is based solely on intuitive reasoning. The chapter on the properties of the normal curve includes material seldom found elsewhere; another treats correlation from the point of view of regression, the bivariate probability function, and the analysis of variance. Here a gem deserves quotation "Galton's humility, after years of collection of data and subtle analysis of the same, in the face of the neat but not involved mathematical derivation, is worthy of note by the social scientists of this day who scoff at mathematical analysis." This enthusiasm for statistics is well communicated. * Chapter eleven furnishes an authoritative treatment of the reliability of a test, the tetrad difference, and various other topics in psychological testing. Multiple correlation is thoroughly discussed in chapter twelve * Chapter thirteen includes....a substantial section, concise and clear on sequential analysis. * Appendix A has the unusual feature of a mathematical background test in mathematics for elementary statistics with scoring keys, percentile norms, and reliability. * Problems are given only in the first five chapters. While a photo-offset process has been used, the results are quite clear. Misprints are very few. * It would be helpful to indicate that the formulas for the percentiles are merely linear interpolation formulas. In chapter five a generalized measure of variability is defined as

$$f = \frac{\Sigma\,|x_i - x_j|^m}{N(N-1)}, \qquad i, j = 1 \text{ to } N,\ i \neq j$$

Then "This function, f, is worthy of investigation for different values of m,....but the writer has found the function rather intractable except for $m = 2$." This function for $m = 1$ is Gini's mean difference without repetition, and if divided by N^2 instead of $N(N-1)$ is Gini's mean difference with repetition. For $m = 4$ the expected value of $(x_i - x_j)$ would be $2(\mu_4 - 3\mu_2)$, where both μ_4 and μ_2 indicate population values. Thus for $m > 2$, it cannot be claimed that f is a measure of variability. A formula is stated for the standard error of the average deviation from the mean. It is rather useless, since to evaluate it would be difficult for any of the well known distributions. In the comparison of critical ratios for certain measures of skewness, all such measures should be consistent and estimate the same parameters. For example if α_3 in the population does not exist, it still may happen that the percentile measure of skewness may exist. While intuitional techniques are suggestive, they are not substitutes for rigorous mathematical demonstrations. The impression is created that if a curve has a high peak at the mode, then $\alpha_4 > 3$, certainly not true in gen-

ral. One confused remark is the following: 'Thus the sample mode, defining with maximum likelihood the parent mode, is a maximum ikelihood statistic." The sample mode is usually ery unreliable, seldom the solution of a maximum likelihood equation. In chapter nine Paulon's formula is given for the normalization of he F distribution, in slightly different algebraic orm, without a reference to its source, Annals of Mathematical Statistics, 1942. A convenient able is furnished by the author for its calculaion. The results of Hotelling and Pabst would ave strengthened the section on the coefficient of rank correlation. In the treatment of sequenial analysis it should be clearer that the theory vas developed almost solely by A. Wald. * The eviewer feels strongly that the Neyman-Pearon theory of testing hypotheses merited a very rominent position, a regrettable omission. Other omissions are the theory of confidence ntervals and methods of sampling. More emhasis should have been placed on exact samling distributions. While a few deficiencies ave been noted, this book fulfills a real need n the social sciences, psychology, and educaion. Both teachers and students will find it worthwhile as a text and for reference.

Ann Eug 14:277–8 N '48. J. B. S. Haldane. This book is intended for elementary students of statistics, as is shown by the fact that it ncludes such information as the binomial heorem, and the names of the Greek letters. At this level it covers a wide ground, including sequential analysis and multiple correlation. Its nost original feature is perhaps the use of the uthor's theorem that the distance between the 7th and 93rd percentiles gives a much more eliable measure of the standard deviation of a ormal distribution than the total or interquartile ranges. A number of other useful combutational methods are given. The reviewer annot, however, agree with the author's pinion that "the designation of the standard error by the $\pm$ sign....is definitely bad practice." There are a certain number of errors, for example the statement (p. 291) that in a normal distribution $\mu_{10} = 735V^5$, and (p. 211) that $\mu_3 = 0$ in a symmetrical distribution, but not otherwise. (μ_3 may of course vanish when μ_5 does not.) These leave a certain doubt as to the reliability of the tables, a doubt which may be quite unjustified. No attempt is made to deal with the special problems which arise in human genetics, and although the book has its place in a library as a source of methods both in practice and in teaching, it will hardly be used as a standard text by statistical workers in this field.

Ann Math Stat 19:282–4 Je '48. A. M. Mood. * This....is another book which deals with the descriptive aspects of statistics. Despite its title, it omits discussion of distribution theory, sampling theory, the theory of estimation, tests of hypotheses, or the theory of probability. The phrase "confidence interval" appears not once, I believe, in the entire 750 pages. The discussion of Student's distribution is brief enough to be quoted in its entirety (page 284): "The t-distribution, shown through the courtesy of Dr. Philip J. Rulon, in Chart VIII II, is appropriate for interpreting the significance of means, differences of means, and of regression coefficients, for small samples—say N less than 15. It is the distribution of these statistics computed from small samples drawn from a parent normal distribution." Thus the author denies any value to the developments in the fundamentals of statistics during the past twenty-five or thirty years. He does this not merely by implication but in so many words; referring to modern statistical inference, he writes (page 13): "A still greater weakness is that it is essentially a deductive procedure and relatively sterile in [illegible] new courses—in inspiring creative inferences. It is fundamentally a method of proof and not one of invention." He is therefore fully aware of his extreme position, and takes great pains to justify it. His thesis is that the main purpose of statistics is to suggest new hypotheses to the scientist. In developing this thesis he writes (page 15): "The physicist observes seemingly irregular changes in x as y changes. He repeats his experiment, controlling more and more of the conditions, and repeats again and again, and, if successful, he reaches a law at the end of his work. He has been using statistics." But his discussion avoids certain relevant questions. Why does the physicist repeat the experiment? Why did he perform it in the first place? Did he suspect before he collected any data that x and y might be related? At any rate, the opinion of most present-day statisticians is that the primary role of statistics in scientific research is statistical inference. This opinion is certainly well-founded in my own experience. Here at Iowa State College the Statistical Laboratory is intimately implicated in the re-

search programs of all departments—physical, biological, and social. These scientists perform their experiments with a specific purpose in mind—usually the estimation of some parameters, sometimes the testing of a hypothesis. They never seem to seek in a collection of data some new hypothesis by artful selection between the mean, the mode, the geometric mean, the harmonic mean, and the median. It must be reported that, even as a book on descriptive statistics, it leaves much to be desired. The errors usually found in such books are to be found here as well as many more. There is the long discussion of skewness and kurtosis based on the false notion that moments are determined by the nature of the distribution in the neighborhood of the mean. Certain properties of the normal distribution are imputed to all distributions. Erroneous criteria for selecting amongst the many means are given. The universality of the normal distribution seems exaggerated; thus, for example, referring to deviations from regressions (page 364): "Since the quantities $(x_0 - \bar{x}_0)$ are 'errors' we may regularly assume them to be normally distributed." Population parameters and their estimates are confused. The book contains a great many statements (like the final one in the section on the Student distribution quoted above) which are so carelessly written that they have to be counted as errors. Several of the derivations and arguments are also carelessly constructed; an extreme example of this appears on page 206: "Is the mean an unbiased statistic? $M = (x_a + x_b + x_c + ... + x_n)/N$. Since the various x's are independent, there are just N degrees of freedom and M is unbiased." Students will likely have difficulty with this book. There is an air of artificiality because of the omission of any discussion of population distributions and the notion of random sampling. Without any background of this kind it is hard to motivate the presentation, and the various topics become isolated. Moments are defined in terms of sample observations, and population moments are defined merely as the limits of these moments as the sample size becomes infinite. To introduce the mean, the author writes essentially: let us consider the function $f(b) = [\Sigma x^b/N]^{1/b}$. There is no pointing to the middle of a distribution function, or even a sample, or a histogram. The variance is introduced the same way; one considers the function $\Sigma |x_i - x_j|^m/(N^2 - N)$. Technical terms are used without definition; for example, in the passage about the mean quoted above, the student suddenly encounters the word "unbiased" without definition or previous discussion and must infer its meaning from the context. Perhaps the best part of the book are three chapters on correlation and regression. The idea of correlation is here introduced with the discussion of a numerical example, and several other topics are discussed in terms of examples. This part of the book is very exhaustive; every sort of correlation coefficient is discussed as is every sort of correction to such coefficients. But still the writing is careless, and there is some confusion of ideas. The worst confusion occurs because the distinction between normal and intraclass correlation is never brought out; the discussion hops back and forth between the two ideas with no hint that they are not the same thing. This part of the book, too, is in the style of statistics of thirty years ago; the emphasis is on correlation coefficients rather than regression coefficients.

Biometrika 36:470 D '49. F. N. David. * The author aims at setting out the logical processes which are involved in the application of any piece of statistical technique and generally succeeds with admirable clarity. Many who are interested in what statistical methods are about but do not care for mathematics may read this text with profit, for the mathematical theory is kept to a minimum in the first 200 pages. It is perhaps open to question whether Prof. Kelley achieves the clarity with his mathematical analysis that he does with his exposition of general principles. The reviewer found his notation cumbersome in places, and it is likely that a student coming fresh to the subject will very often find himself in difficulties. For example, the section on sequential analysis gives the outline only of the mathematical analysis. Reference is given to other publications whereby the student may supplement this analysis, but for the elementary student these other publications will prove too difficult. On the whole it would be fair to say that this book is a useful addition to statistical text-books, although it will never take the place of such old and tried classics as Yule and Kendall's *Elementary Theory of Statistics*, for the student beginning the study of statistical methods. Biologists, medicals, *etc.*, will probably find it useful to read before attempting R. A. Fisher's *Statistical Methods for Research Workers.*

Brit J Ed Psychol 18:170 N '48. As the pages and price indicate, this is a very substantial volume, and the name of the author ensures a welcome. * It is regrettable to find once more in an American book the relative neglect of British workers in the field dealt with. There is no reference to Sir Cyril Burt (especially surprising in view of Burt's emphasis on the logic of statistics), and the only reference to Professor Godfrey Thomson is to his very early book in collaboration with William Brown.

Brit J Psychol, Gen Sect 39:115–6 D '48. E. G. C(hambers). In his preface the author writes: "The early chapters constitute an elementary text, and call for no mathematical background other than that of arithmetic and elementary algebra." This is true, but the text is by no means an easy one for a beginner since it calls throughout for sustained symbolic thinking. The system of symbols adopted, although entirely adequate for mathematical exposition, is difficult for a student to grasp and the number of numerical illustrations is small. The later chapters of the book call for increasing familiarity with advanced mathematics, including calculus and the algebra of matrices and determinants. There is a good deal of useful material for the psychologist in this book, since many of the techniques described are mainly applicable to biological data. The author is careful to point out the mathematical assumptions and limitations of the methods given. * The book is printed in typescript of different sizes, which is rather unpleasant to the eye, and there is a fair sprinkling of misprints, some of which are apt to be confusing to the elementary student. In spite of this, the volume should be of considerable value to the research worker who is capable of readily understanding symbolic formulas.

Brit J Psychol, Stat Sect 1:133 Jl '48. D. N. L(awley). Kelley's....new volume contains all the admirable features of the old; but, as he points out, it is something more than a mere revision of the earlier work. * the present volume lays a welcome stress on the logical principles underlying statistical arguments. * such topics as the presentation and tabulation of data and the use of graphical methods are discussed in a clear and instructive fashion * it is gratifying to find a brief discussion of sequential analysis * there are helpful notes on various mathematical techniques employed in the theory of statistics—such as determinants and matrices, the solution of equations, the use of Lagrange multipliers, of growth curves, and the like * The present volume will probably prove particularly useful to workers in the field of education or psychology, where multivariate analysis plays a large and important part. Nevertheless, it seems a pity that more attention has not been given, for example, to the analysis of variance, a method whose value is becoming increasingly well realized. Factor analysis is formally defined in the useful appendix of definitions; and in the text we are told that the relations connected with this subject can usefully be expressed in matrix notation. But it is surprising to find that these brief allusions are all that the volume contains on a subject to which Kelley himself has made notable contributions. The reviewer would also have liked to see more discussion given to the theory of probability and its relevance to tests of significance. Since this is a book on the foundation of statistics, some consideration might also have been given to the theory of estimation beyond the references to R. A. Fisher's work in this field. The author is careful to distinguish between population parameters and their estimates from a sample. The notation adopted appears to the reviewer, however, to be somewhat cumbersome and inconvenient. * In spite of these minor criticisms, the book should prove extremely helpful both to beginners and to research students. It contains many suggestive explanations of difficult questions. The treatment throughout is at once lucid and logical; and the selection of novel topics original and instructive.

J Am Stat Assn 43:328–9 Je '48. Cyril Burt. This book....preserves many of the admirable features of....[Kelley's] excellent [*Statistical Method*] * while the book includes nearly all the stock topics, it also contains much useful matter that is not to be found in the usual type of statistical textbook * The psychologist will probably regret that more attention has not been given to the analysis of variance and to factor analysis. In the discussion of the logical basis it is perhaps disappointing that more space has not been given to the theory of probability and its relevance to tests of significance, and particularly to the latest developments in the theory of estimation.

J Am Stat Assn 43:330–2 Je '48. Horace W. Norton. * The book is addressed to no specified class of readers, but it is fair to say that in

flavor, language, examples, references, and point of view, it is definitely of the social sciences. * As a text, it should be regarded as of more nearly 500 pages than 750, roughly 200 pages being given to miscellaneous aids, such as mathematics, references, tables, and indexes. There are a few problems, and much emphasis on vocabulary. * it is....especially noteworthy that there is....a mathematical background test with instructions and scoring key, enabling the student to assess objectively his readiness to read this book * Because the author has not designated a specific group of readers as his target, critical evaluation is not easy. * The analysis of variance is mentioned a number of times but without systematic treatment. There is nothing on independent comparisons or single degrees of freedom, no mention of components of variance, no analysis of variance tables, and no worked example. Analysis of covariance is not mentioned, and experimental design receives only a half page. All this may be accepted by students and teachers in the social sciences, though its adequacy for their needs is surely doubtful. However this may be, it certainly will be unacceptable to most, perhaps all, other beginning students of statistics, though doubtless many will realize this only when they have ceased to be beginners. The lack of systematic treatment of the analysis of variance and covariance is the more difficult to understand because it is so widely regarded not only as fundamentally important to applied statistics but also as so helpful to the author's stated primary objective of emphasizing the logic and understanding of statistics. Likewise, systematic treatment of experimental design would have been helpful to the same end, revealing as it does an entirely different aspect of the statistical whole, even if it were kept to only a few pages. Nevertheless, the author pursues his objective with some success, chiefly in the early chapters. He has done well, for example, in formulating some of the quasi-axioms of statistical thought, which can be so helpful to the tyro who remembers them * On the other hand, it should not be supposed that misleading and erroneous statements have been entirely avoided, as the following examples show. It is asserted (p. 73, using hypothetical temperature forecasts!) that the error is independent of the prediction "as it universally must be." There may be a definition of "error" which makes this statement true, but it need not be and usually will not be for real data analogous to the example. After a test for normality resulting in rejection of the hypothesis, we read, "knowing that successive daily maximum temperatures at a single spot are correlated and not independent, we have a ready explanation in that our items are not independent random samplings" (pp. 304–5), but of course this has nothing to do with the normality of distribution of either the sample or the parent population. A graph of the chi-square distribution for one degree of freedom (p. 285) shows an inflection where chi-square is about 0.13. Of t it is said that "It is the distribution of [means, differences of means, and of regression coefficients]....computed from small samples drawn from a parent normal population" (p. 286), obscuring the nature of this revolutionary statistic. We are told (p. 226) that the expected value of the standard deviation is the square root of the expected value of the variance. There is the old error of "explaining" kurtosis simply in terms of the relative frequencies near the mean and in the tails (p. 242). In addition to faulty statements, there are errors in formulae and tables, many of which are probably typographical, though none the less consequential to the student. For example, formulae for Fisher's fourth k statistic appear on pages 215 and 247, neither being correct, and a few errors were noted in the table (pp. 640–52) of normal probability functions. The list of tables of statistical functions (including the usual mathematical tables) is excellent, each table being described as to content. It was a pleasure to the reviewer to find himself correctly credited for the table of the 20 per cent level of the z and variance ratio distributions. However, this pleasure was immediately mixed by inclusion of the 0.1 per cent table which of course is due to C. G. Colcord and L. S. Deming. The list of references, to both books and papers, would be much increased in value by elimination of such entries as Peters and Van Voorhis, *Statistical Procedures and Their Mathematical Bases* or, better still, by furnishing critical comments for each entry. The notation seems unnecessarily cumbersome, and the terminology is sometimes unfamiliar, not to say strange. * The author indulges in occasional flights of fancy as to subject matter or phrasing which serve to enliven the text, as when, in discussing significant figures, he considers a palsied man using a meter stick to measure a live angleworm. The typography leaves much

to be desired, both in appearance and accuracy, the spacing of lines, words, and letters being irregular, and typographical errors being frequent, especially in names. The index suffers from numerous errors of omission and commission, and additional cross-referencing would be helpful.

J Ed Res 42:145–9 O '48. T. G. Andrews. * There is a need for greater emphasis on the logic and philosophy underlying the concepts of statistics as methods of thinking and problem solving. This emphasis is promised in the preface and the introduction, in the reading of which the reader or student may be led to believe that he will discover a relatively complete treatment of inferential statistics as they apply to the solution of scientific problems by experimental and statistical analysis. This is not the case. What Kelley has done he has done well, and the question is raised as to whether he should be subjected to criticism for not doing something that many of us would expect and prefer. The organization of the 15 chapters in the book is somewhat novel and has many interesting features. * there is a disappointing brevity in the handling....of sampling distributions and their powerful uses in testing hypotheses. Chapter 9 enters a discussion of the statistics of attributes. Here is treated, although briefly and quite incompletely, the binomial distribution (binomial theorem comes later), the simple Chi-square case for contingency tables and its use in normalizing the distribution of the variance ratio. So many methods come in for a very brief and incomplete treatment within the book, and the following quotation is typical of the way in which these sections are ended: "The student should not believe that the Chi-square method is in any way limited to contingency data." As in his previous work, Kelley offers a relatively complete section on regression and correlation * Chapter 12 is devoted to the general multiple linear regression problem, which was presented somewhat out of context in the previous chapter. Here the modified Doolittle is described and this is one of the first complete matrix and determinantal forms presented in any textbook. It is to be noted, however, that a description of the general forms and uses of matrices and determinants does not appear until in Chapter 14. In this section on correlation and regression there is little or no attention given to the concept of partial correlation and its uses and pitfalls. * [the] 15 page treatment of sequential analysis....is, of course, modern but it does not allow the reader to evaluate this newer statistical possibility in comparison with other standard methods of statistical inference. Chapter 14, titled "Mathematics, the Mentor of Statistical Ingenuity," is another very heterogeneous section of the book. * In very few cases are the concepts and methods presented in sufficient detail or with sufficiently well chosen examples for a student or a researcher to employ them directly. This would then appear to have little connection with the "statistical ingenuity" promised in the chapter's title. * A chronologically arranged bibliography of selected references to published tables is given. (The reason for the chronological order completely escapes this reviewer.) * we now have available a large volume covering a wide range of topics for reference. This work, however, was designated as a textbook and it is this reviewer's contention that it will not serve that function very adequately. There is a lack of systematic development of ideas and methods. The student will require a set of page references and be forced to jump around from chapter to chapter in order to cover the related material on several of the topics. * the book [gives] a hodgepodge appearance, and certainly not the developmental characteristics we desire in a textbook. The student and research worker will unfortunately have to seek elsewhere for adequate material on sampling distributions and the most powerful tests of statistical hypotheses. The author is ultra-conservative in regard to modern tests of statistical hypothesis. The null hypothesis itself does not come in for mention until the section on Regression, and there is no mention at all of power functions and their relations to acceptance or rejection of the null hypothesis. Regions of acceptance and rejection are mentioned in connection with sequential analysis, but not in such a way as to show their generalization. Critical ratios are described early in the book, and before the section on the normal distribution. The important concept of degrees of freedom is presented in a particularly poor manner because the reader is given so little basic information on populations and sampling constraints. There is a marked lack of adequate examples for students to check, and in this regard the textbook function of the volume is not met. Kelley's notation and symbols are systematic but suffer from not being wholly

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sample." This is not correct because an unbiased estimate of population variance is a statistic whose *expected value* is the population variance. However, the *particular* function given is an unbiased estimate. * It is pointed out that the normal distribution is the continuous approximation to the point-binomial. However, it should be emphasized that the normal distribution is based on the postulate of the arithmetic mean. Also, the nonuniversality of the normal distribution should be stressed. * Chapter IX gives, in the reviewer's opinion, an inadequate treatment of the Theory of Attributes. * Chapter XIII is devoted to....many topics, such as periodicity, trends, periodogram analysis, and the lead and lag problem, are mentioned and very briefly discussed. In addition, we are introduced to the problem of curve fitting by the method of moments, the finding of optimum intervals, interpolation, special machine methods for root extraction, and sequential analysis. In the reviewer's opinion, these topics are treated too briefly. All the experimentalists can hope to obtain from the exposition given is a superficial background in these topics. Chapter XIV, which presents a heterogeneous mixture of mathematical topics, is definitely inadequate for the experimentalist who wishes to have a thorough knowledge of statistical theory for intelligent use. Chapter XV is an excellent bibliography of statistical tables. * The reviewer is not at all certain that the book is practical for use as a textbook in a statistics course. It contains a wealth of very valuable information in condensed and concentrated form, however, and, as a handbook for reference by the experimentalist or collateral reading by the student of statistics, it is excellent and second to none.

Social Forces 27:338 Mr '49. D. O. Price. * contains a great deal of material not ordinarily found in an introductory text * The major contribution of the book probably lies in its emphasis on the philosophy and logic of statistical methods.

[186]

★KELLEY, TRUMAN LEE. **The Kelley Statistical Tables, Revised 1948.** Cambridge, Mass.: Harvard University Press, 1948. Pp. ix, 223. $5.00. (London: Oxford University Press. 27s. 6d.) *

Math Gazette 33:65–6 F '49. J. Wishart. In spite of the title this book cannot be described as a set of tables for general statistical use. The main table (Table I) is the same 101 page table of the normal probability function that appeared in the 1938 edition. * No differences are given, the author preferring to rely on subsidiary tables (II to V) which give the three-, four-, six- and eight-point Lagrangian interpolation coefficients. Table II is new, and at the cost of 50 pages of print gives the three coefficients to five places of decimals, for the fraction of the interval ranging over .0000 (.0001) .5000. This means that interpolation for an eight-decimal p can be made by a triple multiplication-addition on a calculating machine, but the absence of first differences makes linear interpolation, the feasibility of which (for a reasonable standard of accuracy) should be the justification of a table at so fine an interval, a somewhat troublesome process. Doubtless the author does not wish to encourage linear interpolation, for he comments on the limits of accuracy attainable with the use of Table II, and adds, froms the previous edition, the ten-page Table III for four-point interpolation, wisely cutting down the decimal places to seven, and also the two-page Table IV (six-point) and one-page Table V (eight-point). Since, however, the author describes inverse interpolation methods at some length, doubtless to meet the needs of those who would prefer to see a table with x as the argument and p as the "consequent," it should be added that the absence of differences, which are a common feature nowadays of mathematical tables, makes inverse interpolation tiresome, while the space devoted to Lagrangian interpolation coefficients is of no use in this connection. * Table VIII (one page) gives θ values for use in a normal transformation suggested by the author to enable the probability associated with a variance ratio to be deduced from Table I. This is an interesting innovation, but possibly not very practicable, since direct variance-ratio tables now exist in many textbooks and enable the answer the experimenter usually wants to be reached without calculation. While it is true that a number of statistical significance tests can be put into the form of a variance-ratio, Table VIII can hardly be made the basis of a claim that the book is of general utility as a set of statistical tables. The value of the collection, as before, rests on an inverse normal probability table at a much finer argument interval than is published elsewhere, and is increased by a detailed table of Lagrangian interpolation coefficients which will be of general utility for other mathematical tables.

Math Tables 3:301–2 O '48. Will Feller. * The main part of the book is devoted to tables of the normal distribution arranged in a handy form which will in many cases increase the usefulness and convenience of the tables. All other tables are more or less auxiliary tables designed so that maximum information can be extracted from the main table. A special feature of the book is the attention paid to interpolation errors. Careful instructions for direct and inverse interpolation are given. With the natural exception of the tables of interpolation coefficients all columns in this book indicate at the bottom the corresponding maximum two- and three-point interpolation errors for both direct and inverse interpolation. This feature will be appreciated by many users. *

Q R Biol 24:89–90 Mr '49. A. Chapanis. * These tables will be indispensable to any statistical laboratory, and professional statisticians will almost certainly want to own a copy of them. They are probably far too detailed and complicated, however, for ordinary students of statistics or research scientists.

For reviews of the first edition, see 38:B642 and 2:169.

[187]

★KENDALL, MAURICE G. **The Advanced Theory of Statistics, Vol. I.** London: Charles Griffin & Co. Ltd., 1944. Pp. xii, 457. 42*s.* * [The second, third, and fourth "editions" of this book appear to be reprintings, with minor corrections, and consequently are not listed separately.]

Am J Sociol 50:332 Ja '45. Ethel Shanas. This detailed and carefully organized volume is at once a workbook and a source book in statistics. * At the end of each chapter there are a number of problems which can be used by the student who is interested in improving or testing his knowledge of the material presented. In spite of these exercises which would lead one to believe this volume is designed as a workbook, it would not seem that it can profitably be employed as such by anyone whose mathematical training does not include calculus. For these statistical students who have a background in mathematics through differential and integral calculus, Mr. Kendall's book should prove to be extremely valuable for consultation and study.

Am Sociol R 10:443–4 Je '45. Raymond F. Sletto. * One of the merits of the chapters on frequency distributions is their abundance of illustrative tables drawn from a wide range of fields of research endeavor. These tables give emphasis to the generality of application of statistical techniques, and to the diversity of types of distributions encountered by scientists in widely separated fields of specialization. * The chapters on probability and sampling are likely to be of particular interest to social statisticians. Those who have turned in the past to Yule and Kendall's *Introduction to the Theory of Statistics* for its lucid treatment of the conditions of simple sampling will find the present volume no less valuable. It has, for example, an excellent discussion of the effects upon sampling statistics of non-replacement of items drawn from a larger universe, a modification of the conditions of simple sampling that is often present in research studies undertaken by social statisticians. There is also a concise discourse on the problems involved in preparing tables of random sampling numbers, and on the use of some of the standard tables of this type available to statisticians. * Among the most useful contributions of [the chapters on correlation]....to social statisticians are likely to be the coefficients of consistence and of agreement, techniques particularly applicable in problems where the method of paired comparisons is employed in an effort to secure scaled values for items. There is a very good treatment of the logic underlying statistical inconsistencies often met in the application of the method of paired comparisons of the study of preferences, as, for example, in studies of social distance calling for choices among paired alternatives. Notes and references at the ends of the chapters will be helpful to readers in search of more extended treatment of special topics and to those seeking information on the historical development of statistical techniques. * This important volume is virtually certain to become a standard reference work and belongs in every college library serving advanced students of statistics.

Biometrika 33:266–7 N '45. B. L. Welch. * The work is encyclopaedic and will receive little criticism on the grounds of what is omitted. It is not an elementary book, the various topics being all carried to an advanced stage and at times requiring of the reader considerable mathematical powers. As with advanced theoretical work in most of the sciences, the practical problems which originally suggested the discussions have often receded well into the background. * Kendall is here, in the main, content to present us with a picture of statistical theory as he finds it. The more controversial job of

assessing the value of the different parts of the structure, whether from a purely practical or from an aesthetic viewpoint, he leaves to the reader. Within these self-imposed limitations he has scored a notable success. * Chapter 3, entitled "Moments and Cumulants," is....particularly satisfying. It develops concisely the general relationships between the various families of power statistics. The simple presentation of the transformations giving moments in terms of cumulants and vice versa will be welcomed, and the listing of a large number of the resulting formulae will enhance the value of the book as a reference work. In addition, the familiar corrections for grouping, due to Sheppard, are derived, and the rather subtle distinctions between the conditions necessary for their application and the conditions under which the so-called average corrections for grouping may be applied are clearly drawn. * the interest in the limits of sequences of distribution functions [in Chap. 4] is almost exclusively theoretical, and this chapter should appeal to anyone who enjoys himself in this type of work * One welcomes the fact that both the Gram-Charlier and the Edgeworth developments from the normal distribution are given, for although these series may be but rearrangements of each other, it is the order and grouping of the terms that are all important when any practical applications are intended. Indeed, although this point is well made, it is of such importance that, even at the risk of appearing to labour it, the addition of some further numerical illustrations might have been useful. The next five chapters deal with Theories of Probability, with Sampling and with Sampling Distributions. On the first topic the author rightly does not dogmatize, judging that the rest of the subject appears to go forward in much the same way, whatever are one's basic concepts as to the meaning of probability. This determination not to take sides in the present book is extended also to the problem of induction, where he minimizes the too violent contrasts which have in recent years been drawn between Bayes's Theorem and the Principle of Maximum Likelihood. Far from being diametrically opposed, Mr. Kendall observes that, if some account is taken of the limiting processes by which continuous distributions are defined, and if Bayes's Postulate is introduced in an appropriate manner, the two principles have a very strong resemblance. The chapter devoted to the so-called "exact" sampling distributions follows familiar lines. Perhaps of greater interest is Chapter 11, which is entitled "Approximations to Sampling Distributions." Here the problems associated with the distribution of the k-statistics are given a very full treatment. It is, moreover, an authoritative treatment since Mr. Kendall has himself contributed so much to the elucidation of the methods which are here required. The k-statistics, which were introduced by R. A. Fisher in 1928, have the property that their expected values in repeated samples are the cumulants of the populations sampled. In general the exact distributions of the k-statistics cannot be derived, but the cumulants of the k-distributions can be obtained by following out certain rules which were given by Fisher. Mr. Kendall describes these rules and gives full proofs of their validity. A large number of the formulae derived from applying the rules in particular cases are quoted for reference. This is a very live subject, and one feels that there is still some scope for development and simplification of these methods, for it must still be admitted that their successful application requires a high degree of virtuosity. Aesthetically, however, they are far in advance of the heavy algebraic manipulation demanded by the earlier approach. The mathematician will perhaps find most in the chapter to satisfy his sense of what has come to be called elegance in such studies. After this the reviewer found the remainder of the book dealing with the χ^2 distribution and with the Theory of Correlation something of an anti-climax. Most of all at this stage one feels the need to refer to the promised second volume, to which has been assigned the general theory of regression analysis. Correlation and regression are so closely allied that even a temporary separation is distressing. While the above remarks may give some idea of the nature of the subjects discussed in this first volume, they do not do justice to the thoroughness with which the author has accomplished his task. It is by no means a book to skim through. * anyone who can follow a mathematical argument, and who has also at least some small experience of practical statistical problems, will find plenty to reward him in a study of Mr. Kendall's book.

Brit Med J 4338:290–1 F 26 '44. M(ajor) G(reenwood). * A reader of a mathematical book has two difficulties: the writer may assume knowledge of methods and results the reader does not have; he may use a notation or a

calculus which is unfamiliar. In this book the difficulties are rather of the second than the first class. We think that an amateur who reads carefully a pamphlet by the late H. E. Soper entitled *Frequency Arrays* (published by the Cambridge University Press in 1922) would find Mr. Kendall's exposition easier to follow. We should add that Mr. Kendall follows the admirable example of Karl Pearson—*viz.*, provides arithmetical examples wherever possible. Comparing past with present, summarily, we may note that the great pioneers of half a century ago, particularly Karl Pearson, were empiricists in the best sense of the term. Their new methods were powerful instruments, but their logical justification of them was much less complete than we, their pupils, or perhaps they themselves, supposed. It is indeed certain that Karl Pearson did not suppose he had placed the method of moments upon a wholly satisfactory basis of mathematical logic, but his pupils were often free from doubts. A comparison of Pearson's article in *Biometrika* (1902, 1, 265) with Mr. Kendall's 4th chapter, especially pp. 105 *et seq.*, shows how far we have travelled since 1902. But that does not mean the debt to Karl Pearson is small and that those medical biometricians who "fit" by moments are wasting their time. A natural association of ideas leads one to compare the editorial on probable errors of frequency constants in the second volume of *Biometrika* (1903, p. 273), which was the model we admired 40 years ago, with Mr. Kendall's 9th, 10th, and 11th chapters. We know now, among other things, that it is not quite so easy to evaluate sampling moments as we had thought, and that moments are not the most useful functions to study. Here we might remark that a reader coming fresh to *k*-statistics would find a little book by the late P. A. Macmahon (*An Introduction to Combinatory Analysis,* C.U.P., 1920) helpful. Macmahon wrote this booklet (71 pages) as an introduction to his large treatise; the modern history of statistics shows how wise was Macmahon's own remark that "the theory of probabilities is to a large extent concerned with and dependent upon the enumeration of combinations subject to conditions, and almost every theorem in combinatory analysis has its application to that theory" (*Combinatory Analysis,* vol. I, p. vi). We are, however, diverging from the general to the particular. The remaining chapters of Mr. Kendall's book, treating of association and contingency, product moment correlation, partial and multiple correlation, and rank correlation, will not be too hard reading for those who have had practical experience of the methods and already studied an elementary textbook. While....we have no pretension to give judgment on a work primarily addressed to a mathematical public, we have no doubt of its value and are sure that many medical statisticians who are not mathematical experts could read it with profit if they will (*a*) take hints we have given as to preliminary study, and (*b*) read slowly. It is not a book for hasty perusal. There is a good deal to be said for statistics, in the most general sense of the term, as a source of intellectual pleasure appealing to a wide range of tastes and natural aptitudes. To some its chief merit is as a method of research which can be applied without access to a laboratory; to others it is an opportunity to test [illegible] and a sense of logical consistency. Mr. Kendall appeals more to the second class; but students of the former class—no doubt a majority of medical readers—will find in the book danger signals intelligible enough even if the proofs that there is danger may be hard to follow. We wish Mr. Kendall equal success in the second part of his undertaking.

J Am Stat Assn 40:261–3 Je '45. Burton H. Camp. * Each section of the theory is in itself well explained, and set forth in detail even when such detail is a duplication of fairly well known mathematical theory. This has the advantage of making the book a complete unit in itself * It has the disadvantage of making the book unnecessarily bulky, and it may lead some readers to suppose that certain well-known mathematical developments have been specially devised for statistical theory. The discussion of the Fourier integral, and of Dirichlet's integral is an instance of this. * a fair index. Unfortunately there is no table of contents * Distribution theory is handled rather thoroughly * For the most part the exposition is excellent, detailed enough to make acceptable reading in an armchair, without being prolix, and certainly without skipping the difficult parts of the theory. The remainder of this review will be devoted to occasional critical remarks * They will give an incorrect impression, however, unless it is added that there were many more marks in the margin indicating approval and praise. Kendall's definition of probability (Chapter 7) is multiple. That is, he recites many of the well-

known definitions. If he could show that these various definitions were equivalent, then in what follows he could logically choose one or the other definition as might best suit his purpose, but he should not do this without such a proof. It would have been better first to have explained them all, as he does, then to have chosen one, and subsequently to have pointed out wherein the one he chose failed to satisfy the logical requirements of certain situations. He is also sometimes indefinite in describing these definitions. He says (p. 171): "It is found in practice that there exist selective processes which educe members of a population in such a way that the constituent events may be regarded as equiprobable," but does not indicate how it is possible to give meaning to those last five words without begging the whole question of what probability means. The difficulty in defining probability is not the practical difficulty of finding coins or other "selective processes" which will behave in certain ways, but rather in stating what are the ways in which one would like to have them behave. The real question is not whether a given definition "provides a reasonably accurate picture of the way things happen in the world" (p. 167), but rather whether it provides a well defined picture of how we might conceive of things happening. * The general effect on the reader of this discussion of probability is that the author is sidestepping the necessity either of accepting an undefined element in it or of showing that at least one of his definitions will satisfy the ideal requirements. "The series in the Charlier form may behave irregularly in the sense that the sum of k terms may give a worse fit than the sum of $(k-1)$ terms" (p. 153). The sum in the Charlier form satisfies the same least square requirements as other bi-orthogonal series, and therefore it is impossible for Kendall's statement to be true if goodness of fit is interpreted in the sense of weighted least squares, and if the whole infinite interval is considered. His statement is true when only a part of the interval is considered, as in approximating the terms of a point binomial. "A systematic account of the various methods for deriving sampling distributions has not been previously given, except.... Kullback." This statement (p. 250) ignores P. R. Rider's paper in *Annals of Mathematics* (1930), and Wilks' book (1937). * "When the theoretical proportion in a cell is not $\frac{1}{2}$, the binomial distribution is skew, and there do not appear to be any simple corrections to compensate for this effect. The continuity correction.... is probably best made in all circumstances" (p. 303). Since the basic theory of the chi-square test for a 2×2 table is only the summation of a specified set of terms in a point binomial, there should be no difficulty about the so-called continuity correction whether the point binomial is skew or not; in fact the "correction due to Yates" was essentially nothing more than what was involved in the usual technique for summing terms of a point binomial by means of the partial integral of the normal curve. "If the variates are independent they are uncorrelated, but not *vice-versa*" (p. 330). There is an illustration of this, but it would have been more effective if the reason had been given. That is, the coefficient of correlation ρ applies to a linear relationship: if $y = x^3$, the dependence of y on x is complete, but ρ is not equal to 0. Kendall's definition of partial correlation (p. 370) is that it is the correlation that exists between two residuals from the least-squares regression planes. This is what is sometimes called "net" correlation. He omits altogether the rather elegant picture of partial correlation as the correlation that exists in a plane section of a normal solid. It is only in the latter sense that it is literally true that the partial correlation is (p. 368) "the correlation of 1 and 2 in the sub-population for which 3 is constant." He does not therefore exhibit the truth of his remark that "such partial correlations bear an obvious analogy to the partial association of Chapter 13." "Those distributions for which $\gamma_2 > 0$ are called leptokurtic, and will, relative to the normal curve, be sharply peaked. Those for which $\gamma_2 < 0$ are called platykurtic and will be flat-topped" (p. 82). This is commonly supposed to be true and is implied in the Greek terms, but as a matter of fact, the size of γ_2 is more clearly associated with the behavior of the function in the neighborhood of infinity than with a superficial appearance of sharpness or flatness. For example, the function which equals $|x|^{-0.1}$ in $(-a, a)$, and equals 0 elsewhere, does certainly appear "sharply peaked," for it rises to infinity at the origin, but by this test it is almost as "flat-topped" as a rectangle. Its γ_2 is -1.1; for the rectangle γ_2 is -1.2. As another example, the function which equals a^{-4} in $(-a, a)$ and equals x^{-4} elsewhere appears "flat-topped," being constant over the central

portion, but its γ_2 is infinite. There are very few misprints, and almost none of these will trouble the reader. An exception may be the one on page 319: equation (13.31) should read, $V^2 = \chi^2/N$.

J Inst Actuaries 72:137–8 Je '44. H. L. S(eal). * Kendall....is a polished mathematician and has set out to provide the first complete text-book on mathematical statistics. His wide acquaintance with English and American (rather than Continental) literature is plain from the lists of references and valuable sets of problems at the end of each chapter. But his very strength is also a source of weakness, for the historical development of the subject as revealed by the successive volumes of *Biometrika* is apt to minimize the importance of the theory of probability as an essential mathematical and epistemological *point du départ.* That Kendall has been influenced by this historical background is evident from his relegation of Probability to Chapter VII, and his suggestion that this chapter can be read after Chapter I if desired is no solution, for the reasons which induced him to adopt his actual chapter numbering have implicitly affected his viewpoint throughout. Although in the reviewer's opinion this is a misjudgment of the proper position of probability, Kendall has written a very fine text-book on mathematical statistics. * There are as yet no norms of the relative importance of the various portions of the subject, so the author cannot be blamed for showing that his interest lies with particular chapters. Of the sixteen in this book, the last, on rank correlation, is the longest and most original. From the point of view of the actuary anxious to learn something of modern statistics two serious drawbacks present themselves. The mathematical knowledge required varies considerably from chapter to chapter: few actuaries will be able to manage the important Chapter IV on Characteristic Functions, the results of which are so essential to the understanding of some of the later and easier chapters. Furthermore, there is a good deal of "dead wood" in the book: the reviewer wonders when "tetrachoric r" and "biserial η" were last used in a statistical analysis, and why a student has to face a whole chapter on "Association and Contingency" (with six of its seven references written in 1915 or earlier) before learning about Correlation. Kendall has nowhere indicated what method a practising statistician would use. In a book of over 450 pages slips of pen and printer are bound to occur and this book is no exception; nevertheless, Kendall has produced a very satisfying text-book and work of reference, and his second volume will be awaited with keen anticipation.

J Royal Stat Soc 107:127–9 pt 2 '44. E. S. P(earson). There is evidence that during the last twenty years more than one person has braced himself for the effort needed to write a book which would do justice to the mathematical theory of statistics, but for one reason or another these plans have never been completed. Now, at last, Mr. Kendall's forceful energy and, one may perhaps add, his sense of passionate discontent with the situation which has faced the advanced student, these have seen the job through. There were, no doubt, good reasons for this hesitation in others to commit themselves in print; the past twenty-five years have witnessed a vigorous jostling and development of ideas, such that the teacher of statistics had found that his lecture notes for one year's course needed substantial modification a year or two later to keep pace with rapid advances in technique and to conform to his own development in outlook. A difficulty which the would-be text-book writer has had to face is the choice between what Mr. Kendall terms in his Preface the logical and didactic methods of approach. The order of presentation he has chosen himself is of some interest * In describing....[his] approach as logical Mr. Kendall means, I presume, that the mathematical framework is built up in an orderly way, each step providing the tools required later on. This is the justification for devoting two of the very early chapters to a full treatment of moment, cumulant and characteristic function theory. It must also be accepted as the reason for leaving to Volume II the greater part of the discussion on how the theory is best applied—*i.e.*, the chapters on estimation and testing statistical hypotheses. While the basic mathematics can be established beyond dispute, the question of how best to use the mathematical model as a guide to practical decisions is one which is always likely to be subject to personal opinion. Part of this subject is therefore, as Mr. Kendall says, controversial, and may not fit readily into the solid and impersonal presentation required in a mathematical text-book. It seems to me that Mr. Kendall's achievement is to have presented for the first time, in admirable form for refer-

ence, the mathematical framework of our theory. Thus, he has provided a book which will be invaluable in the advanced teaching course, since by directing the student to appropriate chapters on theory the teacher will be freer than he has ever been before to tackle the difficult problem of training the mathematician to apply his knowledge soundly in interpreting the numerical data of practical experience. The book will also be welcomed by those of us whose theory has become somewhat rusty and who want to find a clear re-statement in one place of a particular branch of the subject which hitherto it has been necessary to track down in back issues of a number of scientific journals. There is, however, another class of readers who should not be forgotten. At the present time there are likely to be many persons beyond the reach of university training who will take up the study of mathematical statistics; indeed, through its recent Reports and plans for the Diploma, the Society has been encouraging this step. There is also the case of the lecturer in mathematics who hopes, by reading, to qualify himself as a teacher of mathematical statistics. Is Mr. Kendall's approach that best suited to help this type of reader? The question is an interesting one because of its bearing on the broad problem of how best to teach statistics. Clearly no final answer is possible until Volume II has appeared, but I am inclined to think that the mathematician who reads Volume I without guidance may be left with a somewhat unbalanced view of the practical function of mathematical statistics. The problem with which teachers of mathematical statistics are faced is that of training the mathematical student so that he may turn a sure hand to the scientific analysis of numerical data. The most important qualification of the good mathematical statistician is not the extent of his knowledge of statistical mathematics but his appreciation of the difficulties involved in fitting a mathematical model to the observations of actual experience. He must be clear-headed and self-critical, never letting his knowledge of theory run away with him; he must be always on the look-out to see whether the assumptions upon which the mathematics and probability theory have been constructed are, in fact, realised in practice, and, if not, whether the discrepancy will vitiate his conclusions. He should never employ a complex technique until he is clear in his own mind that it provides more accurate and useful information than a simpler method. And he should remember how often the most illuminating first step in the analysis of data is to examine them in appropriate diagrammatic form. During this war mathematicians, physicists and biologists have done their best to fill the gap which has resulted from an inadequate supply of mathematical statisticians. Many of them have taught themselves to become useful working statisticians, but it has been noticeable that when they have gone beyond the use of the simpler methods, they have often shown a lack of critical sense and have embarked on lengthy calculations which have been unjustifiable and likely to end in misleading conclusions. I think that this has occurred because the available textbooks have rarely been so written as to encourage the critical faculty. And with all its admirable qualities as a reference book, is it clear that Mr. Kendall's Volume I is altogether free from this defect? I put this as a question, aware that I may be demanding the impossible in a primarily mathematical text. A few examples will illustrate the points that have struck me. I feel that the author is more than once faced by a dilemma of his own making because he has introduced the mathematical theory before he has discussed the problems which it should be developed to solve. Thus a discussion of Bayes' postulate and that of Maximum Likelihood (7.24–7.31) is inevitably unsatisfactory and inconclusive until we have formulated from the practical point of view the user's requirement for an estimate. If a single value only is wanted, we can surely say straight away that there can be no "best" value, only a number of convenient methods for picking out a plausible value. If it is desired to estimate an interval within which the unknown value probably lies, then we can devise other methods of determining this according to the user's requirements. Again, does not the baffling problem of the hypothetical population and the imaginary sampling (8.3) fall into the background if we accept as fundamental the distinction between a conceptual probability theory and the perceptual world of experience in which certain "random happenings" are observed or can be made to occur with frequencies more or less in conformity with the theory? Our purpose as statisticians is to make use of this conformity (never perfect) to reduce as far as possible the frequency with which we make wrong decisions —*i.e.*, decisions that would have been different

had more data been available at the time. On a smaller point, the criticism (2.21) that the coefficient of variation is "hardly suitable for advanced work" because it is affected by "the value of the mean measured from some arbitrary origin" seems a little unjustified. In many practical problems the origin is not arbitrary, but clearly fixed on physical or biological grounds by the type of variable measured, so that the ratio of the standard deviation to the distance of the mean from, say, zero is in fact the relative measure of variation most appropriate. Consequently it is up to the mathematical statistician to find out what he can about the distribution, whether it is suitable for advanced work or not. Again, the range appears to be dismissed rather summarily in three sentences (2.15) without mention of the fact that in a certain broad class of sampling problems its use has proved more expeditious and, from the practical point of view, as effective as that of the standard deviation. Obviously this book cannot be concerned with the quadrature of integrals where there is no neat theory, but I think a reference to the practical value of such tabled distributions would have been worth while. There are places also where the opportunity might have been taken to encourage a critical outlook in the reader. Thus, in Example 8.9, introducing for the first time the test of a hypothesis, Mr. Kendall takes the case of a coin which is tossed 20 times and gives heads 15 times. He asks whether this conflicts with the hypothesis that the coin is unbiassed and bases his answer on the fact that the chance of getting 5 tails or less, if the hypothesis be true, is about 1 in 50. But why sum the chances in the tail of the binomial distribution, the inquiring reader might ask? Why not just consider the chance of getting 5 tails? Is the point too obvious to need explanation, remembering that this is the first appearance of the procedure? Another point which is here, as elsewhere, assumed as self-evident, yet appears to call for some comment or explanation, occurs in applying the χ^2 test to contingency tables. Why, the reader might legitimately ask, is it stated that the marginal totals may be regarded as constant (12.11, 12.16, 13.5)? In so far as the test is related to a sampling problem, it is a little difficult to regard both margins as fixed or constant and the usual test can, in fact, be established without appeal to this convention. These are criticisms, but what brother-statistician could be expected to read a book of this scope without coming on many points with which he disagreed! And the disappointments are few compared with the pleasures: the admirable synthesis of scattered work; the inclusion of much of the older useful technique which is apt to be overlooked in the rush for the more attractive "exact solutions" based on the normal distribution; the illustrative examples and the Exercises left for solving; the Notes and References at the end of chapters. At any rate the reviewer is already clear of the value that Volume I will be to him personally when he starts on preparing his first post-war lectures. May printer and publisher soon give us Volume II!

Math Gazette 28:223–4 D '44. Frank Sandon. * an attractive survey of a wide field. There is no talking down to the weakness of the statistician who wishes to avoid a bit of rigorous mathematics, but the needs of the working statistician are kept in mind throughout. The general lay-out of the book is like that followed in the more elementary Yule and Kendall * In the references the proportion of native writers is larger than in Wilks [*Mathematical Statistics*], British publications being in the great majority, though there are more references than in Wilks to Russian and Italian work. The book is thus more definitely representative of a particular school than is that of Wilks. But it is a very live and growing school, and though each writer employs Stieltjes integrals in the early part of his book, yet Kendall keeps his feet much more on the ground of everyday life. * concludes with a section on rank correlation that is of special interest to those school teachers who face classes of the order of 30 and are in the habit of ranking these pupils. Much of this last, together with the part on quantiles generally, is Kendall's own work. It may be noted, however, that psychological grading depends on an estimate of equality which may lead to two things being assessed as equal that differ by less than the *minimum sensibile:* this does not mean, as Kendall seems to suggest (p. 422), that the ranking is illegitimate, for there may quite well be a real and meaningful measurable quantity or quality behind our attempt to rank. * The section on standard error includes some very interesting matter about the estimation by various percentiles and ranges. There is no reference here to the recent development of the quantity control method. * The

present first volume is a great acquisition to the shelves of the working statistician. There is no other volume quite like it known to the reviewer; it brings together in convenient form a great deal of not readily accessible work; it is free from serious inaccuracies and errors. And above all it is welded together in such a way as to make of a rapidly growing subject with many ramifications and hazy limitations of subject-matter and scope a coherent body of principles and applications. Statistics developed from several independent sources: the study has united many different problems, and the applications of the science are now extremely wide and varied. Statistical technique is needed in many different fields of study and Kendall's book should prove invaluable to workers in any of them.

Math R 6:89–91 Ap '45. H. Scheffé. The scattered nature of the literature and the existence of excellent treatises in other branches of applied mathematics have made conspicuous the lack until now of a treatise on theoretical statistics. The appearance of the first volume of such a work claims more attention than books of a more limited scope, and its author must be honored for the greater courage required to undertake the huge task. On the other hand, having accepted the responsibility of the potential influence on future research of a treatise, he may expect more severe criticism of his efforts. * One's attitude toward the large amount of space devoted to calculations with moments, the small amount given the theory of probability, the manner in which statistical inference is introduced and the presence of certain mathematical inelegancies will be to some extent a matter of taste. Let us consider some of these aspects of the book. The place of probability theory in the book, "too little and too late," is indicated by the fact that, of the book's 457 pages, pages 164–185 are devoted to the chapter on probability (and likelihood). Postponing the theory causes difficulties in some of the earlier chapters; thus the "derivation" of the binomial and other distributions by the method of "frequency arrays" is vague and confusing. The amount of probability theory introduced is inadequate to the needs of the theoretical statistician; there is no mention of the law of large numbers, nor of stochastic convergence in general. This omission contributes to the logical fuzziness of many of the sections concerned with order relations among random variables and parameters. The author seems reluctant to use probability concepts even after they have been finally introduced. Many important statistical quantities are defined and their properties derived only for finite populations, when the treatment could as easily be general if it were based on probabilities. For instance, for a population partitioned into a [illegible] table, various measures of association are defined in terms of the number of individuals in the cells, instead of the probabilities associated with the cells. Here and elsewhere the limitation of the theory to finite populations tends to obscure the difference between sample and population, the tendency being enhanced by the frequent use of the same symbol for a population parameter and for its estimate from a sample, and by commonly occurring phrases like "distribution of a parameter," and once even "statistic of a population." Regression theory also, including partial and multiple correlation, is developed for finite populations, whereas the definition of the regression function as an expected value in a conditional probability distribution would have clarified the meaning of linearity of regression, the distinction between the regression function and a linear function fitted by least squares, and other regression concepts. Calculations of distributions of functions of several random variables are not always preceded by a clear statement of the joint distribution assumed for these random variables. Thus, the notion of statistical independence except for certain linear restrictions is used in the derivations of some distributions but not defined. The intra-class correlation coefficient is defined only for finite populations, then the distribution of the sample intra-class correlation coefficient is derived for the case of "a normal population in which the intra-class coefficient is λ"; this occurs before the definition of the k-variate normal distribution for $k > 2$. Again, the assumed underlying probability structure must be quite hazy to permit the statement pertaining to two population parameters (correlation ratio and multiple correlation coefficient) that "from some points of view the two are formally identical." With the language of probability theory available there is little reason for perpetuating such statistical jargon as "If we measure x_1 and x_2 about their respective means," or "the binomial distribution $f = (p + q)^n$," or "proportion" of "all possible samples." If we imagine an intelligent reader, who was unaware of the work of Neyman,

E. S. Pearson and Wald, and had to base his opinion of statistical inference on the exposition in this volume, he would have to judge it unscientific and arbitrary. In 1943 one could and should have given the reader of a book on "advanced theory" a more satisfactory introduction to statistical inference than this: "Although in the remainder of the present volume Bayes' postulate and the principle of maximum likelihood will not often appear explicitly, we shall frequently use a type of argument which is, in the ultimate analysis, based on them. A certain event or series of events is observed; on a hypothesis H the occurrence of these events is found to be highly improbable; and therefore H is rejected in favor of some hypothesis which makes the observations more probable." The statement that "the school of statisticians which rejects Bayes' postulate has substituted for it an apparently different principle based on the use of likelihood" is misleading if not incorrect. The above mentioned writers and others certainly do not at present use as the basis of their theories of statistical inference either likelihood or Bayes' postulate. (However, it is mentioned in a footnote that an account of Neyman's approach will be given in the second volume.) The mathematical flavor of this book is peculiar. One is pleased by the introduction and use of such tools as the Stieltjes integral and the characteristic function, and at the same time one may confess to an impression of mathematical awkwardness. There is no point to itemizing here the many details building up to this general impression; perhaps it will suffice to characterize one sort. In the same amount of space a larger degree of useful generality could have been imparted to many definitions and theorems. For instance, besides the matter of finite populations already mentioned, there is the following. Let $\{x_i\}$ be random variables with a joint distribution ($i = 1, 2, \cdots, n$) and consider the variance of a linear combination y. We find separate formulae for the cases $y = x_1 + x_2$ and $y = x_1 - x_2$; these are then specialized to the case of statistical independence; this is followed by the formula for the case $y = \Sigma_i a_i x_i$ with independent x_i, but the formula for the general case $y = \Sigma_i a_i x_i$ without the assumption of independence, whose derivation is as easy, is not given. A further example: in several special cases random variables of the form $\frac{1}{2} \log (n_2 u_1 / n_1 u_2)$, where u_1 and u_2 have independent χ^2-distributions with n_1 and n_2 degrees of freedom, respectively, are shown to have Fisher's z-distribution with n_1 and n_2 degrees of freedom; the general statement is never made. * Praiseworthy features of the book are the collections, after each chapter, of problems for the reader to work, and the large number of numerical examples worked throughout the text to illustrate every step of the theory. There are several hundred misprints and minor errors, few of which should trouble the reader. One mistake, which has appeared several times in the literature, is serious because it concerns a fundamental and frequently applied result; it consists of omitting the bracketed phrase from the converse of the first limit theorem [§ 4.12]. "Let $\{\phi_n\}$ be a sequence of characteristic functions corresponding to the sequence of distribution functions $\{F_n\}$. Then if $\phi_n(t)$ converges to $\phi(t)$ [for all real t and] uniformly in some finite t-interval $|t| < a$, then F_n converges to a distribution function F at all continuity points of F, and ϕ is the characteristic function of F." The author does not give the forms of the theorem usually more convenient in statistical applications, in which "uniformly in some finite t-interval $|t| < a$" is replaced by "$\phi(t)$ is continuous at $t = 0$," or by "$\phi(t)$ is a characteristic function." We note here also the omission [§ 4.9, also § 4.11, top of p. 101] of the bracketed word in the theorem: "if a sequence of distribution functions $\{F_n\}$ converges to a [continuous] distribution function F, it does so uniformly." Finally, there is a curious justification of the statement [§ 2.5 (b)] that "the mean of a sum is the sum of the means," in which "frequency functions" are added; if the statement refers to composite populations it is false, if to the sum of random variables, the addition of "frequency functions" makes no sense, and besides there is a correct proof in a later section [§ 3.36].

Nature 152:431–2 O 16 '43. R. A. Fisher. This very handsomely produced volume is one which it will be a pleasure to any mathematical statistician to possess. Mr. Kendall is indeed to be congratulated on the energy and unswerving perseverance needed to complete his heavy task, and encouraged in the still unflagging energy which will be needed for the second volume. So far as he has carried his work, he has certainly done something to sustain the credit of Great Britain in mathematical scholarship. * On the many occasions on which I have been consulted as to the feasibility and

desirability of a large-scale work on mathematical statistics, I have pointed to the discouraging circumstance that the advances of recent decades had been so subversive, not only to the methods but also to the points of view from which statistical problems are approached, that any presentation containing material expected by, and acceptable to, the leading minds of an earlier generation would come soon to be recognized as pointless and obsolete. Mr. Kendall deals tactfully with this difficulty, though without altogether solving it. Thus at first sight his contents pay at least formal respect to the old convention of expounding statistical methods under the headings, measures of central tendency, measures of dispersion, and finally, crowning the arch, measures of correlation. The last four....chapters....are indeed given up to various coefficients of correlation and assocation, not, it is true, quite in the old style, for the subjects are treated with a mathematical competence, based on a wide familiarity with the literature, far beyond anything previously attempted, but one is tempted to say also, beyond the intrinsic interest or practical utility of the methods under discussion. Why should anyone now wish to calculate a rank correlation, or a coefficient of contingency? The modern reader, on the other hand, would like to see a much fuller development of Chapter 10, on exact sampling distributions, and a far wider and more varied exposition of the uses of the χ^2 distribution than is supplied in Chapter 12. In the case of both these chapters, the subjects of which are of the greatest importance to the statistical reader, the approach is barred by an opening section of quite unnecessarily complex algebra. The perfunctory treatment of χ^2 suggests that Mr. Kendall is not immune from the weakness of other heavily burdened authors to scamp those portions of the work in which they are not particularly interested. The same perfunctory attitude emerges on p. 59 on a short section devoted to the calculation of factorial moments by successive summation. The author says: "The use of the method in practice lies in the fact that for certain calculating machines the progressive summation is easier to carry out than the processes involved in the method of Example 3.1." From one very highly equipped machinist to another, this may be true enough, though surely an understatement, for a method which replaces a large number of multiplications by an equal number of additions. The saving of labour is evidently most important when no machine is used at all, a condition in which even the most perfectly equipped among us must occasionally work. The method also of abbreviating the process further by summing from both ends to a chosen origin is not given, so that, unless he has independent information, the reader is not in a position to judge how valuable the procedure really is. The presentation of purely mathematical points is, generally speaking, careful, although, as has already been suggested, cumbrous proofs are sometimes used just where, for the general usefulness of the book, they should have been avoided. Two small points and one of greater importance are perhaps worthy of the author's attention with a view to subsequent editions. To say, as on p. 53, that "The moment about the mean of order $2r$, if it exists, is given by" a certain expression is not logically the same as to say that it is defined by the expression, and therefore exists, if the expression has a meaning. Kendall's form of statement suggests, contrary I suppose to his intention, that there is some other condition necessary for the existence of the moment. In examples 3.7 (p. 59) and 3.8 (p. 66) the symbols μ and κ appropriate to the population are applied to statistics derived from a sample. It is true that the sample is large, giving the heights of more than eight thousand men, and therefore the errors of random sampling will be comparatively small, but it is none the less a pity to confuse the student at this stage by blurring a distinction which will later require his full attention. The other examples, 3.9–3.11, are properly applied to distributions. Mr. Kendall is much interested in the rather formidable algebra of the symmetric functions used in mathematical statistics. Thus the formulae for translating moments into cumulants and *vice versa* are set out in full to the tenth degree on pp. 61–64, and in other parts of the book a good deal of space is given to proofs establishing similar relationships. In my own experience the approach to all work of this kind is greatly eased for the majority of mathematical statisticians by a preliminary consideration of the nature of partitions, and an introduction to the appropriate terminology and notation. Whereas, however, in Chapter 3, on moments and cumulants, mention of partitions seems to be carefully avoided, the reader of Chapter 11, in which more comprehensive methods of analysis are developed, is confronted without warning

or preparation with the notions (*a*) of partitions, (*b*) of partitions of multipartite numbers, and (*c*) of separations of partitions, as ideas which are essential to each difficult stage of the argument. The fact is that some mathematical statisticians have thought about partitions and in terms of partitional notation, while others have not done so at all. These are not going to be helped, but only baffled by the manner in which the ideas are here introduced. Each chapter is followed by a series of exercises, some of which are exceedingly good. Some examples in the text are at least equally difficult to the reader anxious to understand the solution. Thus in example 7.2, the following argument is used to demonstrate the recurrence formula, which yields very prettily the series of sub-factorials developed by Euler for the problem of the game of *Rencontre:* "Suppose that u_n is the number of ways in which all the letters go wrong. Consider any two letters. If these occupy each other's envelopes, the number of ways in which the remaining $n - 2$ letters can go wrong is u_{n-2}; and there are $(n - 1)$ ways in which two letters can be interchanged. But if one letter occupies another's place and not vice versa, which can happen in $(n - 1)$ ways, there are u_{n-1} ways in which the others can go wrong." I have not made the test widely, but I submit that very few mathematicians unfamiliar with this particular argument would be able from this form of statement to see where the two factors $(n - 1)$ really come from.

Plant Breeding Abstracts 16:245–6 Ap 1 '46. J. Wishart. * a fully authoritative exposition which at once has taken an honoured place in the literature of a subject in which the present half century has seen such a remarkable development. Not the least of the author's successes has been the synthesis of the work of foreign mathematical statisticians with that published in English. * The ground covered is the standard field ranging from probability and the study of frequency distributions up to correlation (simple, partial, multiple and rank), and is varied only by the somewhat unusual deferment of a formal study of probability and likelihood until after the various standard distributions, and their properties, have been described. Although the field is standard, the treatment is new in that it is formally mathematical throughout. In particular there is a chapter on characterization functions, developing a powerful method not only for the alternative description of a frequency distribution but also for the evaluation of many exact sampling distributions, although these are not developed as fully as they might be, *e.g.* to the distribution of the second order moment about the sample mean, or to that of the joint second order moments for a two-variable distribution, including the distribution of the estimated covariance. A valuable part of the book is the series of examples given together with the exercises with which the chapter closes. Many of these latter are extensions of theory quoted from papers, and are designed doubtless to stimulate a wider reading in this field. A number of corrections have been made in the revised edition, and while it would be too much to expect even now the volume to be completely free from errors, examination shows that it has been carefully compiled.

Sci 100:249–50 S 15 '44. Edwin B. Wilson. The title page contains neither date nor place of publication * New statistical theory....is really scattered very widely * It is therefore a great convenience that Kendall has brought a large amount of this new and advanced statistical theory together in one place. * there is no table of contents in the book * There is an excellent detailed index * If the reader desires to try his hand at exercises there are plenty in true English style, some easy and some so hard he will probably have recourse to the original source cited for help. Although many who work with statistics will find much of the book quite beyond them, the author states his results succinctly and many who stop not for the proofs will use the results. There are of course a few points I consider bad among so many good ones. I do not like the old statements that leptokurtic curves are sharply peaked and platykurtic ones flat-topped relative to the normal curve (p. 82) because I have never been able to appreciate in what way an isosceles triangle is flatter-topped or less sharply peaked than the normal curve—and for other reasons. I do not like the suggestion (p. 53) that it is a matter of convention whether we consider that a frequency function has a mean when the "principal value" of $\int xfdx$ is finite though $\int |x| fdx$ diverges, or the similar suggestion (p. 145) that there is nothing sinister about heterotypic frequency functions; for from the point of view of the sampling theory the mean in the first case and some at least of the parameters in the second have infinite standard deviations and are thus statistically indeterminate. I note that the name

of C. S. Peirce does not occur in the index nor, so far as I have observed, in the text, despite the importance of his ideas on chance and statistics. I do not like the phraseology (p. 166) "certainty that a proposition is not true is represented by zero"—it is all right, I suppose, but somehow it sounds queer. Then on page 184 it is offered as an exercise to prove that the probability is $\frac{1}{4}$ that three points taken at random on a circle lie on the same semi-circle; if the circle is divided by a given diameter the probability is $\frac{1}{4}$ that the three points lie on one or the other of those two semi-circles, but it would seem that there must be other ways in which they could lie within some same semi-circumference. In the hypothesis that a coin which comes down heads 15 times out of 20 (p. 198) be unbiassed the author considers only one tail of the distribution, *i.e.*, when there are 15 or more heads, but in the succeeding paragraph he seems to imply that we should use both tails. This seems inconsistent, but perhaps it is merely unclear to me. I am likewise troubled by the developments in pages 342–3 and in particular by the formulas 14.45 and 14.49, the former of which contains $\Gamma(n-2)$ in the denominator and the latter is for the special case when $n = 2$; as $\Gamma(0) = \infty$ I have had trouble making the transition. The statement of the problem on page 367 seems unfortunately confused. These criticisms are but trifles; Kendall's book is really a "must" for all who are concerned with advanced statistics.

For additional reviews, see 189; for reviews of Volume II, see 188.

[188]

★KENDALL, MAURICE G. **The Advanced Theory of Statistics, Vol. II.** London: Charles Griffin & Co. Ltd., 1946. Pp. vii, 521. 50*s*. * [The second "edition" of this book appears to be a reprinting, with minor corrections, and consequently is not listed separately.]

Ann Eug 14:89-90 O '47. Cedric A. B. Smith. * Together with volume I....covers almost all the most important parts of statistical theory, though some of the more complicated refinements which are chiefly useful to specialists have been omitted, as for example some of the types of experimental design. These two volumes give for the first time a connected account of the mathematical theory of statistics, together with examples illustrating its practical uses; and the book should be most valuable to anyone who has to make extensive use of statistics. It is, however, to be regretted that there is no account of the partitioning of χ^2, which would be specially useful to the geneticist. The inclusion of such recent developments as sequential tests and the use of control charts would also be helpful, together with a chapter on quick approximate methods which are often useful when exactness is either not necessary or would take a prohibitively long time. We hope that some day these subjects may be added, either in a later edition of this volume, or perhaps in a "volume III." The first part of the book is concerned with the estimation of parameters. The simplest way of estimating a parameter is to specify a "most probable value" for it, together with a standard error—a method which may be called "point-estimation." In large samples the method of maximum likelihood is shown to be unrivalled, and its properties are carefully and fully dealt with in the opening chapter, together with the related subjects of "efficiency," "sufficiency" of estimates and "the amount of information" given by a sample. The second chapter deals with certain other methods of point-estimation, but these are mainly of theoretical interest apart from Jeffreys's minimum χ^2 method, which forms a useful efficient estimate when maximum likelihood is tedious. (This indeed is a particular case of a general method of efficient estimation, as yet unpublished, which is being worked out by Tweedie.) Unfortunately the author does not use any genetical examples to illustrate these methods. In small samples it is more accurate to consider some form of "interval-estimation," *i.e.* the specification of a range of values within which the unknown parameter may reasonably be expected to lie. As leading statisticians do not agree on this subject, Kendall with scrupulous fairness gives an account of Pearson's method of confidence intervals, Fisher's fiducial probability, and Jeffreys's inverse probability, together with the logical foundations on which they are supposed to be based. Fortunately in most practical cases all these methods give the same or very similar results. Chapter 22 is devoted to the theory of regression, linking up with the theory of correlation and linear regression discussed in Chapters 14 and 15 of volume I. This chapter gives a useful account of curvilinear regression both for equally and unequally spaced ordinates, the use of orthogonal polynomials to simplify the arithmetic, and the necessary tests of significance for the regression coefficients. There

are two chapters on the powerful analysis of variance technique and its simpler applications. This is one of the best features of the book, since there are few other connected accounts of the subject which clearly explain both the practical method and underlying theory: and without a clear idea of what assumptions are being made it is easy to go wrong in applying this tool. The next chapter reviews the principles of sound sampling and experimental design. These will naturally be of considerable interest to the experimentalist, but the special difficulties of avoiding biased sampling which face the human geneticist are hardly touched on. It is also rather to be regretted that the author has not included more designs of the type used in agricultural experiments, such as incomplete blocks and lattice squares; but most types which are now considered of practical value are included. Kendall coins one very useful word in this connexion: "deviance" for what is usually called "sum of squares (of deviations)." Similarly one might well use "co-deviance" for "sum of products." We then have the simple rule that the variance estimate is the deviance divided by the number of degrees of freedom, and similarly for the covariance. Indeed, the analysis of variance would be more accurately called the "analysis of deviance." * The fast-developing subject of multivariate analysis is discussed in Chapter 28 (though Kendall fails to point out that the discriminant function is simply a particular application of the Neyman-Pearson theory). The last two chapters are on time series, and the determination of trend and oscillatory movements. Unfortunately this seems to be the least satisfactory part of statistical theory, but all methods used at present are carefully described. * A complete proof is given of every important result, so that a good mathematical background would be necessary to follow every detail: but most of the results of immediate applicability involve no more than elementary calculus. On the whole, the book is very clearly written, but there are difficult parts and a large number of errors and misprints. For example, the second sentence of example 17.2, page 3, should read "$(t_n - \theta)/\sqrt{v_n}$ will tend to a normal deviate, and $(t_n - \theta)$ to zero." The fifth sentence of paragraph 17.9, page 4, is incorrect: the modal value of a maximum likelihood estimate, in repeated sampling, is not necessarily the true value of the parameter. (Choose x from a Poisson distribution with non-integral mean μ. Then x is an estimate of μ, but its mode is an integer.) There are a number of obscurities on pages 8, 9 and 14–17. In equation (17.25), page 8, the argument is simpler if we do not insist that L_1 and L_2 should be *frequency* functions: the last two lines on the page would then read "the quotient may be taken to be a constant, for if it were a function of the x's that function could be assimilated to L_2." On page 9, 13th line up, for $\partial(x_1x_2)/\partial(t_1t_2)$ read $\partial(t_1t_2)/\partial(x_1x_2)$; and on the 7th line up, for "let t be sufficient" read "let (17.27) hold good." The final differentials of example 17.6, page 11, should read $d(s^2)$, $d(s'^2)$, not ds^2, ds'^2. The function K of 17.47, page 13, is not a likelihood function. On page 14, line 7, $K_m = -\Sigma n_i \log m$. On page 20 the usual convention of using Greek letters for parameters is violated by the use of m. At the top of page 53 it is not possible to estimate t by putting it equal to the unknown parameter τ: but if we substitute t for τ in L we see that the maximum likelihood equation (18.11) must be satisfied. Similarly paragraph 18.6 might begin "Let θ have minimum variance estimator t." Page 277 line 6 should read "curly brackets vanishes in the limit...." On page 381, 4th line up, the proportional frequency is equal to the angle measured in units of 2π radians. *

B Am Math Soc 54:863–8 S '48. Harold Hotelling. The great treatise....is now complete. For the first time a connected account is available of the main outlines of the whole theory of statistics, from elementary probability and the fundamentals of estimation and testing of hypotheses to recent advanced researches and techniques, with attention to many unsolved problems. A debt of gratitude is due the author for the prodigious task of working through thousands of papers scattered through a multitudinous variety of journals devoted to statistics, mathematics, economics, psychology, actuarial work, physics, biology of many kinds, and other fields, and assembling, arranging and rewriting their contents with original additions and comments. The second volume covers many of the more difficult and controversial subjects concerning which knowledge is still incomplete. This was apparently one object in the ordering of the chapters of the complete treatise, though both historical and logical bases for the arrangement are also discernible, and the actual arrangement seems to be a compromise. * [Chapters 17–20] constitute chiefly an expansion of R. A. Fisher's work, with more mathematical

details than Fisher himself gives, and with accounts of the extensions of Fisher's ideas by ....others. Chapter 22, on regression, includes an account of the orthogonal polynomials used for fitting with equidistant intervals of the argument. The next two chapters, on the analysis of variance, and Chapter 25 on the design of sampling inquiries, again reflect strongly Fisher's influence, though Mr. Kendall's interest as an economic statistician leads to a greater emphasis on social-economic sampling than on the agricultural and biological problems * The work of Neyman and Pearson on the fundamentals of testing hypotheses is postponed until after all this, with the result that its assimilation with Fisher's work into a rounded theory is incomplete. However the treatment is excellent and many a reader will get his first clear idea of the subject from these two chapters. The difficult problems of testing hypotheses involving two or more parameters are expounded as adequately as the present stage of knowledge permits. The chapter on multivariate analysis covers most of the fundamental work in this field, including Wishart's distribution, the T distribution, discriminatory analysis, and canonical correlations. It is not, however, made clear that the distribution found for the roots of a determinantal equation is applicable to the comparison of two samples as well as to canonical correlations; and a fuller account would be desirable of the contributions of Wilks and Hsu to the generalized analysis of variance. The two final chapters deal with time series. This vexing but urgent subject is still not in a satisfactorily complete state. Mr. Kendall has given the principal available material a thorough working over, using a variety of series of actual observations and a series of random numbers as examples for the application of weighted and unweighted moving averages, correlograms, and other devices. * Kendall amplifies R. A. Fisher's discussion of fiducial probability, including the Behrens test for the difference between two means. In attempting to understand these ideas and connect them with other statistical tests one encounters some fundamental difficulties. Probability is in the conception of Fisher and nearly all other present-day statisticians an idealization of frequency-ratios in large samples, and is thus subject to operational measure and verification. This concept should be distinguished sharply from the "degrees of rational belief" of writers such as Keynes who have used the word "probability" in this sense, a sense to which the reviewer would prefer, in the interest of clarity, to attach the word "credibility." In this review "probability" will be used with the former "objective" or statisticians' meaning. When we speak of probability distributions, and of probability levels for tests of significance, we ordinarily understand probability in this sense. Thus, when the Student distribution is used in a way now familiar to test the hypothesis that a sample has been drawn from a population of mean value 37 and the .05 probability level is employed, with the certain knowledge that the sample is a random one from some normal population, we can make the following statement: In the class of cases in which the mean of the population is 37, this hypothesis will be erroneously rejected with probability exactly .05. This statement implies an anticipation that in a long run of such trials the erroneous rejection will take place in almost exactly one-twentieth of the cases. Experiments of just this type have in fact been made, and have yielded close agreement with theory. Further consequences of routine application of the Student test have been elucidated through the power function and certain theorems on optimum properties of tests. The growing popularity of such tests is based on considerations of this kind. "Belief" in the hypothesis that the true mean is 37 may be determined by the outcome of the Student test in a way wholly consistent with the pragmatic philosophy of William James, according to which the truth is that which works, and the goodness of a belief is to be judged by its total consequences, in this case its probable consequences with measurable probabilities. The "fiducial probability" and "fiducial distributions" introduced by Fisher and now expounded by Kendall do not refer to probability in the sense indicated above. This fact, which has been lost sight of in much discussion, is pointed out by Kendall on pages 90 and 112. Furthermore, if one tries to read into the derivation of the Behrens-Fisher test on pages 91 and 92 the objective or frequency meaning of probability, the result is nonsense. Thus the distribution of

$$\epsilon = t_1 \cos \psi - t_2 \sin \psi$$

is obtained by convolution of two independent Student distributions of t_1 and t_2, with ψ regarded as a constant. But ψ is defined as the arctangent of the ratio of the two sample stand-

ard deviations, and if these are held constant t_1 and t_2 do not have the Student distribution but normal distributions, whence the conditional probability distribution of ϵ is normal. Thus the Behrens distribution does not give probabilities in the ordinary sense, but fiducial probabilities. The application of this test for the difference of two means does not yield definite proportions of fallacious rejections which can be expected to be verified in long series of experiments, but instead a specially defined measure of the degree of belief imputed to the result. What may be the consequences of routine application of the test remain to be elucidated through study of its power function. The underlying principle is in contrast to the pragmatic interpretation of the simpler tests. Thus we have what appears to be a dangerous and objectionable dualism. To escape from such dualism the available alternatives seem to be (*a*) to modify or abandon the Behrens test, (*b*) to derive it from some different principle, such for example as the comparison of the sample in hand with a sub-population of possible samples defined by constancy of some function of the sample standard deviations other than their ratio, but using the standard notion of probability, or (*c*) to insist that the proper justification of all statistical tests is to be obtained through fiducial probability. The last would be a drastic step hard to justify on pragmatic or other established principles, and in any postulational treatment would require an independent axiom not yet precisely stated and whose full consequences have not been explored. In trying to understand the literature of modern mathematical statistics it is essential to remember that, wherever written, it is fundamentally British, and derives historically from the British tradition of applied mathematics much more than from the meticulous continental tradition of rigorous pure mathematics. Karl Pearson began as a mathematical physicist working in elasticity, R. A. Fisher as an astronomer, "Student" as a chemist, and all became biological statisticians. Like Newton, Stokes, Green and the physicists, English statisticians have been more concerned with getting useful formulae than in delimiting the exact conditions of their validity, and have frequently used loose mathematical arguments. The proofs in the present volume are largely carried over from the original sources, often with arguments in forms subject to criticism. Thus on p. 7, following the formula for a two-dimensional normal distribution regarded as a limiting form, the statement is made and proved that the correlation is unity, meaning that it approaches unity, but this contradicts the postulated two-dimensional density. A more serious difficulty is with Fisher's famous original proof of the efficiency of maximum likelihood estimates, which became the point of departure of much new work and is here reproduced on pages 18 and 19. The free interchange of various limiting processes in the absence of any proof of validity, and the omission from (17.66) of terms involving the derivative of v, are faults in this proof which should be repaired at the first opportunity, even though similar results have recently been obtained by Cramér and Rao using other methods. An error due to the present reviewer, who in 1930 gave a proof of consistency and asymptotic normality of maximium likelihood estimates for discrete distributions but used insufficient care in passing over to continuous distributions, is here reproduced. The essential correctness of the result was established in 1936 by Dobb by a different method. There are some difficulties due in part to oversimplification of notation without sufficient indication as to what arguments enter into particular functions. Thus in various uses of the formula $\phi' = A + B\phi$ in Chap. 27, the reader will do well to remember that A and B may involve the variable parameter. On p. 333 there is a slight error in the statement of the region of variation of the a_{ij}; the matrix must be positive definite. Also, it is still not clear what the statistician is supposed to do with ancillary statistics. These and similar shortcomings are far more than compensated by the accomplishment of the immense task. The 62-page bibliography of something like 1800 entries (which the author states constitute only half his collection of references) is in itself enough to make this an indispensable work of reference. With the companion Volume I (of which a slightly revised third edition has now appeared) it forms a contribution far beyond the range of ordinary textbooks, suitable for reference and for serious students.

Biometrika 35:210–1 My '48. B. L. W(elch).

* The first four chapters of this second volume are concerned with the fundamental problem of estimating population parameters from sample values and of assigning limits to such parameters on a probability basis. * Mr. Kendall devotes most attention to the approach which does

not make explicit use of the concept of inverse probability. Some readers might consider that he should have given more space to the alternative position which is founded on Bayes's Theorem and its corollaries. However, in a sense, Harold Jeffreys's excellent restatement of this position in his *Theory of Probability* renders a lengthy description of it unnecessary, unless, indeed, Mr. Kendall's object had been to make a critical comparison and evaluation of the inverse and direct probability approaches. Mr. Kendall is content to describe rather than to judge. One might, perhaps, criticize him in this section of the book for carrying his non-committal attitude too far in the face of the irreconcilable viewpoints which emerge from the discussion. He could, possibly, have pressed his own ideas upon us more strongly in certain passages, without departing from the high standard of fairness which he maintains throughout in representing the ideas of his statistical colleagues. The problem of scientific inference discussed in these first four chapters, although a fertile source of argument, is, strangely enough, one which, in whatever way it is settled, does not appear to influence much the actual way in which scientific investigation is carried out in practice. The next five chapters are concerned with a miscellaneous range of questions, which, while not having the same attraction for the pure theorist, are more closely related to those statistical methods used most frequently in the everyday interpretation of experimental data. * The succeeding two chapters revert to a more generalized treatment following the same lines as the earlier ones. They are again concerned with the fundamental problem of scientific inference, although now from the restricted angle of significance testing. They furnish another illustration of the author's remarkable ability to reproduce the spirit as well as the substance of the original contributions covered by his survey. They again suffer, perhaps, from some lack of critical evaluation on the author's own part. The next chapter deals with multivariate analysis, including discriminant functions. From the theoretical standpoint this is a straightforward development from the univariate and bivariate cases. Some new problems are raised, but much is simply generalization. Of the possible applications of these recent developments it is difficult to speak confidently. It is clear that in many fields multivariate analysis of the type here described can only proceed on the basis of many dubious assumptions as to the nature of possible connexions between the variates. Moreover, simple interpretation of the results of a multivariate analysis in terms which convey much to the layman is difficult. On the other hand, in certain cases where a very large number of variates are measured (e.g. in intelligence testing) some logical way of dealing with the results is needed, and one may in some instances be sure enough of one's assumptions to exploit this recent theoretical work. The two final chapters deal with Time Series, a subject perhaps most studied by economists, but not one which has borne much fruit. Trade cycles have been sufficiently talked about, but there has been little analysis of data demonstrating their existence in an unequivocal fashion. Mr. Kendall is the foremost representative of a school of thought which holds that the search for regular periodicities in economic data has been largely a waste of time, and that much more is to be hoped for by considering so-called autoregressive schemes, which allow for irregularities in the lengths of periods—albeit irregularities governed by some simple law. It is too soon yet to say whether the new conceptions will be much more successful than the old, but whatever success is obtained will be largely due to Mr. Kendall's own efforts to clarify the subject. Looking back after reading through the two volumes of Mr. Kendall's ambitious enterprise, one is forced to the realization that here we have one of the most remarkable compilations that has ever been attempted by a single writer in any branch of science. If several writers had banded together to produce it one would still be impressed by the wide range of topics and viewpoints which it embraces. One might almost be pardoned, indeed, for thinking that "M. G. Kendall" was a pseudonym standing for the collaboration of several persons. This would, at all events, be a pleasant theory to explain the many excellences of the work, particularly its freedom from personal animosities and the generosity of its references to the contributions of so many different writers. It would also explain the somewhat loose-knit nature of the work judged as a whole. Occasionally one feels the lack of a sufficiently strong common thread running through it and holding it together; such as one would perhaps obtain if the author were inclined to be more trenchant in his criticisms of what other people write and more self-assertive in putting forward his own contributions.

But in reply to all possible criticisms, Mr. Kendall has the final word, when, in his concluding section, he says: "Much remains to be done; and this book will have served its purpose if the reader is left with the desire to do some of it himself." Few authors could by implication have exposed so clearly just what it is that remains to be done.

Brit Med J 4509:809 Je 7 '47. Major Greenwood. * Kendall has completed a difficult and important task in a manner which would have been creditable to one able to devote his whole time to the work. To have completed it while engaged in important administrative duties is indeed a triumph. * The technique of sampling is now well developed, and in the 25th chapter Mr. Kendall gives a lucid account of the best methods which does not make very heavy demands on the reader's mathematical knowledge. * In the last two chapters....on time-series, the author discusses, with adequate arithmetical illustration, a subject of universal interest. * Mr. Kendall, who has himself made important contributions to this branch of analysis, has admirably summarized the work of the last twenty-five years, and it is clear that statistical epidemiologists must reconsider the interpretation of so-called epidemic periodicity. It never seemed very probable that arithmetic, however extensive, would enable us to predict accurately when the next pandemic of influenza would afflict the world. Modern research has not increased the probability; yet few will deny that the subject is alluring, and we now have improved tools. Mr. Kendall has placed all statisticians, including medical statisticians, under a heavy debt of gratitude.

J Am Stat Assn 42:185–7 Mr '47. A. Wald. * gives perhaps a more comprehensive account of the existing theory than other books published so far on this subject. Statisticians will welcome the book as a valuable addition to the exisiting literature. * Some recent results by Cramér and Rao concerning the lower bound of the variance of an unbiased estimator are not discussed by the author. Presumably these results appeared too late for inclusion in the book. This is somewhat regrettable, since the Cramér-Rao results go beyond some of the theorems mentioned in the chapters on estimation. In the discussion of the principal test procedures in current use, perhaps a little more emphasis could have been given to the power functions of these tests. For example, the power function of the analysis of variance tests is only very briefly mentioned on page 302. The author discusses the asymptotic distribution of the likelihood ratio statistic when the hypothesis tested is true. It would have been useful to include also the asymptotic power function, especially since most of the test procedures in current use are likelihood ratio tests. Some comments may be made as to the clarity, precision and rigor of the author's presentation of the material. The standards maintained in this respect are not quite so high, in the opinion of the reviewer, as would seem desirable in a book on the advanced theory of statistics. For example, on page 5 it is stated: "If, of two consistent estimators t_1 and t_2, we have var $t_1 <$ var t_2 for all n, then t_1 is more efficient than t_2 for all sample sizes." This is correct only if t_1 and t_2 are unbiased estimators. The proof of consistency of the maximum likelihood estimate, as given by the author, does not seem to be entirely complete. The proof is based on the assertion (see p. 13) that the difference between the statistics t' and t defined there can be made arbitrarily small by choosing the class intervals sufficiently small. It seems to the reviewer that the assumptions made by the author still leave the possibility open that for any choice of the class intervals there may exist values $n, x_1, \ldots, x_n$ such that $|t'-t|$ remains large, *i.e.* the convergence of $t' - t$ to zero is not necessarily *uniform* in $n, x_1, \ldots, x_n$. The Fisher-Cochran theorem on the distribution of quadratic forms in normally distributed variables, as formulated by the author in sections 23.4 and 23.6, is much weaker than that given elsewhere in the literature. (*See,* for example, S. S. Wilks, *Mathematical Statistics,* p. 107.) It is unclear to the reviewer how the author concludes, on the top of page 183, that $\Sigma_{j,k}(x_{jk} - x_{j\cdot} - x_{\cdot k} + x_{\cdot\cdot})^2$ has the χ^2 distribution. This would easily follow from the identity (23.14) and the strong formulation of the Fisher-Cochran theorem as given, for example, by Wilks. In several examples given in the chapter on analysis of variance, the author suggests the amalgamation of the high order interactions that are found nonsignificant with the residual. This is a frequently adopted procedure in practice but not always quite justifiable from the theoretical point of view and should not be done indiscriminately. First of all, the general adoption of such a rule would introduce a slight bias in the estimate of the residual variance even if the interaction in question is exactly zero in the

population. The more serious objection to such a procedure perhaps is that nonsignificance of a certain interaction does not prove that the corresponding interaction in the population is really absent. Nonsignificance means merely that the sample does not give sufficiently strong evidence for the presence of such an interaction in the population. If there are strong *a priori* reasons to believe in the absence of the interaction under consideration, a nonsignificant result may justify the amalgamation of that interaction with the residual variance. In the absence of such *a priori* reasons, it would be, however, somewhat risky to rely merely on a nonsignificant result, especially if the level of significance is set as low as .05. The criticism implied by some of the comments in the preceding paragraphs should not detract from the many other merits of the book. The author has rendered an important service to statisticians by writing such a comprehensive book on the theory of statistical inference. It contains much important and valuable material that hitherto was not available except in papers scattered over a number of journals not easily accessible. The reader will also welcome the large number of examples and illustrations given throughout the text. After each chapter a great number of interesting exercises and problems are listed. Teachers of statistics will find these exercises particularly helpful and useful in their classroom work. The author is to be highly commended for the literature references after each chapter and for the extraordinarily large bibliography at the end of the book. This will be most helpful in guiding the student to the main sources about any particular topic discussed in the book.

J Am Stat Assn 42:473–5 S '47. E. J. Gumbel. * an author of a book on statistics is faced with two dangers: either its outgrowing into a theory of probabilities or its degeneration into a series of kitchen rules. Kendall avoids sophistication and overempiricism. He does not attain the philosophical beauty and mathematical rigor of Cramér's book, but he also avoids the purely empiristic attitude of letting statistics degenerate into a system of interpolation formulae ready for any use or abuse. Thus he succeeds in satisfying an urgent need. This valuable book, besides introducing new problems, reconsiders many topics of the first volume on a higher level. * The reviewer regrets a certain logical discontinuity in the arrangement of the fourteen chapters. * Chapters 17 to 21 dealing with estimation, inference, and significance ought to have been followed by Chapters 26 and 27 and that Chapters 23, 24, and 28 dealing with the analysis of variance belong together. In Chapter 21, on tests of significance, the probability papers now widely used by engineers might have been mentioned. However, this and other lacks must be accepted since completeness in such a rapidly expanding field cannot be reached, and it seems doubtful whether it is even desirable. The last two chapters dealing with time series are relatively short, probably because the author has devoted a separate brochure to these problems. The important contribution of Stumpf on periodogram analysis might have been given more space. The essential advantage of the book is the clear logical arrangement within each chapter. Many problems are first stated in such a simple way that an intuitive answer is ready at hand. This is then confirmed, or refuted, by mathematical methods, a procedure highly recommendable from the pedagogical point of view. Cauchy's distribution is frequently shown as an antithesis to the normal one, thus clearly demonstrating the limitations of the normal theory. After the mathematical treatment, numerical examples for the most important methods are given. Finally, exercises are chosen from the current literature summarizing a large body of research which could not be treated exhaustively. Thus, the book offers the right choice for both types of readers, for those interested in the advancement of research and for the practical statisticians who want definite prescriptions of how to act. The variety of numerical examples taken from economics, agriculture, biology and medicine may be accepted as a substitute for not treating separately the different independent statistical problems arising in these sciences. The index and the large bibliography are very valuable. A list of the graphs and tables would have increased the practical usefulness of this book.

J Inst Actuaries 73:456–7 pt 2 '47. H. L. S(eal). * The Neyman-Pearson method of confidence intervals and the Fisher technique of fiducial probability distributions are discussed in separate chapters. But although one may sympathize with the author in his dilemma over the conflicting claims of these protagonists, it seems hardly fair to the student to be given these two chapters without more detailed indications that whilst they are mutually inconsistent they are not equally plausible, and a

statement that, for what it is worth, the majority of professorial opinion appears to favour one at the expense of the other. Kendall continues to strive after impartiality by proceeding to devote five chapters to significance tests, regression, analysis of variance, and design of sampling inquiries, without specifically linking them to the general theory of significance tests which we owe to Neyman and Pearson. The latter is given with considerable detail in Chapters 26 and 27, and it is convenient to have for the first time such a summary of work which has been scattered widely in time and place since the first paper in 1928. The subsequent chapter on multivariate analysis is also useful for its description of recent work on canonical correlation and discriminant functions—techniques which are bound to have a much wider application now that they have been disinterred from the specialist periodicals and collected together in a connected account. Might one not hazard the opinion that in due course a discriminant function might be constructed to distinguish the potential success from the likely failure at the actuarial examinations?—though even this would be a long way from deciding whether passage of these examinations is proof that the candidate will make a successful actuary (whatever he may be)! The last two chapters in the book are concerned with time-series, a subject to which Kendall has made original contributions. The author here allows himself to make some pointed criticisms of current applications of periodogram analysis and moving averages and makes a good case for his point of view. The first appendix contains a few addenda to Vol. I, whilst the second consists of a valuable bibliography of statistical works running to 61 pages. A useful index completes the volume. A general comment which these two volumes of Kendall elicit is the extraordinary differences in statistical outlook and mathematical knowledge required from chapter to chapter. This is explained by the care which the author has taken to report and summarize the published works of the statisticians whose names are listed in his bibliography. Not unexpectedly, his chapters on analysis of variance derive from the Fisher and Yates "arithmetical" method of writing, whereas in the theory of significance tests and multivariate analysis Kendall has used the advanced mathematical methods of current writers on those subjects. As was suggested in our review of Vol. I the result is a patchy effect of simple and advanced conceptions; it would be very difficult for a student to work through Kendall's volumes in order to teach himself statistics. For example, the average actuary would find Chapters 1–3, 5–9, 12–14, 16, 21–25 and 29–30 for the most part comfortably within his mathematical reach, Chapters 10, 11, 15, 17–20 and 26–27 much harder going, and Chapters 4 and 28 only assimilable after considerable further mathematical reading. Yet we cannot believe that this is the necessary mathematical level of each of the portions of the subject thus categorized. In the result Kendall's becomes a first-class work of reference but not a book to be indiscriminately recommended for self-study.

J Royal Stat Soc 110:144–5 pt 2 '47. E. S. P(earson). * the completed work takes its place as a quite invaluable reference book. The assistance which it will provide in teaching an advanced class is, as I see it, very considerable. It will be possible in future to leave a good deal of mathematical treatment to the students' reading and to concentrate on the essentials of method, the guiding ideas and the training in what Mr. Kendall aptly terms "self discipline in the use of advanced theoretical techniques." * Mr. Kendall....presents parallel chapters on Neyman's theory of confidence intervals and Fisher's theory of fiducial inference. But the fact that he is being "fair all round" means that when, in describing the reasoning process by which conclusions are drawn from practical examples, he has need of a consistent logical approach, he sometimes cannot drive his argument home. This handicap is perhaps particularly noticeable in Chapter 21 on "Some common tests of significance." Throughout the two volumes the reader may often have found himself wishing that he knew "what Kendall really thinks." In this chapter (§21.1–21.8) we are given some insight into his views on the justification for the common procedure used in carrying out tests of significance, which he relates back to the theory of interval estimation. But he does not write as if he were quite confident that this approach is altogether satisfactory and, at the end of the chapter, he has accumulated such a number of different alternative methods of dealing with the main significance problems that the reader, anxious for guidance in tackling new situations, may be left in a little confusion. Now the approach to the testing of statistical hypotheses which Neyman

and I developed and which is fully and fairly presented later in Chapters 25 and 26 has as its purpose a synthesis of the solutions of these different problems. It may or may not be generally acceptable, but presumably because it is regarded by Kendall as controversial, it is kept within its allotted chapters and its application to the problems of Chapter 21 is not discussed. For example, from lack of guidance the reader might suppose that the illustration of weighing bags of sugar introduced in Ex. 21.1 (p. 99) is being dealt with on the lines later discussed in Chapter 25. But this is not the case, and a useful opportunity has been missed of discussing alternative ways in which the risks that the manufacturer has to face can be related to probability measures associated with a statistical test. The view that either the theory of estimation or that of testing hypotheses are abstruse and must be left for late consideration is, I am convinced, mistaken. They are concerned with the shaping of an analytical technique based on the theory of probability in such a form as to satisfy intuitive requirements of a calculus that is to aid us in reaching decisions from numerical data. The idea of comparing the power functions of two tests is no more difficult to grasp than that of comparing the sampling variances of two alternative estimators of a parameter. Experience shows that basic ideas of this kind can be introduced usefully at an early stage in teaching, and long before it is necessary to deal rigorously with the admittedly elaborate mathematical analysis required to establish existence theorems or maximum properties. As we all know only too well as practising statisticians, the distributions of experience do not always conform to those mathematical laws which lend themselves to the determination of optimum techniques based, say, on sufficient statistics. But the broad requirement of a good technique, since it aims at satisfying the scientific mode of reasoning, is something which must be independent of the functional form of the probability distributions which we happen to meet. As was to be expected from the standard he has set himself, Mr. Kendall's chapters on the analysis of variance contain the clear statement of the mathematical set-up and assumptions that is so often missing in current books on Statistics. He has spared no effort to make clear in algebraic form and by discussion of numerical examples, points which the beginner has frequent need to turn over in his mind—the interpretation of sums of squares when the hypothesis tested does not hold, the meaning of interactions, the difference between "normal" and randomization theory, etc. The fascination which the mathematical mind finds in the development of more and more complex experimental designs has its obvious dangers. Mr. Kendall's handling of his illustrative material aims at encouraging the student in the critical appreciation of his primary material. It is indeed instructive to go even further into this process and to go through the numerical examples given in Chapters 23 and 24, using diagrammatic representation to the limit imposed by two dimensions. One sees then how a number of the conclusions reached by arithmetical analysis are at once obvious to visual inspection and how, in other cases, the conditions assumed by theory are hardly borne out. For instance, a simple spot diagram of Bartlett's germination example (p. 208) and a little elementary calculation shows that the transformation of variable carried out at some length is in this instance scarcely justifiable, since there is no suggestion whatever that the variance within groups increases with the mean. One of the greatest contributions of the advanced theory of statistics lies in the way in which it trains the mind to think when faced with the planning and interpretation of scientific inquiries. Because this training gives a great impetus to clear thinking, it is not wasted even if, perhaps, more problems than are commonly admitted submit to simple handling, graphical inspection and the application of common sense. Mr. Kendall's book provides a wealth of material to illustrate the various aspects of this text. Chapter 25 on "The design of sampling inquiries" does not attempt to be exhaustive, but is a really useful statement of principles and ways and means. The last two chapters of the volume on Time Series, as the final chapter of Vol. I on Rank Correlation, deal with a field in which Mr. Kendall has himself made notable contributions. The subject is one in which exploration has far to go, and where the advancement of mathematical theory must proceed in very close touch with an understanding of the physical and economic phenomena which it aims at representing and analyzing. The author is aware of this, and the chapters provide an admirable example of the Statistician at work on a difficult problem. As in Vol. I, each chapter concludes with some use-

ful notes and grouped references; there are also, again, a number of appropriate exercises. An extremely valuable Bibliography is included as an Appendix; it covers the subjects dealt with in both volumes. Presumably, in later editions there will be a common subject index to the two volumes.

Math Gazette 31:126–7 My '47. Frank Sandon. * The system of reference numbers for sections of a chapter, tables, graphs, equations, examples (in the text) and exercises (at the chapter ends) indicates immediately in each case the chapter in which any particular item is to be found, but we find, for all that, that the necessary consultations are very awkward in the absence of any page reference. * The Appendix includes a valuable sixty-page bibliography. It is not complete: we notice—in particular—that Kendall's own revision of Yule's *Introduction to Statistics* is not listed. The Index at the end is for this volume only: Vol. I had its own index. The volume now before us is a masterly survey of the field. Much of the work was formerly to be found only in the scattered literature and had not been coordinated before this. Some matters that we would like to have seen are not here: teachers in particular will regret that, after getting near the topic in his references to Hotelling and after listing appropriate works in the appendix, the topic of the psychologist's "factor analysis" does not appear. Although there is a certain amount of arithmetical treatment of experimental facts and observations, particularly in connection with the last two chapters, yet the volume will probably not be so immediately serviceable to the computing statistician as is Vol. I. Thus the Quantity Control of the industrialist, though demanding logically the survey at the beginning of this volume, will appear to the engineer to get little from this book. But the author has put all serious students of this rapidly widening subject very deeply in his debt. The book is well produced, and misprints are extremely rare.

Math R 8:473 S '47. J. Wolfowitz. * the second volume of a very ambitious work * a valuable book. Not the least among its merits is the scope and volume of its contents, which are such that an advanced worker who wishes to read in a new (to him) branch of statistics will usually find sufficient preliminary orientation and an initial bibliography. The extreme paucity of good books on mathematical statistics is such that a serious work with many merits such as this one, which represents the fruit of so much labor, deserves much commendation. Nevertheless certain serious adverse criticisms must be made. (*a*) The first and most serious is that the level of mathematical rigor is not always satisfactory. This has two causes. Much of the now classical theory, which is British in origin, and even some of the contemporary British work, is written in a heuristic, nonrigorous fashion by people who use mathematics as many engineers and physicists do. To see what is meant consider, for example, the question of the number of degrees of freedom for the test of goodness of fit when several parameters are estimated from the data. [The correct solution of this problem is, of course, due to R. A. Fisher.] Section 21.20 of the present book contains an argument of the type which for many years has passed as a proof of the correct result. This should be compared with a sound proof of the same result in Cramér's "Mathematical Methods of Statistics" * Even if the nonrigorous argument had pedagogical value it would still be out of place in a book called "The Advanced Theory of Statistics." Actually it is the precise argument which is unambiguous and easier to understand, and the fuzzy argument which is so often incomprehensible. It is the necessity of putting these fuzzy arguments on a sound basis that makes the writing of good statistical books so difficult. Kendall has not, in this book, done much in this direction. What is worse, he has introduced errors of his own into results already on a sound basis. A few examples follow. (1) The first major proof with which the book begins, that of the optimum properties of the maximum likelihood estimate, is not, in the opinion of the reviewer, completely rigorous. The bibliographical appendix to the first chapter cites, however, a reference to a correct proof of this result by Doob. (2) Throughout the book the "delta method" (Taylor series) is used repeatedly, without validation. In this connection differentials are copiously abused. (3) The proof of the Fisher-Cochran theorem, fundamental in the analysis of variance, cannot be considered satisfactory as it is described in chapter 23. The correct proof is not difficult. The following questionable procedures advocated by many statistics books occur in various places in Kendall's book. (I) The pooling of estimates not found to be significantly different, even if there is no *a priori* reason for supposing equal the quantities

being estimated. (II) The testing of hypotheses on the data which suggested them. (III) Repeated tests of significance on the same data. (*b*) The Fisher theory of fiducial probability and the Neyman theory of confidence limits are treated "impartially," a separate chapter being given to each. The author notes that there are problems for which the two theories give incompatible results, but feels that he is keeping the treatment "objective." This reviewer is aware of the author's dilemma, but cannot regard the solution adopted as praiseworthy. If the description of adverse criticisms appears longer than that of the favorable comments, it is only because one usually has to document the former rather more than the latter. The book is indispensable for advanced workers in the field, who are competent to be critical of occasional doubtful arguments, and capable of supplying their own where necessary. It is not, in the reviewer's opinion, very suitable for use as a textbook or by not very advanced students.

Nature 159:148 F 1 '47. Godfrey Thomson.

* I may perhaps speak for those who want to apply statistical methods in various fields—in my case experimental psychology and education —but want also to understand them, indeed become interested in them for their own sake. Such must welcome Mr. Kendall's book warmly, and perhaps especially this second volume, in which Chapters 23 and 24 on the analysis of variance, and 25 on the design of sampling inquiries, are of peculiar interest to them. In agricultural experiments, properly designed, there seldom arises the problem of "unequal numbers in subclasses" (par. 24.6 *et seq.*). But in all sociological experiments, numbers in subclasses are liable to inequality. Absences from school affect one class more than another. An island population does not fall into occupational or racial classes of equal size. So the procedures to be adopted with "nonorthogonal" data (pp. 220–9) are of importance. I am sorry there is only a page and a half (pp. 262–3) about "confounding." It is very useful, however, to have everything in one book, and the examples and exercises (easy and difficult) are an admirable training and clarification. Mr. Kendall describes the work on canonical correlations of Hotelling and others, on pp. 348–58. Their perusal reminded me of a problem which I posed a few years ago, to which I have not received an answer. In work with intelligence tests the canonical correlation technique appears as the problem of finding sets of weights to apply to two batteries of tests so that the correlation coefficient of the two weighted scores is a maximum. I applied this in 1940 (*Brit. J. Psychol.*, 30, 358) to the problem of finding what weights would maximize a battery's reliability, that is, its correlation with a duplicate battery. These weights will, however, be different from those which cause this battery to give the best prediction of some "criterion," such as future success in a secondary school, and straining after reliability may spoil prediction, and vice versa. The problem was to find weights which would make reliability equal to prediction and both as large as possible under this condition. In simple cases a solution can be found. But what is the general solution? Students who are not primarily mathematicians very much need and welcome preliminary general explanations of the logic and purpose of the procedures to be proved and used in the succeeding pages, and some of them find geometrical analogies helpful. Given such assistance, they are able to follow the algebraic work more easily, or at least to appreciate its general trend, and to feel able to accept, not quite blindly, the formulae arrived at. Such assistance is not wanting in Mr. Kendall's volume—I may instance pp. 269–72 with the diagram, at the outset of the discussion of the general theory of significance tests, and the diagrams of confidence belts on pages 68, 69 and 77. In the latter I suggest the addition in dotted lines of the whole sausage-shaped region of acceptance, of which the shaded area is a section. The theory of probability has always been an arena for controversies and even quarrels. Mr. Kendall has refused to take sides in present-day disputes, but has objectively described both points of view. About the different approaches to the treatment of confidence intervals and fiducial inference, differences which so easily escape from one's mind even when one has again and again grasped them fleetingly, he has written two admirably lucid chapters, and has had them read by Prof. Egon Pearson and Prof. R. A. Fisher respectively to ensure that he has at least not misrepresented them. To the outsider, now one and now the other view seems the better. In sociological work, it is important not merely to consider the possibility of a hypothesis being the true explanation, but also its relative standing when compared with alternatives. Neyman and Pearson make just this point, and in addi-

tion to defining regions within which we reject a hypothesis because the odds are so and so that the data did not arise from it (of which regions there may be many) they choose among them that region which minimizes the chance of accepting the hypothesis when it is false. On the other hand, the Behrens test does not hold in the theory of confidence intervals, and the reply that "some questions may not have an answer" seems scarcely sufficient. Then Kendall protests that we can never test a fiducial distribution by drawing samples. But we can set up some apparatus corresponding to the value of θ and find experimentally the proportion of samples which give rise to t. Then we can change θ and repeat; and so on. Surely this is an experimental frequency distribution. Many will look forward to the future publications which Mr. Kendall half promises, in which he hopes to show that all these disagreements are more apparent than real. The book is beautifully printed and the proof-reading has been excellent.

Plant Breeding Abstracts 17:95 Ja 1 '47. J. Wishart. This volume completes the first comprehensive attempt which has been made to present the theory of statistics as a formal mathematical study, and the author is to be commended for the immense pains he has taken to gather so much material from a multiplicity of sources. * most useful bibliography of titles, extending over 62 closely printed pages * The practical statistical worker who is not a professional mathematician will find the early part hard reading. For the rest he will be concerned to supplement his knowledge of statistical tests gleaned from the first volume by the more advanced methods appropriate for two and more variables, and in particular regression analysis. In this connection the many worked examples will be of very great assistance to him. The biological worker will turn with interest to the sections on analysis of variance and experimental designs. These have been expounded many times, generally from the non-mathematical point of view, but it is important to keep in mind the assumptions behind the common tests, and it is valuable, therefore, to have a mathematical exposition. * The design of experiments is considered somewhat briefly in a separate chapter, which also hints at the various complexities behind sampling enquiries generally.

For additional reviews, see 189; for reviews of Volume I, see 187.

[189]

★KENDALL, MAURICE G. **The Advanced Theory of Statistics, Vols. I and II.** London: Charles Griffin & Co. Ltd., 1944, 1946. Pp. xii, 457; vii, 521. *42s.; 50s.* *

Ann Math Stat 18:139–42 Mr '47. M. S. Bartlett. With the recent appearance of the second volume, it is now possible to review as one work this comprehensive treatise. * The volumes are attractively printed; and each chapter concludes with a useful collection of examples for the reader. * the author's order of chapters in Volume II and in particular his inclusion of analysis of variance among the chapters on the theory of statistical tests is a little puzzling, and the reviewer's preference would have been to see this important subject treated earlier, together with regression analysis, and their link with the classical method of least squares more firmly outlined. Incidentally, there appears to be no mention of the Fourier analysis of observational data except in its relation to periodogram analysis (Ch. 30). This change of order would perhaps also have allowed a shift forward of Chapter 25 on the design of sampling enquiries, and a more compact section on multiple correlation, culminating with the chapter on multivariate analysis before the chapters on the general theory of statistical inference were begun. Another arrangement of rather doubtful value in Volume II is the allocation of separate chapters to fiducial probability and to the theory of confidence intervals. The problem of how to deal with a field which is still a battleground is admittedly not an easy one, and this particular one is an embarrassment at present to many teachers, but it may be questioned whether strict impartiality is the best answer. * The most criticizable arrangement, however, occurs in Volume I with the late and rather scanty treatment of probability in Chapter 7. To begin with examples of statistical data is sound, but since the whole conceptual model erected to deal with such data is based on probability theory, it does not seem sufficient for a reader who "feels keenly on the subject" to do as the author suggests in the Preface and read Chapters 7 and 8 after Chapter 1. Even if he does so, he will find no very clear exposition of the statistical theory of probability,—no mention, for example, of the laws of large numbers, whether for simple dichotomies or for entire continuous distribution functions, that show how the conceptual model adequately corresponds with the empirical notions of "in the

long run" or "for a large enough sample." The actual arrangement, moreover, leads to an apparently rather arbitrary treatment of theorems on limiting distributions; the First Limit Theorem, which deals with the equivalence of the limits of distribution function and corresponding characteristic function sequences, is given in the chapter on characteristic functions (Ch. 4), and the Central Limit Theorem, dealing with the convergence to normality of a sum of n independent random variables, is given in the chapter on probability. In the proof of the second part of the First Limit Theorem, dealing with the conditions under which a sequence $\phi_n(t)$ of characteristic functions determine the limiting distribution function $F(x)$, the author has not yet corrected an error that occurred in Cramér's original version, which Kendall follows (section 4.12). Correct conditions for convergence of the distribution function sequence $F_n(x)$ to $F(x)$ (at all continuity points of F) are convergence of the characteristic function sequence to $\phi(t)$ for all real t, uniformly in at least some finite t interval (*cf.* H. Scheffé, *Math. Reviews,* Vol. 6 (1945), p. 89). Another proof in Volume I which appears to need clarification is the geometrical derivation of the distribution of the multiple correlation coefficient in the case of a non-zero true correlation (section 15.21). The blunt statement is made, following equation (15.51), that the sample correlation coefficient R and an angle ψ (defined in the text) are independent, a statement which is incorrect. However, if the logic of Fisher's original derivation is examined, it turns out that the relation of R and ψ is only required when the true correlation is zero; under such conditions R and ψ are independent. In Volume II there is a sentence requiring correction and amplification in the derivation (in the case of zero true canonical correlations) of the sampling canonical correlation distribution (section 28.30). The sentence "Consider the distribution for a given value of t_{ij} and z_{ij}...." should be corrected to read "Consider the distribution for a given value of $t_{ij} + z_{ij}$...." Some justification that the distribution is independent of $t_{ij} + z_{ij}$ is then still needed. There is inevitably, owing to the time the book was written, no mention of sequential analysis, the sampling technique developed during the war by Wald and others and only recently "derestricted." Again, in Chapter 18, where the work of Aitken and Silverstone on unbiased estimates with minimum variance is referred to, the simple inequality connecting the variance of any unbiased estimate with Fisher's information function throws an interesting new light on this aspect of the estimation problem (see, for example, H. Cramér, *Mathematical Methods of Statistics,* section 32.3, or C. R. Rao, *Bulletin Calcutta Math. Soc.,* Vol. 37 (1945), p. 81), but was not known to the author when this chapter was written. Such omissions are merely an indication of the developing nature of the subject, and it is hoped they can be remedied in later editions. There is, however, especially in Volume II, an occasional impression of patchiness in the treatment not always [illegible] excusable on such grounds. This can perhaps be illustrated from the last chapter, a valuable contribution to the still-growing subject of time-series, but where the importance of some known results does not always seem sufficiently stressed; in particular, the Wiener-Khintchine relation between the periodogram and correlogram is noted (section 30.68) as "an interesting relation," whereas it is a fundamental relation in the modern method of approach to time-series, giving much deeper insight into the correct interpretation of classical periodogram analysis. These criticisms, which could be extended to cover minor errors and misprints, are not intended to detract seriously from what is a remarkable achievement. An excellent sense of proportion has been maintained throughout between mathematical theory and illustrative discussion and examples. This makes this treatise, if both the breadth and level of the subject matter are taken into account, at present unique. It will be an indispensable reference book to every teacher and advanced student of the theory of statistics.

For additional reviews, see 187–8.

[190]

★KENDALL, M. G. **Contributions to the Study of Oscillatory Time-Series.** National Institute of Economic and Social Research, Occasional Papers, IX. London and New York: Cambridge University Press, 1946. Pp. viii, 76. Paper. 7*s.* 6*d.*; $1.75. *

Economica 13:217–20 Ag '46. H. S. Booker. * a most valuable contribution * The studies are valuable despite the fact that the conclusions are largely negative, indeed we may say that their value lies therein. The trade cycle as a fluctuation with a systematic periodicity has been dying for a long time and Mr. Kendall has done more than drive another nail into its coffin. He shows not only that common sense and mathe-

matics give different periodicities to the same series but that different mathematical methods will give different results. Thus in a series of 480 items the periodogram suggests periods of 20 and 42 items, whilst the correlogram in so far as it suggests any periodicity at all indicates periods of 16, 33 and 44 items. But further, Mr. Kendall shows that with series of the length most frequently met with in economics, periodicities might appear simply from chance factors. * Are we....to assume that correlogram analysis, which seems to be the best mathematical method available, ought to be abandoned for economic series of ordinary length because only long series justify this analysis? Cannot it be argued that there is a difference in that the fluctuations that the economist observes and the statistician tries to measure are real fluctuations? They are not simply errors of observation normally distributed nor do they arise from the application of random numbers. They are the effect of causes; any periodicity that analysis reveals is likely to be real periodicity; what is to be doubted is whether any such regularity is inherent in what might be called the generating equation of economic activity. If one concentrates upon any periodicity which happened to exist in recent years one might miss significant features of the fluctuation. Mr. Kendall has shown that a periodicity may result from random factors. But are we going to be any safer in relying on a very long series? Do not conditions change with time and may not the "generating equation" itself change significantly? It seems to me that systematic mathematical analyses of economic data yield results of very limited value in interpreting economic activity but not necessarily in recording it. We must continue to look primarily to the application of common sense in the application of economic analysis to current economic movements, each case being treated on its merits. But these expressions of opinion should not be taken as justification for not examining relevant facts carefully and for not analysing the position rigidly. [See original review for critical comments not excerpted.]

J Am Stat Assn 42:187–8 Mr '47. T. W. Anderson. * The inferences drawn in the book are very interesting, but unfortunately, because of the empirical method used, are not very reliable. The four artificial series can be thought of as four observations, each from a statistical population of all series for a given a, b, and distribution of ϵ_t. One cannot have much confidence in conclusions drawn on the basis of only four observations, particularly when the problems are highly complicated. In studying some of the statistical techniques, the author does obtain the expected values of the statistics involved (or the expected values of the reciprocals), but he does not obtain indications of the sampling errors. The most significant part of the study, the effect of applying periodogram analysis of autoregressive series, needs a mathematical analysis to give definite conclusions. In the comparison of methods it would have been instructive to consider a method designed specifically for the autoregressive model. From the maximum likelihood estimates (assuming normality of ϵ_t) of the coefficients a and b one can calculate an estimate of the period. This estimate has certain desirable statistical properties such as consistency. The book should be educational to investigators who have applied methods such as periodogram analysis and have obtained results difficult to interpret. The author points out that the mathematical model of a finite series of trigonometric functions with a superimposed random term does not fit in economic theory well. The stochastic difference equation gives a better description of the economic process; the parameters of this model may have economic meaning. It is generally recognized that in a large number of economic time series there is no period in the sense of recurrence of phenomena after a certain exact time unit; the autoregressive model does not impose a strict period. In terms of stochastic difference equations the "period" is of secondary interest; the coefficients of the equations are the primary consideration. As the author suggests, much more mathematical statistical research is needed along this line.

J Am Stat Assn 42:188–90 Mr '47. Oskar Morgenstern. * The method employed in the study is essentially experimental. Its outcome is that methods other than correlogram analysis are to be rejected, especially the periodogram analysis. * A great amount of labor has gone into the computations, and the author is aware that much more experimentation is in order. He points out that the mechanization of computations could be carried further; part of the study concerns computational short cuts. This part of the investigation is, however, already obsolescent in view of the enormous progress in high-speed computational devices of which the author seems to be unaware, probably because of war-

time restrictions of information. In the future, far more extensive calculations become a possibility than the small example which the author has computed himself. Incidentally, even at the time his work was going on, speedy machines, suited for periodograms and autocorrelations (some developed in connection with the study of encephalograms), were available which apparently were not used. The author is particularly concerned with harmonic analysis and tries to show its inadequacy for economics. There is much to be said for this point of view if the given series are, for example, really autoregressive; but it would have to be proved for the empirical cases. It cannot be simply assumed. There are methods, developed by N. Wiener, Kolmogoroff and others, which would have to be employed for that purpose. It is not convincing when the author merely implicitly postulates the Beveridge series to be autoregressive and dismisses their periodograms because these appear similar to those considered inadequate—obtained for his artificially constructed autoregressive series. If, however, the Beveridge series are not simply autoregressive, then in turn their correlograms may have to be rejected while, *e.g.,* their periodograms may be acceptable. Another difficulty—recognized by Kendall—for general application of the correlogram is that short autoregressive series will not dampen sufficiently and—far worse—that the method is insensitive to changes in the scheme of autoregression. The latter becomes a real possibility in economics, especially when use is made of long series (*e.g.,* Beveridge's), which are so highly desirable; however, these "long" series are still only short in the sense of the method; *i.e.,* they do not tend to dampen well. In the present phase of analysis of economic time-series, it is very difficult to state which is the best model to assume. Certainly, it is premature to decide in favor of any one, and it is risky to decide against some, especially if theories as powerful as that of the Fourier transform and integral are available and find ever increasing applications to more and more fields. Experimental work with empirically given series on an enormously larger scale than anything done thus far and with a minimum but variety of assumptions about the underlying generating mechanisms seems to be indicated. Thus would then also advance our theory. The reader will find the paper very well written and highly stimulating.

J Pol Econ 55:391 Ag '47. Gerhard Tintner. This is a most valuable contribution to the difficult subject of time series, which is so important for economic statistics. * the author ....is inclined to pin his faith on methods based upon runs and sequences in the series. These methods are somewhat related to the ideas of W. A. Wallis and G. H. Moore and to similar ideas by Wald and Wolfowitz. The author derives a formula for the mean distance between peaks which fits the artificial data remarkably well. But the distributions of runs and intervals become very complicated. No complete theory is given. It is also to be feared that such "nonparametric" methods discard a good deal of the information available in the series. *

J Royal Stat Soc 109:504 pt 4 '46. F. J. A(nscombe). * The autoregressive structure chosen for the artificial series seems a reasonable one * The investigation has yielded striking and valuable results; and it is interesting that Mr. Kendall's observations on the failure of the correlogram to damp out have already been confirmed by subsequent theoretical researches of Dr. M. S. Bartlett. The treatment is complementary to the account of the mathematical theory of time series given in the last chapter of the same author's *Advanced Theory of Statistics,* Vol. 2. Our thanks and congratulations are due to Mr. Kendall and the National Institute of Economic and Social Research (which supplied computational assistance) for carrying through an arduous programme. * That Mr. Kendall's little book is lucid and pleasant to read goes without saying. It will interest both the economist and the mathematician—the economist for the light cast on fundamental ideas of time-series analysis, the mathematician for the wide field of research suggested.

Math R 8:471–2 S '47. J. L. Doob. The author discusses stationary time series, that is, stationary stochastic processes, with particular reference to their periodicity properties. He is particularly interested in those whose chance variables are solutions of linear second order difference equations (*) $u_{t+2} + au_{t+1} + bu_t = \epsilon_{t+2}$, $t = 0, \pm 1, \ldots$, where a and b are constants and ϵ_{t+2} is independent of u_s for $s < t + 2$. Since he neither formulates his problems in probability language nor uses the standard harmonic analysis of stationary processes, he is reduced to making statements supported principally by the analysis of sample series obtained from (*) by choosing values of the con-

stants a and b, obtaining ϵ_t's from sets of "random numbers." There is considerable discussion of periods and their meaning, but the author is apparently unaware of the significance of the spectral function of a stationary process and, in particular, of its role in defining the periods of such a process.

Nature 161:187 F 7 '48. David G. Kendall. The classical approach to time-series was a search for hidden periodicities, observational error being considered the only obstacle to accurate prediction * Now, however, in this and many other fields one prefers to work with a quite different model, in which the time-series is generated by a linear operator supplied with a random input. (A pleasing example is the music made by a sea shell.) The resulting series, though in general oscillatory, will not be periodic, and the possibility of prediction will be severely limited by the continued occurrence of random changes in phase and amplitude. Mr. Kendall's monograph discusses all existing methods of time-series analysis in relation to one of the simplest of these models, Yule's autoregressive scheme * The book contains much useful computational advice together with a new set of tables for harmonic analysis. The correlogram and periodogram analyses of four artificial series of great length supply the first empirical evidence about the relative value of these two methods, and this part of the work is sure to stimulate much further research. The labour involved in the work must have been very great, and the debt already owed to its author by the statistical world has been correspondingly increased. Mr. Kendall's chief conclusion is that the periodogram analysis of autoregressive series is misleading and not worth the labour involved, but his case seems to me to be overstated. The greater share of condemnation really belongs not to the periodogram itself but to the classical (here inapplicable) method of interpretation. Recent work by the late Prof. P. J. Daniell suggests that a *smoothed* periodogram might be of much diagnostic value, and one would like to see Mr. Kendall's sample periodograms compared with their expectation forms. Daniell also showed that the *sample* periodogram and correlogram are algebraically equivalent, so that each contains exactly the same information; a very interesting consequence of his identity is that the smoothed periodogram depends mainly on the first few sample autocorrelations. Mr. Kendall's observations should also be compared with recent work by Prof. M. S. Bartlett on sampling properties of the correlogram, which explains the failure to damp according to expectation when the series is of finite length. The present debate about the best definition for the "period" of an autoregressive series seems to me of doubtful value. What we need in practice is not a period of recurrence so much as an estimate of the time from the present boom to the next slump (and conversely). This might well be measured by the location of the principal negative minimum in the correlogram, and the ordinate there would indicate the degree to which the series was oscillatory. (Bartlett has already pointed out the need for distinguishing between *oscillatory* series and those which are merely *fluctuating*—Kendall's series 2 is an example of the latter type.) I am puzzled by equation (6.8) for the "m.d. (peaks)," because the latter expression has several possible meanings; "mean number of peaks per unit length of series" appears to be the quantity actually determined, this being, of course, equal to the reciprocal of the given expression.

Q Appl Math 5:240 Jl '47. J. Krumhansl. * As an account of inadequacies of the methods discussed, the paper will interest statisticians, but mathematicians and physicists who have been interested in the general time series problem in the broader sense will notice the lack of reference to a large body of the work done in this field.

Sankhyā 8:287–8 O '47. K. C. Cheriyan. A short summary of available literature on any particular topic of research will be welcome to research workers, but more so when the topic happens to be one on which very few papers have appeared. The last exhaustive work on this topic was by Herman Wold in 1938 and the present work differs from that one in dealing only with the main researches on the subject and dealing with them in such a way that even non-mathematical readers would benefit by a perusal of the book. * For workers in economic statistics, this book will serve as a guide in the use of correct methods of analysis and also as an incentive to further research.

[191]

★KENDALL, MAURICE G. **Rank Correlation Methods.** London: Charles Griffin & Co. Ltd., 1948. Pp. vii, 160. 18*s.* *

Ann Eug 15:91–2 O '49. C. A. B. Smith. * To a large extent the subject is covered by

chapter 16 of the author's earlier book, *The Advanced Theory of Statistics,* vol. 1 (London, 1943), but this book includes certain recent developments (such as partial rank correlation) and presents the whole subject in a self-contained manner. * Unfortunately, there is as yet no test of significance for partial rank correlation. * The book is written on a novel plan. Some of the chapters concentrate on the practical use of the methods, for the benefit of the less mathematical reader who is interested in the applications; between them are sandwiched the chapters containing the full theoretical justification of the procedures. All the chapters are very lucid, clear, and accurate, and the minimum of previous knowledge is assumed, so that a reader who begins with very little statistical background will find little difficulty in following the methods. It remains to be seen how these ideas work out in practice, but in the reviewer's opinion they are excellent, and (within, of course, reasonable limits) might well be copied elsewhere. One point which the author might have made more clearly is the necessity for a suitable caution and critical faculty in interpreting statistical results. There is unfortunately a tendency for some users of complicated statistical procedures to regard the obtaining of a "significant" or "non-significant" result almost as an end in itself, without asking too closely what is it significant of—is it the effect we are looking for? or could it have some other obvious explanation? This danger is particularly great in ranking methods: supposing that we have found that a person can make preferences between pairs of objects with considerable consistency, what does this mean? If the experiment is well designed, we may indeed be testing a single effect; but it may be that the "preferences" are the resultant of several different kinds of effect, and that the results of the test, despite their statistical significance, are of little value. It may also be necessary to make sure we are eliminating errors in the way explained by Fisher in *The Design of Experiments.* A few small errors....have been noticed *

Biometrika 37:190 Je '50. F. N. David. * Kendall succeeds admirably in both....[his] aims, and he does so by dividing the book so that the application of techniques can be read without reference to the chapters on mathematical derivations. Such a division of spheres of interest is useful and helpful in any discussion on order statistics, since the application of such statistics is easy but the theory often very difficult. It is interesting to note in the univariate case, which Prof. Kendall does not touch upon, that while many order statistics have been proposed (all of which are easy to apply and interesting mathematically), yet it is rare indeed to find the need to use them in practice. It is customary to twist the observations about and/or to make various assumptions in order that existing techniques may be applied. This, the writer would suggest, is because of the instinctive feeling that tests based on ranks cannot be very discriminating. If, on the other hand, we consider the bivariate case, the order statistics proposed by Spearman and latterly by Kendall are used fairly frequently with little thought of the undoubted loss of information which using them implies. Is it that there is no alternative, or do we not know enough about bivariate techniques to try to do something better? Or is it that with bivariate techniques we are still wedded to the idea of description in a way which no longer applies in the univariate case? Mathematical statisticians will find Prof. Kendall's book stimulating, in that it makes one aware of questions which may be raised and for which answers have not yet been found. Applied statisticians will find here all that they can be offered at the present in the way of techniques.

Brit J Psychol, Stat Sect 2:67–8 Mr '49. Cyril Burt. * The chief outcome of....[Kendall's] discussion is to demonstrate that rank correlation is no longer to be regarded as a somewhat dubious makeshift, but leads to procedures which are of considerable practical value and to problems of great theoretical interest. * He....deduces two formulae for rank correlation. * The first equation [ρ] is simply the ordinary Pearson product-moment formula, applied to ranks instead of to ordinary measurements, and appropriately simplified: Mr. Kendall names it after Spearman, who, he adds, "introduced it into psychological work." † The second [τ] has been ingeniously devised by Mr. Kendall himself (*Biometrika,* XXX, 1938, p. 81). * It is not difficult to show that the cor-

† In reviewing Spearman's article Binet claimed that he and Henri had already used this procedure, and in early psychological discussions the name "Spearman's rank correlation formula" was usually understood to refer to the still shorter procedure given in *Brit. J. Psych.,* II, p. 93. Spearman himself explained that "in the simplified form the standard or r method Mr. [Kendall's ρ] shows itself to be distinguished from *our* short or R method by the fact that the differences are squared." The simplification of the Pearson equation he attributed to Lipps. However, the popularity of rank correlations in psychology, if not their actual introduction, is undoubtedly attributable to Spearman.

relation between the two is approximately $1 - \frac{1}{4}n$, and that, when n is large, τ will be about two-thirds the value of ρ. Evidently Σd^2 will be easier to compute than s; and, although there are short cuts, ρ would seem to be the more convenient for practical calculation. On the other hand, τ is the only coefficient of correlation that depends solely on linear processes. Hence a machine might readily be constructed to compute it. After three introductory chapters on the general theory, Mr. Kendall discusses methods of testing significance. Here, if the practical advantage still lies with the older coefficient, the theoretical advantage undoubtedly lies with the newer. The sampling variance of the newer is of an order twice that of the old; but the old presents considerable difficulties in its sampling distribution. Mr. Kendall next considers the problem presented when we have a number of rankings, *e.g.*, when m observers rank n objects. As he formulates it, his problem would appear to be that of finding a general factor for a set of rank "correlations between persons." He points out that the most obvious procedure would be to average all the possible correlations; but shorter methods can be substituted. And he then shows that, if we rank the items according to the sums of the ranks allotted to the individuals, the ranking so obtained "gives a best estimate in a sense associated with least squares"—the best estimate, it may be added, for what the psychologist would call the "general factor." Here again "ρ is a more convenient coefficient than τ"; and the expression reached seems identical with that already used by psychologists. (It has been called the "corrected square sum ratio," *Factors of the Mind*, p. 275.) Mr. Kendall next proves that τ can be generalized to the case of partial rank correlation. The advantage now lies with the new procedure. This, as he proves, yields an expression for the partial coefficient that is formally the same as that for the ordinary partial product-moment coefficient. Finally he deals with the more general problem of "paired comparisons"—a method which enables us to obtain coefficients of consistency and of agreement for those cases in which the underlying variable is not necessarily linear. Readers who are acquainted with the chapter on rank correlation in Mr. Kendall's *Advanced Theory of Statistics* (I, pp. 388–437) will be interested to learn that the new account contains much new material and several new tables. The exposition too introduces a novel and helpful device: throughout the volume the author writes in alternate chapters; with each fresh topic the first chapter describes the main results and their applications in simple terms; the next gives the more technical proofs for the equations employed. As Mr. Kendall employs it, the method seems eminently successful—far better than the commoner practices of incorporating the advanced mathematics in the general text or relegating them to footnotes or appendices. The discussions are a model of lucidity; and both the new book and the new correlational procedure may be strongly recommended to the notice of all psychologists interested in developing the statistical side of their work.

Econ J 59:575–7 D '49. R. C. Geary. * In its field of application, and to a certain extent in its adepts, the statistical theory of ranks stands apart from the main body of statistical science. It is accordingly useful to have a monograph on the subject which the author shows lends itself to tidy treatment, and to which he has himself notably contributed. Two coefficients of rank correlation are discussed in this book, ρ, which is the familiar Spearman figure, and τ. * The author briefly discusses the relative merits of the two coefficients, preferring τ to ρ and, in consequence, devoting more attention to τ. The reviewer ventures mildly to demur as to this preference, while agreeing that it is very useful to have a theory for τ. It would be interesting to investigate the relative efficiency (or sensitivity) of the two coefficients for determining real relationship between two characters in samples of given size. The reviewer's guess—he may be quite wrong—is that ρ is the more sensitive because it seems to take more account of the magnitude of the characters than does τ; furthermore, as the author shows, Spearman's coefficient in the large-sample normal case is a far better estimator of the population-correlation coefficient ρ' than is t the estimate of τ. If this were so, it would outweigh the disadvantages mentioned by the author of slower approach to normality in frequency distribution and greater difficulty in dealing with the problem of ties. Mathematically, ρ seems, in general, easier to deal with than τ; it gives a clear concept of partial correlation and in general makes it possible to apply ordinary theory (multiple regression, analysis of variance, etc.) to problems of rank simply by regarding rank as an actual measure. * In using the normal approxi-

mation for testing significance, the author indicates that, as a correction for continuity, unity should be added (for negative scores) or deducted (for positive scores) before dividing by the exact standard deviation. As a theoretical point of little practical importance unless the samples are very small, it may be observed that the Sheppard corrections should be applied to the "raw" variance, *i.e.*, $\frac{1}{3}$ should be deducted from the original variance in the case of τ. The author discusses not only the significant departure from true zero values of the coefficient τ but also the possible deviations in random samples of given size when the universal value is not zero. The reviewer found it difficult to envisage applications in which this problem has practical importance. It seems to endow τ with an objective validity which it does not possess. The analogous problem of the classical correlation coefficient has the practical justification that approximate ascertainment of the true (or universal) coefficient is a means towards the end of determining the joint frequency distribution. Is it correct to state (p. 109) that there is no parent value of the Spearman correlation ρ? Surely the procedure outlined on page 49 for estimating the value of τ from a sample of n from a parent population of N could equally be used to derive an estimate of ρ, and hence to define a population value of ρ. In clarity of treatment, in nice balance between mathematics and application, in accuracy, the present work reaches Mr. Kendall's high standard of text-book writing.

J Inst Actuaries 75:140–1 Je '49. N. L. J(ohnson). * The appearance of works on special aspects of statistical theory is a welcome sign of the growth and recognition of statistics as an independent discipline. The present book on rank correlation is an excellent further example of the "coming-of-age" of statistics. As is to be expected from the author of *The Advanced Theory of Statistics,* the book is notable for the completeness of treatment of its special subject, and for the profusion of numerical examples it contains. It is a book which should certainly be studied by anyone who uses, or is interested in, the particular subject with which it deals. * The general theory of ordered observations covers a much wider field than rank correlation and it is a matter of some regret that it was not possible to issue a volume covering more of the subject. Nevertheless this cannot detract from the merits of what actually has been produced. * The author points out that.... [the separation of practical application and mathematical theory into different chapters] was necessary....to satisfy both practical users of rank correlation methods and persons whose main interest is in the theory. It appears that the practical users are assumed to possess little or no knowledge of general statistical theory. This leads to certain extra explanations which could well be omitted if a slight acquaintance with elementary statistical theory could be assumed. In the reviewer's opinion such a general knowledge of statistical theory should be obtained before reading any book on special statistical subjects, and not picked up in the course of reading such a specialist book. A second valuable feature of the book is the set of tables provided. The tables on the distributions of rank correlation criteria appear for the first time in consolidated and handy form. * For those especially interested in rank correlation theory, everything of importance is there *

Nature 164:680 O 22 '49. John Wishart. * Kendall has gathered together what is known on the subject, and has given a coherent mathematical treatment to it all. With the growth of mathematical statistics, it seems inevitable that books should begin to be issued on specific topics within the general framework, and this book is to be welcomed as a worthy addition to such a series. * A commendable attempt has been made to formalize the theory, and so put it on a par with other coefficients of statistical theory. It is very unlikely that the last word has yet been said, and undoubtedly there are still difficulties to face. The subject is a live one, however; and for those who wish to go on with it, or to use the best-known methods, the present book will be exceedingly valuable as avoiding on one hand the painstaking business of reading up from scattered publications all that has previously been written on the subject, and on the other as presenting clearly the methods to be followed, with a wealth of illustrative material. *

[192]

★KENNEDY, CLIFFORD W. **Quality Control Methods.** New York: Prentice-Hall, Inc., 1948. Pp. viii, 243. Text edition, $3.55; trade edition, $4.75. *

Adv Mgmt 13:181–2 D '48. Joseph M. Juran. [See 107 for joint review.]

Am Machinist 92:186D–E Ag 12 '48. * Written from a practical viewpoint the book relates theory to practice and will appeal to personnel in the manufacturing divisions. * Nu-

merous charts and examples are presented to good advantage.

Ind Qual Control 5:29–30 S '48. Franklin E. Satterthwaite. * Kennedy....has demonstrated in his book an ability to pick out the important points. He discusses them in down-to-earth style. His illustrations and examples always make the point. Where arithmetic is necessary, he goes through it in meticulous detail so that anyone can follow it. He sets forth a wealth of experience as a practical quality control worker. In some important spots, however, Mr. Kennedy's book falls short of technical perfection. Many instructors will wish to use the book as an introductory text because of the ease with which operating personnel can understand its style. Unfortunately they may find this impossible because of these technical deficiencies. It is hoped a second edition will soon be prepared overcoming this weakness. * The introductory sections on selecting and checking samples, sample size, quality levels, and producer's and consumer's risks are very good. The use of Peach's simplified method makes an excellent introduction to the design of a sampling plan. * Part 1 is well written except for a few technical lapses. Quality Levels would be much clearer if p_1 and p_2 were defined to be identical with Acceptable Quality Level and Lot Tolerance Percent Defective. As presented, the definitions are hazy and the reader is confused as to just what quality level is being talked about. In fact, on page 44, Lot Tolerance is used in an example as p_1 which confuses the discussion generally. On page 68 a common slip is repeated: "the chances would be 95% good that the lot was of quality equal to p_1 or better." Of course, such statements cannot be made without bringing in the theory of inverse probability. Generally if the process average is poorer than p_1, then less than 95% of the accepted lots will be better than p_1. It would be helpful if this chapter contained a clear discussion of process average as the factor which should be used to control the amount of inspection. * part [2] starts out with good practical advice on using acceptance sampling techniques for process control within the factory. * However, this chapter suffers greatly because Simon's "grand lot system" has been incorrectly used to illustrate percent defective and p-chart methods. Grand-lot n instead of sub-lot n is continually used to calculate control limits. The student had better put large question marks on pages, 100, 109–110 and 116–117, and on Figures 24, 26 and 28 before studying this chapter. On page 115 the author comments on the significance of a downward trend although the trend in the example used would not be considered significant by any statistical test. * Part 3 seems to handle a difficult subject very well. * The discussion of the relation between control limits and specification limits is weak, because the author does not tell how to calculate control limits for individuals from the average range. This carries over into the discussion of standard values. On page 202 the correct formula is given in a footnote while a different one is used in the text. The two are identical for samples of four but for samples of five or more the text formula is unsafe. The discussion of standard limits based on three sigma for individuals does not appear to be correct. * To sum up: this book was written for practical shop men by a practical man. The points of arithmetic and theory which give the shop man trouble are outlined with every detail clearly stated. Occasionally the book gets beyond its depth technically.

J Am Stat Assn 44:320–2 Je '49. Sebastian B. Littauer. * seems to be the first [book on statistical quality control] which is admittedly addressed to shop operating personnel, and therefore is to be viewed in that light. One might, on that account, reasonably have anticipated a greater emphasis on operating procedures, practical examples, administrative and economic problems, and in general the important non-statistical aspects of quality control which have yet to be adequately presented. The fact, however, is that this work is devoted primarily to reporting statistical aspects of quality control, supposedly to fill the gaps left by other authors' omission of "basic details and primary concepts." * 'Statistical quality control can be motivated naturally by introducing the principles of acceptance sampling which can, again, lead naturally into control chart procedures. This has been effectively done by another author. In the present work, however, acceptance sampling procedures are presented apparently because "the progressive business house establishes a receiving system designed to make *certain* that the goods delivered fulfill requirements before the invoice is paid." The presentation of the various sampling plans is not prefaced by any exposition of statistical principles nor is their practical use validated by bringing in the role of statistical control in acceptance sampling

practices. The exposition is necessarily descriptive and follows from one plan to another, single, double and sequential, with little foundation that can be called statistical. It seems questionable, at best, to devote so much space to an attempted simplified explanation which "follows closely the instructions in *Sequential Analysis of Statistical Data: Applications*" when the readily available S.R.G. work does the job so well and so thoroughly. The present treatment neglects to show the natural place of acceptance sampling in statistical quality control viewed both as a system of thought and as a system of practices. The author seems to confuse estimation with testing hypotheses. For example, early in Part 1, page 12, the author advises: "Throughout the use of sampling methods, never lose sight of the fact that basically you are attempting to estimate or judge the whole by what you see and think from examining a part or a sample." While this is altogether wholesome advice it does not apply to the use of the sampling plans presented, and, in fact, the originators of these plans would argue quite strongly against this practice. In a number of other places the author makes reference to estimating either the "condition" of the lot, or the quality of the lot. Many statements made by the author must be read with great care in order to avoid misinterpretation. On reading (p. 7) that, "A sample is defined by the dictionary as a part shown to prove the quality of the whole," this reviewer checked some six dictionaries. The closest approach to the quoted statement was found to be, "A part of anything presented as evidence of the quality of the whole," from *Webster's Collegiate Dictionary* (Merriam and Co., 1917). Perhaps a statistical dictionary is needed. Again (p. 31), "The sample size n may be a number of ounces or pounds, a proportion of a fifty-ton gondola of ore, for example, or it may be so many drops of liquid, or 100 persons interviewed during a public opinion poll in a certain city" does not say what it may have been intended to mean. Nor can the statement (p. 68) "In other words, the chances would be 95 per cent good (with the buyers' risk from error in sampling, p, at 5 per cent) that the lot was of quality equal to $p_1 (p_1 = .05)$, or better" be regarded as correctly interpreting the use of a Wald sequential plan. In numerous other places in Part 1 the text requires discriminating reading that it is not likely to get from shop personnel who have had no previous statistical training. The whole treatment of acceptance sampling might have been clarified and simplified by use of *OC* curves. As it stands, the exposition is misleading to the uninitiated. The remainder of the book is conventional except for the use of shop language. In the author's attempt to bypass the preciseness of statistical inference for the suggestiveness of intuitive insight he has inadvertently exposed his whole exposition to question. Thus there is never a clear distinction between parameters and statistics, which leads to confusion between control limits and confidence intervals in the discussion of p-charts. This may also account for the absence of a clear-cut explanation of and emphasis upon the concept of statistical control, stressing the importance of time order and rational subgrouping. There are no exercises for the student to work on and few adequate illustrative examples. In spite of the six practical problems in the last chapter, one might have hoped that this author would have embellished his writing with more material taken from his extensive experience. It is rather surprising to this reviewer that there is no reference in the body of the text or in the index to Shewhart's contributions, and only a belated reference to his earlier book in the brief bibliography. In spite of all the space (26 pages) devoted to sequential sampling, Wald's name does not appear anywhere. On page 102, there is a replica of a table from page 23 of *Introduction to Industrial Statistics and Quality Control* by Paul Peach, with no specific acknowledgment. It is customary to acknowledge any complete reproduction apart from a general reference in the bibliography. Is it not the responsibility of the publisher to supply careful editing in order to pick up omissions like those mentioned?

J Am Stat Assn 44:322 Je '49. Charles R. Scott, Jr. * an informative book * The author handles the subject in a way that a beginner can understand. * Of great importance is the way the author explains how to read a chart and interpret the data collected. Part V very nicely winds up with some good common-sense suggestions on what to do with the knowledge gained from the book. The reader is not left confused as to how to apply practically what he learned. The commercial examples form a basis for practical application. *

Mgmt R 37:654 D '48. * a well-balanced treatment of the subject from both theoretical and practical viewpoints, and it deals mainly

with the basic details and primary concerns which many other texts by quality control experts have overlooked.

[193]

★KENNEY, JOHN F. **Mathematics of Statistics, Part One, Second Edition.** New York: D. Van Nostrand Co., Inc., 1947. Pp. xii, 260. $3.75. * (London: Macmillan & Co. Ltd. 28*s.* 6*d.*)

J Am Stat Assn 43:332–4 Je '48. Howard Levene. * a slight revision, with minor clarifications and additions, of the first (1939) edition * The summation notation is introduced early and used consistently throughout the text. This lends much greater clarity to the extensive discussion and proofs of various moment relations than is usual in a text on this level. * This book is clear and well written and should be an excellent text for a course dealing with the material it covers. However, the reviewer questions the purposes served by such a course. The word "probability" appears for the first time on page 114 and is occasionally used thereafter, but a discussion of the concept is deferred to Part II (not here reviewed), and the notion of sampling and sampling error appears only in vague form in some of the discussions. The same letter is used throughout for both parameter and statistic. Sampling of attributes is not mentioned, presumably since a coherent discussion of it would require probability theory. Because of these and other deficiencies the book is not suitable for a terminal course in statistics. Students intending to go on to a "practical" course in statistics do not require such a thorough algebraic foundation, while those intending to take further courses in mathematical statistics might do better to devote their time to pure mathematics, so as to be prepared for an introductory statistics course using the calculus and probability theory. With the difficulty of finding time in the curriculum for all the subjects a student should study, it is doubtful if time should be devoted to material which must be largely repeated, in somewhat different form, in later courses. Both the virtues and the defects of the book are well shown in the chapter on correlation. There is a good discussion of the nature of normal correlation. The normal bivariate surface is treated briefly, but the major mathematical treatment in this chapter is in terms of an existing finite sample. Conclusions are drawn from this about the predictive value and the amount of relationship implied by a given correlation coefficient. While there is verbal reference to some vague "large" set of values or population, it would seem that this treatment would be confusing. Blakeman's criterion of linearity of regression is given, with a warning that it is not reliable and a reference to Part II for the analysis of variance test. The example on page 220 for which Blakeman's criterion is said to break down is poorly chosen, since the analysis of variance test is not applicable. Blakeman's criterion is the only significance test mentioned in the present volume, there being no mention that a criterion for existence of regression would be desirable. * On pages 147 *ff.* it is recommended that when two variables have a linear relationship and both are subject to errors, the sum of squares of perpendicular deviations from the fitted line should be minimized. This method is not invariant under change of scale of measurement. The problem of the determination of structural relationships is an important one, but requires a much more complete specification of the underlying chance mechanism, and even then cannot always be solved.

J Am Stat Assn 43:334–5 Je '48. Ronald W. Shephard. * an elementary textbook on descriptive statistics, much used and a pedagogically sound treatment * It is difficult to find any changes in the textual discussion, and most students would use the revision along with the earlier edition without recognizing any differences. * One would naturally expect substantial change and improvement of student exercises, but this has not been provided. * More fundamentally, this revision is an example of a practice of publishers to rush into new editions at this time without having ready a thoroughgoing rewrite of their popular textbooks, resulting in little or no incorporation of new treatments and new applications of methods which have occurred during the war years. This is not to be taken as a criticism of Mr. Kenney's general method of treatment, which the reviewer has found to be a relief from the usual elementary textbook on descriptive statistics in the social sciences.

Math Gazette 33:68–9 F '49. F. Sandon. * The book is called the mathematics of statistics but it is not clear how much mathematics the pupil is expected to know. He is given five-figure logarithms in a table at the end, and is expected to know the meaning of "real" and of "ordered," but is required to prove on p. 61

that the harmonic mean is less than the geometric mean and that than the arithmetic mean by presumably the school method. It is a confusing book. There are six chapters, each divided into sections numbered from 1 afresh for each chapter. There are a number of tables numbered 1, 2, ... through the book: the majority of these form the basis of examples and exercises, though Table No. 31 (which by hunting we find again was printed on p. 186) is a reference table: other reference tables appear in the text with no number at all (as on p. 120). There are figures, examples, exercises, equations (apparently these are called expressions), theorems and books for further reference. Some of these are numbered serially through the book, some through a chapter, and some on other principles: there is no page reference for any of them when they are quoted. In some cases it is not clear whether the reference is to an example *or, e.g.* to an equation. The contents pages give simply the headings of the chapters and the sections, and the index is a two-page affair in large type, quoting, *e.g.* a few authors such as Walker from a textbook of whom two lines are quoted—a longer quotation from her does not appear in the index—while original workers are not indexed—even in the text these may be referred to second-hand by giving another textbook as authority. The meaning of the tables is often not clear (*e.g.* on p. 106), the sources of the tables are often not given, or, when given, not given unambiguously (as, *e.g.* p. 89, in the reference to Pearson where no distinction is made between Karl Pearson and his son E. S.). The wording of the exercises is sometimes rather obscure * It is not easy to see what is assumed when we read (p. 134, Ex. 6) that we assume a normal distribution, given $\alpha_3 = .007$ and $\alpha_4 = 3.02$, or again (p. 134, Ex. 7) lamp bulbs have a mean life of 50 days, an s.d. of 19 days, and their lives conform to the normal curve. The definition of expectation of life is contradicted by the table on the same page (p. 136). The note at the end of Ex. 4, p. 199, is, as we read it, untrue. It is a pity to speak of heteroscadastic systems under the heading of Normal Bivariate Surfaces (p. 209). No member of the Mathematical Association would let his pupils "prove" the checks in the way the author sets out his on pp. 66 and 77. The author tries to avoid sampling as a topic. But he uses smoothing, and inevitably needs what is practically some idea of sampling. The method of p. 131 is unsound without sampling: in the absence of it the answer is surely obtained directly from p. 19 as 260/995 or .26 instead of the .24 obtained from the integral of p. 131. In all, the book is unlikely to be of much value in England. There are a few misprints, some rather important. Is a "bitt" (p. 152) what we in the Old World call a "bollard"? And what is the distinction between the number of fish *caught in* a body of water and the number *caught out of it* (p. 189)?

For reviews of the first edition, see 2:172; for reviews of Part Two, see 194.

[194]

KENNEY, JOHN F. **Mathematics of Statistics, Part Two.** New York: D. Van Nostrand Co., Inc., 1939. Pp. ix, 202. $2.75. (London: Macmillan & Co. Ltd., 1949. 21*s.*)

Math Gazette 33:228–9 O '49. Frank Sandon. * The book is rather confusing. Thus the distribution function $f(x)$ is defined in Chapter III, on p. 43, but has already been used in Chapter I. It is not clear how the universe of p. 107 gives what is called the type III curve of this universe on p. 108, with its abrupt lower end. There is no legend to the graphs on p. 47, "Typical Curves of the Pearson System," to explain the various ways in which Pearson described or derived them. *Null hypothesis* is twice defined (once on p. 117, and again on p. 181); *Statistic* similarly is defined twice (on p. 98 and on p. 125). The treatment is not too rigorous: it is not explained what is meant by (p. 50) the observed measurements satisfying approximately the relation given. On p. 171, not interpolation but extrapolation is surely required to deal with chi-squared as 5.8 for $n = 7$. Some of the examples are rather unreal: thus (p. 89) "suppose....solution $r_{1.23} = 1.29$," and (p. 90) "find....in order that $r_{1.23} = 1$." As in Part I, references are badly made. * All this is a pity, for there is much that is good in the book. It would serve well as a note book. It gets near to being quite good in its treatment of the derivation of the chi-squared test, of Tchebycheff's inequality, of multiple and partial correlation and of fiducial limits. The three tables given (of normal curve, of Snedecor's F, and of chi-squared) are all useful. But the whole book should have been rewritten and not merely reprinted.

For additional reviews, see 2:172; for reviews of Part One, see 193.

[195]

★KERRICH, J. E. **An Experimental Introduction to the Theory of Probability.** Johannesburg, South Africa: the Author (University of Witwatersrand), 1946. Pp. 98. 8.50 kr. *

J Am Stat Assn 44:147–8 Mr '49. J. F. Kenney. * the author has admirably achieved his objective as stated in the Foreword: "In this book, a little ground is covered thoroughly and great pains are taken to try to present a clear picture of the physical significance of a mathematical probability. With this background the student will be better equipped to study the many texts which deal with 'pure' theory based on a system of axioms." And this hope is well founded when he says: "It is hoped that students of these pages will never have to reject any of the ideas given here, no matter how much they may refine them as their knowledge of the subject grows."

J Inst Actuaries Students' Soc 6:189–90 Ap '47. H. W. H. * Kerrich uses the time-honoured experiments of tossing a coin and drawing balls from a box. It is a pity that he does not give details of something more important, drawn from biology or physics. It is felt that students would then be more convinced about the value of the frequency concept. * The book or something like it is strongly recommended to Part I and II students. It will give them an attitude to probability which will help them with their future work. * The weakest part of Mr. Kerrich's book is the treatment of estimation and tests. Perhaps this can be excused in an elementary book, but at the present time this is considered a very important part of applied statistics and it is thought that a fuller treatment might have been given. *

J Royal Stat Soc 110:74 pt 1 '47. S. V(ajda). * If we find any fault with the presentation, it is perhaps the rather disjointed treatment of estimation. * The author has succeeded in writing a very instructive and easily readable book, and he may rest assured that "students of these pages will never have to reject any ideas given here, no matter how much they may refine them as their knowledge of the subject grows." (p. 6.)

Math Gazette 30:178–9 Jl '46. Frank Sandon. * The treatment of his book starts with grounds common alike to mathematician and non-mathematician and builds up work to serve as an introduction to textbooks on probability. He does this by considering the results of two experiments. (1) He spun, under stated conditions, a coin (apparently a Danish crown) ten thousand times, and noted the results. * (2) Four ping-pong balls, two of one make and two of another, appearing "to be practically identical," were shaken in a box and two drawn in succession. * On the data the author builds up his development of the theory, that is, the idea of probability * The book can....be recommended to those who have to give their students the preliminary ideas, and the procedure will probably be found to be of definite pedagogic worth. Occasionally a word or phrase might be modified to make the meaning more clear or precise. But by his treatment the difficulties of "equally probable" are avoided. There is no index and no bibliography. The book is printed in Denmark, but only rarely have misprints slipped past the eye of the proof-reader, some in the spelling of English words, and some in the use of mathematical symbolism.

Nature 158:360 S 14 '46. * Whatever views are held about the basis of the concept of probability there seems little doubt that students who meet it for the first time are helped to strengthen their faith by experimental work with coins or random numbers. Mr. Kerrich's brochure will be useful to such students, and his general approach could be studied with profit by teachers.

Trans Actuarial Soc Am 48:177–9 My '47. Hugh H. Wolfenden. The author....will be remembered for the valuable addition to actuarial literature which he made in his paper on "Systems of Osculating Arcs" in *J.I.A.*, LXVI (1935), 88. * For those whose minds feel more comfortable with a primarily statistical approach, this book will accomplish some considerable clarification through its careful analyses and pedagogically valuable insights; for those who have already preferred a more mathematical treatment, and in that process have been able to rationalize the unavoidable hypothetical intricacies which are thereby handled in a shorter way, Mr. Kerrich's discussion will add stimulus and place emphasis upon the ever present conflicts in the several viewpoints which are summarized for actuarial students in this reviewer's "Fundamental Principles of Mathematical Statistics," pp. 4–9, 179–87, 221–23 (*re* Bayes), and 263–64. * The many diagrams are beautifully drawn and excellently reproduced.

[196]

★KESKAR, Y. D. **Statistics.** Bombay, India: Vora & Co., Publishers Ltd., 1948. Pp. vi, 462. Rs. 10/8. *

[197]

KING, ARNOLD J.; MCCARTY, DALE E.; AND MCPEEK, MILES. **An Objective Method of Sampling Wheat Fields to Estimate Production and Quality of Wheat.** U.S. Department of Agriculture, Technical Bulletin No. 814. Washington, D.C.: Government Printing Office, February 1942. Pp. 87. Paper. $0.10. *

J Am Stat Assn 37:549–50 D '42. F. X. Schumacher. * The bulletin should prove very helpful in designing sample surveys of other annual crops and of perennial crops such as timber. Proofreading, however, seems not to have been taken very seriously. *

[198]

★KLAUBER, L. M. **Four Papers on the Applications of Statistical Methods to Herpetological Problems.** Bulletins of the Zoological Society of San Diego, No. 17. San Diego, Calif.: the Society, October 15, 1941. Pp. 95. Paper. Gratis. *

[199]

★KNEALE, WILLIAM. **Probability and Induction.** London and New York: Oxford University Press, 1949. Pp. viii, 264. 15*s.*; $3.75. *

J Am Stat Assn 45:142–3 Mr '50. John H. Smith. * intended for readers interested in philosophical problems * A considerable amount of effort is devoted to the problems of definition in the theory of probability. In this connection, the author brings in most of the unnecessary difficulties connected with the task of incorporating in the same statement the definition of a theoretical concept and the practical conditions under which it would be appropriate to apply it. For example, on page 158, he says that the theoretical meaning of point, line, and plane in geometry are determined by the postulates and it is no objection to the system of geometry that it cannot be applied to experience. He goes on to contrast the situation with respect to probability in which the philosopher is not "to construct a formal system with consistency and elegance for his only guidance. His task is to clarify the meaning of probability statements made by plain men." In all this he seems to assume that the attitude common in connection with applications of pure mathematics would not be appropriate in connection with applications of probability. The reviewer takes the opposite position. * the author considers various concepts which are interesting from the philosophical point of view: such as, Bernoulli's theorem, Poincaré's equalization theorems, the principle of indifference or equal distribution of ignorance, inverse probability, Bertrand's paradox and so forth. * The term secondary induction is used in dealing with "theories as opposed to laws or probability rules." Just as in the case of primary induction of natural laws theories are expected to explain, secondary induction is proposed as a policy—a device which meets with the reviewer's approval. The interesting discussion of the scientific method is made a little awkward by repeated emphasis on the sense in which one should not refer to induced principles as probable. This is not surprising in view of his statement (p. 222) that "the result of the statisticians' work on a sample is not an inference to something beyond the sample, but a lucid presentation of the known facts about the sample."

J Inst Actuaries 75:262–4 pt 2 '49. H. L. S(eal). * Kneale....is interested only in the philosophical problems of the definition of probability and its use in the interpretation of induction generally. Though he considers various definitions of mathematical probability his book contains little mathematical symbolism and is directed towards philosophers interested in the principles of scientific method. However, about two-fifths of the contents of *Probability and Induction* is devoted to an excellent discussion of probability theory in which the frequency definition is criticized and the subjectivist standpoint is demolished—the manuscript of the book was largely complete before the war and Jeffreys is not mentioned. The approach Kneale finds most plausible is a modification of von Kries's notion of the "range" of the characters considered: the probability of an A thing's being B is defined as the proportion of the range of A-ness which belongs also to the range of B-ness. Whatever opinions may be held about this definition there is no gainsaying the fact that Kneale's treatment of his whole subject is skilful and surprisingly easy for the amateur philosopher to follow. *

[200]

★KOLMOGOROV, A. N. **Foundations of the Theory of Probability.** Translated by Nathan Morrison from the original German edition published in 1933. New York: Chelsea Publishing Co., 1950. Pp. viii, 71. $2.50. *

[201]

★KOOPMANS, TJALLING C., EDITOR. **Statistical Inference in Dynamic Economic Models.** Introduction by Jacob Marschak. Cowles Commission for Research in Economics, Monograph No. 10. New York: John Wiley & Sons, Inc., 1950. Pp. xv, 438. Lithotyped. $6.00. * (London: Chapman & Hall, Ltd. 48*s.*)

[202]

★LEVINSON, HORACE C. **The Science of Chance: From Probability to Statistics.** A revision of *Your Chance to Win.* New York: Rinehart & Co., Inc., 1950. Pp. vii, 348. Cloth (trade edition), $3.00; paper (text edition), $2.00. *

N Y Times Book R p. 29 F 12 '50. Rex Lardner. * a meaty, sample-filled book that illustrates how the laws of probability were formulated by early mathematicians and reflective gamblers. It shows how the offspring of the laws—the science of statistics—is now applied to such divergent enterprises as playing the market, determining the number of kernels in ears of corn, loosing depth-charges on submarines. Sound poker play and some of the conventional roulette systems are taken up in the first half of the book; the odds on getting various types of hands at cards are listed. The last half contains chapters on the application of statistics in business and advertising, and one on how statisticians and pollsters sometimes fool themselves. A statistician or a pollster can't be too careful with what he does with the figures he's collected, Mr. L. points out.

For reviews of the first edition, see 2:185.

[203]

LEVY, HYMAN, AND PREIDEL, E. E. **Elementary Statistics.** London: Thomas Nelson & Sons Ltd., 1944. Pp. vii, 184. 5*s*. (New York: Ronald Press Co., 1945. $2.25.) *

Accounting R 22:224–5 Ap '47. J. N. Berrettoni. This minute book....will be of interest to those who possess a mathematical background of college algebra and the elementary principles of differential and integral calculus.... since the authors are mainly concerned with mathematical derivations (without rigor) of statistical formulas. The treatment of the subject matter is conventional * the authors could have been more painstaking with respect both to subjective explanation of statistical concepts and organization of the subject matter. For instance a great deal of confusion is introduced in the explanation of the distinction between an unique value and true value, when in the final analysis the differentiation is merely that between a variable and an attribute. Also, the different explanations of the "best" value could very well be replaced by a brief and more concise mathematical explanation. As to lack of organization, this is very noticeable in the discussions of the binomial distribution and the distribution of sampling arithmetic means. The binomial distribution is introduced as the distribution of the number of all possible different size samples (*i.e.* combinations) that can be drawn from N different objects. In this sense, therefore, it represents the combinatorial formula. When Bernoulli's Law of Distribution is presented no mention is made of the fact that this distribution and the frequency or probability binomial distribution are the same. The discussion of the distribution of sampling arithmetic means is disjointed in that there is no coordination in presenting a unified discussion as to the average, dispersion and form of the distribution. Only incidental mention is made of the form of the distribution of sampling arithmetic means. The discussion of the subject of Quality Control left a great deal to be desired even from an elementary point of view. Any discussion of Quality Control must for purposes of a basic elementary background present a clear-cut distinction between control and specification limits. This the authors fail to accomplish. The mathematical treatment of related measurements, correlation and Gauss's Law of Error represent the authors' best work. The mathematical derivations throughout the book are presented with the greatest of simplicity. Mathematical problems, which are given at the end of the chapters and accompanied by answers at the end of the book, are very instructive. This book, therefore is to be recommended to those students embarking upon the study of mathematical statistics.

Am Math Mo 52:514 N '45. P. R. Rider. * This book....gives, by means of good discussions and simple examples, an insight into the meaning and purpose of fundamental statistical concepts, and the reader who carefully studies it will be able to make elementary statistical analyses and inferences in an intelligent fashion. * It covers more material than the number of pages might indicate, since the print is small. *

J Am Stat Assn 40:396 S '45. Henry B. Mann. This book, although it was written as an elementary textbook in statistics, could also be regarded as an attempt to explain to the layman the basic ideas of statistics. The authors quite intentionally dispense with mathematical rigor and thus gain in simplicity. The book has the advantage of discussing only a few but very important statistics, namely: mean value, variance, correlation coefficient, and range. Thus the student is not confused by a lengthy discussion of various statistics like median, mode, harmonic and geometric mean, mean deviation

and the like as has been customary in elementary textbooks. The simplest significance tests are explained and the binomial, normal, and Poisson distributions are discussed. The book contains a short chapter on quality control which engineers may find useful. It may be remarked that in constructing control charts the authors assume that the mean and standard deviation of the measurements are known from previous observations. This enables them to make an exact statement about the proportion of points falling outside the control limits. The procedure differs however from the actual practice in which it is mostly necessary to determine the control limits from the sample itself. The book does not discuss the problem of statistical inference; it treats significance tests as incidentals rather than as the central problem of statistics. The examples given at the end of each chapter are not of any intrinsic interest. It would have been easy to find more interesting illustrations from biology, agriculture, economics, psychology, engineering and other fields. The book can be recommended as a textbook for a short first course in statistics. It can also be recommended to any reader who wishes to acquaint himself with the intuitive basis of statistics without studying its mathematical foundation.

J Appl Phys 17:535–6 Je '46. D. K. Wright, Jr. This little book presents in simple and interesting fashion some of the fundamental concepts of statistics * It appears to have been designed for students at about the sophomore level in a typical American engineering curriculum; the mathematics employed is for the most part algebra, although no attempt is made to avoid simple differentiation and integration where they can be used effectively. * The text is enlivened by many examples * The authors begin by making a distinction between a problem in which it is known that a true value exists although experimental difficulties prevent its determination, and one in which measurement presents no difficulty, but random variations in the quantity measured must be expected. As an example of each they cite "The current that will circulate in a wire of given size and material when connected to the two poles of a battery whose voltage difference is one volt," and "The number of visitors entering a museum per day." The practicability of such a differentiation is questionable. The existence of *a* true value of any physical property is debatable. In addition, it is doubtful that the system of causes of variability of current in an electric circuit is any less complex than that governing the number of museum visitors. The apparent difference in the two examples is caused by the great difference in "scale" of the units of measurement compared with the smallest integral units of the things measured. Unquestionably some data exhibit some of the characteristics of both classes. Thus it appears to the reviewer that this classification lacks a clear dividing line and is open to question, but it may be that, in questioning, the reader is led to an appreciation of the nature of data amenable to statistical treatment, which is, after all, the authors' purpose. Several minor typographical errors were found, particularly in exponents, but all are obvious mistakes. Otherwise, this book should appeal to engineers and engineering students. * very readable and furnishes sufficient mathematical development to allow the student to use the results with confidence. It is recommended as an introduction to more advanced texts, and, as such, should contribute to the growing use of statistical methods.

J Ed 79:104–6 F '47. G. L. Parsons. * It is....doubtful whether this book is elementary in the sense that an average sixth-former could by its aid learn much about statistical methods. It might be a valuable addition to a [school] library which already contained some easier books on the subject. * There are clear chapters and good examples on all the usual topics. A chapter on Quality Control offers an interesting insight into the part played by statistics in industry. It is to be regretted that the standard of typography is rather poor. Capital letters are often used where they are not necessary, the printing of definite integrals leaves much to be desired, and on pp. 64, 65 a certain formula appears twice, each time with a different misprint.

J Ed Sociol 21:320 Ja '48. Paul V. West. This compact volume....is marked by clear, simple, and interesting style. * There appears to be a surprising neglect of small sample theory and of various applications of reliability of computations. The chapter treating of quality control is modern enough and the last chapter on "the limitations of normal statistical analysis" is a very welcome and helpful discussion.

Math Gazette 29:41–3 F '45. Frank Sandon. * can be well recommended as an original introduction * it is a welcome departure to give

an introduction to quality control. Three special distributions are referred to—the Gaussian (normal), the Poisson, the Bernoulli (p. 175): it is not clearly explained that the last is the skew binomial arising out of the application of Bernoulli's Theorem. It might have been an advantage, especially to the intending biologists and actuaries, to have referred, after the joint survivorship problems of pp. 170–175, to the human survivorship curve. The usual distinction between statistical measurements as continuous or discrete is not here adopted. The authors have instead distinguished—not, in the opinion of the reviewer, altogether successfully—between unique "true" measurements (those of controlled experiments) and measurements each true, but characterised by a deviation from some average. The rather numerous elementary examples which work with sets of integral numbers only become, shall I say, rather unreal from the point of view of ordinary statistical practice. Perhaps as a result of this attitude towards measuring, the treatment of class intervals is slurred over * "Indistinguishable" is perhaps not quite the correct term (p. 129) to apply to the two numbers. Quantity and number seem to be used interchangeably (p. 131). Exercises are given at the end of each of the fifteen chapters. These are mostly interesting and well chosen. Answers are given * In the opinion of the reviewer, the answers given to questions 2 and 5 of p. 112 are not correct. * There is an index, and five tables are given. One of these is of Erf x; it is a pity that this function is not given in its more modern form with the argument x as a multiple of σ, and the area of the complete normal curve as unity. A table on p. 120 gives the significance, at four levels of correlation coefficients: the deduction for two degrees of freedom is not shown. There is a summary table for exp $(-x^2)$ (p. 130). The other two are summary quality control tables for D and for L. It would have been desirable to have indicated for what level of significance D and L are appropriate. Is the reader to assume that "stable production" on p. 165 means the 1 in 10 case of p. 158 or that appropriate to the 6σ range of the foot of p. 165? Unfortunately there are no references (except to the not easily accessible Bell System Technical Journal) nor bibliography. There are a few misprints * Usually the book is rigorous, but there are a few loose phrasings. * The book is a neat, attractive and handy volume, sufficiently illustrated, with the mathematics acceptably printed. Altogether there is nothing else on the English market that is of the same scope and approaches the topic in the same original way: some of the treatment is very interesting and simple, and the booklet is well worth considering by those who give a general course in statistics to their sixth form.

Nature 155:531 My 5 '45. M. G. Kendall. * The mathematics required are not very advanced and are carefully explained; and there are numerous examples and exercises. The book should be useful in giving a general idea of the subject to those who do not wish to specialize in it. Statistical nomenclature is always something of a problem, but there are two expressions used in this book which the authors might reconsider. They refer to the arbitrary origin chosen to simplify the calculation of a mean as a "fictitious average," whereas most writers use the more descriptive phrase "working mean"; and later on extend their usage to a "fictitious standard deviation" for the root-mean-square. Secondly, the authors give the result that the probability of r events in n trials with probability p is $\binom{n}{r} p^r (1-p)^{n-r}$ and call it Bernoulli's theorem. The result was certainly given by James Bernoulli (though Pascal probably knew it); but what is now generally known as his theorem in probability is the much more advanced result at the end of the "Ars Conjectandi," to the effect that the proportion of successes in repeated trials approaches p with as great a probability as is desired.

Q R Biol 21:129–30 Mr '46. Margaret Merrell. In the introduction to this book, the authors give an excellent discussion of the difference between the numbers of real life and the pure numbers of the arithmetic book. In terms of concrete instances from every-day life they show that the "more or less" character of actual observation involves a different approach to numbers, and they make a good case for their statement that "no educated person can afford to dispense with a knowledge of statistics." It is very disappointing to find that this orientation of statistics for the educated layman is not followed by a text of equal merit. The book presents chapters on the treatment of measurements of a single variable, and of two related variables; including a little on least square theory, on probability and error distributions, and finally on elements of quality control. For

the most part the methods are presented around illustrative data, which is a very desirable approach in an elementary book. However, the illustrations are poorly selected, and in fact in a number of cases the methods are not applicable to the data chosen to illustrate them. An extreme example of this is the case used as the main illustration of the calculation of the mean and standard deviation (pp. 23–34). A set of age-specific death rates from pulmonary tuberculosis is presented, and the problem is proposed to get the mean age of death and the standard deviation of the age of death from pulmonary tuberculosis from these figures. In the solution, the tabulation of the variable age is followed by a column headed "Death rates per 1000, *i.e.*, Frequency of death," and the calculation treats these figures as if they were in fact frequencies of death. No interpretation can be given to the constants emerging from this treatment (the mean age of death presented is at least 10 years out of the way), since the methods used are entirely inappropriate to the data, and the data are entirely inappropriate for the solution of the problems posed. In connection with this problem it should be noted that the data themselves are grossly in error. They are stated to be death rates per 1000 for London (1881–1900), and the values are in the neighborhood of 300 to 500 per 1000 for pulmonary tuberculosis alone. In addition, the tabulation starts at age 15, and the problem of getting the mean and standard deviation of age of death from tuberculosis when all children are omitted is decidedly artificial. This uncritical use of material, after an introduction to the subject of statistics which stresses the "false effect if the public generally are uncritical in their acceptance of the meaning of the statistics presented to them," seems especially unfortunate. Other examples, although used less extensively, are equally inappropriate. Thus the frequency of occasions upon which specific numbers of soldiers are reported sick is used as an illustration of a continuous frequency distribution, although it is subsequently pointed out that it is really discontinuous (p. 11). The correlation coefficient is used to measure the degree of association, not merely as an intermediate computing constant, in variables that are not normally distributed (p. 82). The proportion of recruits wearing glasses and the proportion having false teeth are used for an example of the multiplication of independent probabilities (p. 102). There are also certain interpretations of the statistical constants that need careful consideration. On pages 116 and 117 there is a demonstration concerning the value of the correlation coefficient according to the number of common causes in the two variables. However, the demonstration pertains only to the case in which the common causes enter the variables in an additive way, and the statements following this demonstration cannot be accepted as being general. On pages 120 and 159, the meaning of the probability associated with a significance test is misstated. On the latter page it says, "It follows that the chance of this happening by accident is 9 in 100 or the odds are 91 to 9 against it happening by chance." The significance test never measures the odds against its happening by chance. It measures the probability that chance would produce as large a deviation as this (9 in 100), and the probability that chance would produce a smaller deviation than this (91 in 100), but this is quite different in meaning from the quoted statement. Since the faults of the book, in careless acceptance of data and failure to see that the assumptions behind the theory are fulfilled by the data to which the theory is applied, are the greatest pitfalls for the beginner, the book cannot be recommended as an elementary text.

South Econ J 12:166–7 O '45. Dudley J. Cowden. * Topics of special interest to economists, such as methods of sampling, index numbers, and time-series analysis, are not mentioned. Neither is there any treatment of tabular or graphic presentation. The main frequency distribution illustration, *death rates at different ages from phthisis in London,* is very unfortunate. It is questionable whether it should even be considered to be a frequency distribution. The death rates are given as deaths per 1,000, though apparently they are per 100,000. The mean age of death is computed by multiplying each age by its death rate and dividing the result by the sum of the death rates. One should use *actual deaths* rather than *death rates* in making such a computation. The authors are subject to criticism also for publishing the table of normal curve areas in a form inconvenient for use. There are few typographical errors *

[204]

★LEWIS, DON. **Quantitative Methods in Psychology.** Iowa City, Iowa: Bookshop, 1948. Pp. vii, 286. Paper, lithotyped. $4.50. *

J Am Stat Assn 45:144–5 Mr '50. Philip Desind. * The author's aim is laudable but his weapon hardly suits the target. The inability to "think in quantitative terms" is a characteristic that is not restricted to non-mathematical students and the problem of overcoming it is invariably tabled in favor of the less satisfactory solution of substituting knowledge for mature comprehension. * Overlooking the author's claims for the preparation of this book, however, and examining the text itself, one finds a general treatment of a great variety of basic mathematical concepts. There is certainly a great need for such a text in a statistics curriculum for students whose knowledge of mathematics has not kept pace with their studies in statistics. * many topics are treated rather sketchily and in some instances mechanically, *i.e.*, the chapters on "Differentiation" and "Integration." One gross omission is the author's failure to include a chapter on basic probability concepts which are essential for establishing a firm basis in statistics. However, some probability concepts are introduced, though somewhat abruptly, in the chapters on the "Normal Curve" and "Distribution Functions." The author makes use of "degrees of freedom" but makes no attempt to explain the concept. The chapter on "Goodness of Fit" may be somewhat confusing to students primarily because of the abundance of categorical statements (which are not always correct without theoretical justification. This text comes in for its share of misleading statements emanating primarily from the loose presentations which usually occur in attempting to simplify statistical theory for students with limited mathematical training. Typical examples of the type of loose and inexact statements found in this book are as follows: (*a*) "Another common application of χ^2 is to examine the frequencies of a contingency table in determining whether or not the two variables are mutually independent" (Page 182), (*b*) "By chance, χ^2 varies in value from zero to ∞" (Page 260). By and large, however, the author succeeds in avoiding serious errors found in other texts. The author's choice of language is sometimes misleading; for example, Chapter 4, dealing exclusively with curvilinear functions, is referred to as "....complex functions." It should be realized that "complex functions" has a well recognized connotation in mathematics which is not synonymous with "curvilinear functions." This book is the result of the author's many years of experience in teaching experimental psychology on the graduate level. It contains an abundance of illustrative problems in the field of experimental psychology as well as a sufficient number of exercises which should prove of interest to students of psychology. It is wrapped in a paper cover and is reproduced in lithoprint. The diagrams are clear and the printed text is well spaced and quite readable. There is no index but the table of contents is fairly detailed.

Psychol B 46:63–6 Ja '49. C. H. Graham and C. G. Mueller. * the first book to present an account of quantitative procedures for psychologists at a more basic level than the usual treatise on statistics * If....as a result....quantitative psychological theory is made meaningful to a large number of students and eventually becomes a matter of interest and practice to all well trained psychologists, then *Quantitative Methods....* may have an important place in the development of psychological science. Chapter 1 deals with some elementary principles and Chapter 2 considers the fitting of straight lines to empirical data. Chapter 3 is on logarithms. All of these chapters are straightforward and clear. The use of non-linear curves is treated in Chapter 4. The chapter does not give an exhaustive account of the great variety of curves available for representing data, but the material covered is presented in a useful way. In only one respect do the reviewers disagree with the treatment of curve fitting: the application of a special case of the method of least squares to all forms of data. It is obvious that the method of least squares is one which is based upon certain assumptions, and if the assumptions are not fulfilled by the data, then the results of using the method are uninterpretable. When Lewis fits curves other than straight lines to data, he achieves the fit by transforming the data to yield a straight line and fitting this transformed function by least squares. Such a solution involves many assumptions, some of which are mentioned, none of which is emphasized. The problem of what deviations from best fit to minimize is always an important problem. If the data warrant elaborate treatment, the rationale of the steps used in fitting a curve to the data may be developed and may involve a complex analysis. If the data do not warrant such treatment, the fit may be chosen more obviously on a basis of convenience. In the latter case, some of the other methods mentioned by Lewis will

tages and disadvantages of the various *t*-theorems are largely neglected (pp. 189–196). (10) There are two significant omissions from the discussion of chi square. One is the failure to mention Yates' correction for continuity. The second is the failure to point out the suspicion with which one should view a very high chi square *p*-value, when testing goodness of fit. A chi square *p* greater than .95 will occur by chance no more often than a *p* less than .05, and should lead one to a careful check of computations and assumptions. (11) A few typographical errors are evident, but are no more frequent than are expected in a lithoprinted publication of this nature. The author has brought together a great deal of material not available elsewhere. Dr. Lewis has a much more comprehensive treatment than Guilford attempted in a somewhat comparable section of *Psychometric Methods*. The reviewers believe that this volume constitutes a major contribution to experimental-theoretical psychology. They further believe that advanced graduate students with these interests should be offered a course of the type described by this text.

Q R Biol 24:401 D '49. A. Chapanis. It is a common observation that most graduate students have a great deal of difficulty in understanding many quantitative articles they are required to read. Those students who have had at least a course or two in calculus seem to do better than the others, but the difficulty cannot always be traced to inadequate training in mathematics. The main trouble appears to be that most courses in mathematics are taught for mathematicians and engineers. As a result, students in the biological sciences never seem to learn the kinds of mathematics they need to know. Even when they do learn the right sorts of mathematics, the techniques are seldom related to problems which are most meaningful to the student. This book is essentially a treatise of those mathematical techniques the graduate student in psychology should know. * The presentation is clear and, although the student need have only algebra as a prerequisite, he should be reasonably conversant with some high-powered mathematics when he reaches the end of the book. Especially noteworthy is the liberal sprinkling throughout the text of problems and examples drawn from the scientific literature. Incidentally, the problems all come from experimental and physiological psychology, so that the student of quantitative biology should not find them difficult to understand. This is a book which every graduate student in experimental psychology should read.

[205]

★Li, Jerome C. R. **Design and Statistical Analysis of Some Confounded Factorial Experiments.** Iowa State College of Agriculture and Mechanic Arts, Agricultural Experiment Station, Research Bulletin 333. Ames, Iowa: the Station, June 1944. Pp. 449–92. Paper. Gratis. *

[206]

★Lindquist, E. F. **A First Course in Statistics: Their Use and Interpretation in Education and Psychology, Revised Edition.** Boston, Mass.: Houghton Mifflin Co., 1942. Pp. xiii, 242. $3.00. * (Study Manual for a First Course in Statistics, Revised Edition. 1941. Pp. v, 117. Paper. $1.20. *) (Instructor's Manual and Key for Study Manual. Pp. v, 49. Paper. $1.50. *) (London: George G. Harrap & Co., Ltd. 12*s.* 6*d.*; 6*s.*; 5*s.*)

Am J Psychol 55:610–1 O '42. H. E. Garrett. * a simply and carefully written and—for its purpose—adequate book on elementary statistics * A study manual which accompanies the text provides questions and exercises for each chapter. Incidentally, I found some of these questions rather difficult to answer. Lindquist has employed the Socratic method in his presentation, in order (so he says) to have the students take a more active part in the learning. I certainly wish him well in this laudable endeavor, but I must confess my inability to see how the treatment differs markedly from that in other texts. I suspect that students will learn statistics from this book much as they have learned statistics from other books; that is, some will and some won't. There is little one can find to criticize in this text. The treatment of class-intervals and midpoints seems unduly labored, and too much stress, I think, is put upon small sampling theory and the *t*-ratio. The formula for *T*-scores and the accompanying discussion are clearly in error (p. 149). *T*-scores and *z*-scores are "essentially equivalent" only when the distribution is normal. Standard scores are much more general and involve no assumptions as to form of distribution. This book differs so slightly from its predecessor that it seems hardly fair to call it a revision. Only one chapter (that on sampling) is really changed. Lindquist follows closely the treatment of R. A. Fisher *

J Am Stat Assn 37:295–6 Je '42. Paul V. West. This text, with its lack of exercises, impresses one as being too verbal and descriptive. This can be explained, however, in the light of the purposes as stated in the preface. The author

states that he wishes to "stress as much as possible the uses and interpretations and minimize as much as possible the mathematical theory of statistics and the mechanics of computation." While the aims are worthy, it is difficult to see how a sound appreciation of statistical procedures can be achieved or thoroughly critical attitudes can be developed without some training in the mathematical bases of the subject. Furthermore, one may fairly question the inclusiveness of these aims, since it is highly desirable that students gain some adequate facility in the use of all basic processes. The correct choice of procedures and the precise manipulation of techniques are certainly essential aspects of interpretation. The treatment is unique for an elementary text and one which is timely. The emphasis on student activity in logical analysis, the stress placed on sampling theory and especially the techniques suitable for small samples, the use of statistical methods, and the systematic development of essential information, make for a valuable contribution which may help to reshape textbooks in this field and on this level. The text is also to be commended for its clear definition of the "integral measure," its presentation of definite steps in computational procedures, its recognition of the fact that relatively few of the distributions actually encountered are "normal," and its common-sense interpretation of reliability and the coefficient of correlation. There is a tendency toward formalization in treating the determination of the number and size of intervals, a lack of presentation of operations suitable for varied types of data such as attributes and skewed distributions, and a failure to acquaint the student with variations in processes of computation. Some may also question the advisability of omitting such topics as the harmonic mean, the geometric mean, binomial expansion, index numbers, non-linear correlation, and many of the applications of the normal curve theory used in test construction. The manual, as indicated by the title and a statement in the Foreword, is designed for use with the text. One may doubt that it "cannot be used with other texts," as most of it should be clearly comprehensible to the careful student of other texts in education and psychology. One normally anticipates that a manual which accompanies a statistical text will be characterized by many specific exercises calling for much practice in computation. In this case, however, the manual is almost as verbal as the text, since the exercises, for the most part, call for verbal explanation and interpretation. In places one detects a tendency for these questions to become highly involved in minor issues, or to deal with points which have little general significance. The instructor, of course, has freedom of selection. The pages are perforated and punched, making it easy to hand the assignments in and later to bind them in a notebook. Many experienced instructors find it difficult to adapt themselves to the use of a manual constructed by another, chiefly because of variance of convictions as to where emphases should be placed The manual will prove of great assistance to those who wish to stress logical analysis and interpretation, even though they find it advisable to supplement it with practical exercises for the purpose of developing facility in operations by the student.

Psychol B 39:420 Je '42. Quinn McNemar. If a revision and extension of one chapter, plus the changing of four pages in another chapter, constitute the revision of a book, then and only then can this be called a revision of the author's 1938 work * One wonders whether this irritating habit of publishers results in sufficient sales to offset the ill will engendered. We hasten to say that the revised chapter, although adding nothing which wasn't known when the first edition was published, is by far the best chapter on sampling to be found in the elementary texts. The additions include more on sampling distributions, the concept of confidence interval, levels of confidence, the exact and the null hypotheses, small-sample techniques, and a table of *t*. The reviewer still believes that a discussion of the elementary notions of probability would strengthen this text, which is essentially sound and has already demonstrated its usefulness.

For reviews of the first edition, see 38:B649 and 2:188.

[207]

★Loève, Michel. **On Sets of Probability Laws and Their Limit Elements.** University of California Publications in Statistics, Vol. 1, No. 5, pp. 53–88. Berkeley, Calif.: University of California Press, 1950. Pp. ii, 53–87. Paper. $0.50. *

[208]

★Love, Harry H. **Experimental Methods in Agricultural Research.** Rio Piedras, Puerto Rico: Agricultural Experiment Station, 1943. Pp. v, 229. $2.00. *

J Am Soc Agron 36:365–6 Ap '44. F. Z. Hartzell. * Love not only discusses the advantages and disadvantages of the designs

presented but, except as noted above, gives a very complete and systematically arranged illustration of the computation for each example. Thus, this portion of the volume serves as a computer's handbook for the designs treated. These clear presentations should be especially valuable for the worker who first approaches the subject and, as regards some of the designs, will be of great help to many experimenters who use field plots and have some experience with the analysis of variance. It was impossible to illustrate many designs without greatly increasing the size of the volume. Workers who are interested in other layouts will find carefully selected references to the literature which should guide them to the desired information. The fifth chapter, General Suggestions for the Conduct of Experiments, may be considered an epitome of an entire volume. In it the author, drawing on the experiences of a life spent on experimental studies, gives one of the finest presentations of the subject known to the reviewer. (Many of the problems are discussed in greater detail in the author's book "Application of Statistical Methods to Agricultural Research," reviewed in this *Journal,* Vol. 28, pages 867–869.) This chapter could be read with profit by many investigators * an index would have been welcome but the Table of Contents serves to assist the reader in finding the main subjects. The clear, concise presentation of so much pertinent information places this work among books the value of which should not be judged by size.

J Am Stat Assn 40:531–2 D '45. W. D. Baten. * The author has an excellent way of constructing a Latin square. Statistical techniques for testing for significance between means where estimates have been made for missing data is clear and easy to follow. * In the last chapter, [the] author has gone to a great deal of care to cite the opinions of others on the....[conduct of experiments] and to give much data indicating the results of many experiments. This chapter should be read in detail before a design is chosen. * This book is well written, excellently illustrated with appropriate designs and easy to follow with all essential details clearly explained. Everyone interested in analyzing statistical data pertaining to agricultural and the biological sciences should have this book on his desk because of the useful information it contains. It is so written to be used effectively as a text in the class room. *

Plant Breeding Abstracts 18:394–5 Ap 1 '48. N. T. J. B(ailey). * Abstruse discussions are avoided, the emphasis being all the time on actual applications. A wealth of worked examples are provided and show, in a very practical way, just how one handles raw numerical data. * The final chapter, "General suggestions for the conduct of experiments," is a most valuable general discussion of several important subjects connected with the carrying out of agricultural field trials, the experimental field, the size and shape of plots, border effect, sampling for yield, and so on. On the whole this is a most useful little book and well worth study by agricultural research workers who have only an elementary knowledge of mathematics. There are a few misprints and omissions. *

[209]

★LUTZ, R. R. **Graphic Presentation Simplified.** New York: Funk & Wagnalls Co., 1949. Pp. xxi, 202. $4.00. * (London: Mayflower Publishing Co., Ltd., 1950. 31*s.* 6*d.*)

J Marketing 15:119 Jl '50. A. B. Blankenship. This is one of a series of eighteen "Modern Industry Books" * It falls far short of the only other in the series observed by the reviewer—the book by Richard D. Crisp, *How to Reduce Distribution Costs.* The jacket advertises the present short volume as "....invaluable for businessmen, managers and executives...." Blurbs are expected from publishers, but this claim marks a high in exaggeration. This is not a useful book for the sales manager, research manager, or other operating or staff executive in the field of marketing. Instead, it is a book that would be more appreciated by the chartist, who would scarcely need it because he is already familiar with such principles. The book begins by assuming knowledge of applications. It proceeds, in the second chapter, to discuss techniques. The next two-thirds of the book are all on this broad subject. The handling of one type of chart after another is considered. A sentence in the very first chapter underscores the whole approach. When Lutz reports that "Charts are the shorthand of statistics" (p. 5), he is looking at charts as the professional chartist does, rather than a tool for the executive. Shorthand can be understood by no one except those trained in the technique; the purpose of charts should be precisely the opposite—to bring home clearly to almost any layman the meaning of tables of statistics. Thus it is difficult to appreciate why Lutz discusses the major applications

of charting only in a single chapter, virtually at the end of his book. Nowhere, either, does he classify the charts he so blithely begins describing technically in the second chapter. This book cannot be recommended as an aid to the non-professional. It is dubious whether the professional will find anything new within it. It is difficult to see the market for the book.

[210]

★LYLE, PHILIP. **Regression Analysis of Production Costs and Factory Operations.** Edinburgh, Scotland: Oliver & Boyd Ltd., 1944. Pp. xii, 208. For latest edition, see 211.

Accounting R 20:482–3 O '45. M. P. Stoltz. * should prove useful to cost accountants and plant managers, and economists will welcome the additional evidence on the form of empirical cost functions. An analysis of this type appears to be limited, at least in its present state of development, to cases in which one homogeneous product, or a relatively small number of them, is involved in the manufacturing process. This limitation will also help to explain the generally linear regressions found in the studies made to this time. There is relatively little in the book to quarrel with. The meaning of marginal cost for a quadratic cost function is misinterpreted, as is also the meaning of the partial coefficients of regression for a multiple analysis. The author's excursions, in the concluding chapter, into economic miscellanea are regrettable. The long appendix covering various aspects of the technique will be found useful by the beginner.

Econ J 55:108–11 Ap '45. T. Barna. Mr. Lyle's book is important because he appeals to business-men to use statistical methods in their problems, and because he applies the statistical methods of modern scientific research to business economics. It seems desirable that large-scale organisations should separate the functions of economic statistics from cost accounting on the one hand and quality control on the other. No doubt the separation of these functions is a further step in the division of labour leading to more efficient business management, although the demarcation of these functions in precise terms is very difficult. Business-men should certainly welcome this book as it indicates a wide field in which a fairly homogeneous branch of statistics can be applied. The main thesis of the book is the exposition of Prof. R. A. Fisher's statistical methods, following their successful application in certain sugar refineries. It is concerned mainly with the statistical determination of short- and long-term cost functions. The exposition of the statistical methods, relevant to small samples, is admirably lucid, and is properly illustrated with actual examples. Mr. Lyle, however, does not emphasise that the problems of economics are essentially different from those of the natural sciences. That pre-eminent source of pitfalls in economic statistics, the problem of time series, is not discussed at all. It happens that the consequences of this may be illustrated with reference to the example given in Table I of the book. This table gives output and cost data for 40 weeks. The short-term cost function is a regression line in the form of $Y = a + bX$, where X denotes weekly output, Y total weekly cost, a fixed costs and b marginal cost. Four specific points of criticism should be mentioned. First, Mr. Lyle only considers the regression of Y on X, which assumes that there is a statistical error in Y, but not in X. There are, however, reasons to consider the regression of X on Y also, since error enters into both variables. In fact, the actual measurement (as Mr. Lyle admits) is less precise for output than for costs, because of changes in work in progress. The present reviewer worked out the alternative regression line, and this, together with the original regression line and the coefficient of correlation (r), are given in line 1 of the following table:

Line	N	Regression of Y on X		Regression of X on Y		r
		a	b	a	b	
1	40	104 8	430	92 3	.533	.898
2	39	112 7	365	100 9	463	.888
3	37	92 3	534	74.5	.682	.783
4	9	103 3	451	100 2	478	.972
5	11	92 9	501	80 3	601	.913
6	19	107.4	419	99 7	.483	.931

Note.—The correlation coefficient is, in each case, significant beyond its value corresponding to $P = 0.1\%$.

The second regression line gives invariably a higher marginal cost b (and a lower fixed cost a) than the first one, since $b_{12} \div b_{21} = r^2$. Second, the question arises in the book whether "outside" values should be omitted or not, and Mr. Lyle decides against omission. In the example given, output was exceptionally low in one particular week only. If this week is omitted from the series the coefficient of correlation is

hardly affected, but marginal cost b is significantly changed. The constants in the two cases are given in line 2 of the table. The theory of regression analysis implies that the population of X is "normally" distributed. It seems that in the given case this is not so, since (for reasons implied in the nature of machine production) exceptionally low values of X might occur, whereas exceptionally high values may be ruled out. But the distribution of X can be made normal by omitting exceptionally low values. Since the omission of an "outside" value causes a significant change in the equation, it is unsafe to extrapolate the line beyond the ranges of X which actually occur. Hence it cannot be said that a, the constant of the regression equation, is equivalent to fixed costs; this would be so if marginal costs were constant throughout the whole range of output (down to zero), which remains to be proved. Third, when dealing with time series, various authors have recommended the correlation not of pairs of the original series, but of pairs of the differences between successive data, as a more sensitive measure. The present reviewer, employing this method (with the omission of two pairs of data referring to the fluke output mentioned), obtained the constants shown in line 3 of the table. The value of the correlation coefficient has fallen (though not to the extent usual in these cases), and the constants of the regression line have changed considerably. Finally, the theory of regression analysis implies that the data are homogeneous, *i.e.*, that over the period of observation other variables remained constant. The validity of this assumption was tested by breaking the time series into parts, and testing the relation for each part separately. An inspection of the deviations of actual from computed values of Y (given in the book) suggests three part-series of 9, 11, and 20 terms, respectively. The average deviations for these parts (in units of cost) are + 1.1, — 2.8, and + 1.1; the general average is of course 0. An analysis of variance, comparing variation between the mean deviations given and variation within the three series, gives $z = 1.299$ ($n_1 = 2$, $n_2 = 37$), for which the probability is less than 0.1%. Hence, such differences in the mean deviations cannot arise by chance, and therefore the data cannot be homogeneous throughout the 40 weeks. Separate regression equations were computed for the three parts (omitting the fluke value in the last), as given in lines 4–6 of the table. It can be seen that marginal cost b is larger (and a smaller) for each of the series, than if the series were treated (without justification) as one. (Lines 4–6 should be compared with line 2.) Reflection on the nature of short- and long-term cost functions might supply the reason why this should be so. This criticism concerns but a portion of the book. But it was shown that twelve regression lines can be calculated where Mr. Lyle calculated one, and (on the whole) these show a downward bias in Mr. Lyle's marginal cost. It becomes evident that the application of statistics to production requires a knowledge of both mathematics and economics, with the emphasis placed perhaps on the latter. It might also occur to the reader that a thorough analysis of works-accounts might be a substitute for some of the elaborate statistical methods. The present reviewer believes that the solution lies in the combination of the two methods: by using the deductive method based on an analysis of accounts, checking the results by the inductive methods of statistics. But the place of statistics in the economics of the firm is important, and its applications have not been worked out fully yet. Therefore books like Mr. Lyle's are welcome, and it is hoped that he and others will give the non-technical businessmen further examples of their experience.

Nature 155:438–9 Ap 14 '45. M. G. Kendall.

* The most encouraging feature of Mr. Lyle's book is that it is written, not by a statistician, but by a practical industrialist who has proved the value of regression analysis in his own field. One of the better ways of learning statistical methods is to write a good book about them; and that is what Mr. Lyle has done. * Lyle shows in a most illuminating way how the statistician can take up the inquiry into production costs at the point where the cost- accountant has to lay it down. The book is not intended as a statistical text-book but as an introduction to such a book. Nevertheless, it provides one of the best exemplifications of a particular branch of theory I have seen. In feeling his way into the subject Mr. Lyle has encountered a number of practical difficulties, such as the effect of outliers on the regression line, which are apt to be glossed over in theoretical treatments. He has, quite rightly, dealt with them at some length and managed to achieve an excellent balance between theory and practice. It is to be hoped that he will be successful in his main object of "trying to interest industrial workers in a very

useful subject of the very existence of which many of them are quite unaware."

[211]

★LYLE, PHILIP. **Regression Analysis of Production Costs and Factory Operations, Second Edition.** Edinburgh, Scotland: Oliver & Boyd Ltd, 1946. Pp. xii, 204. 15*s.* *

J Am Stat Assn 42:330–1 Je '47. H. A. Freeman. This is a useful and interesting book on the application of ordinary regression and correlation methods to the analysis of production costs and factory operations in the sugar refining industry. * it is by no means a popular, nontechnical account of a statistical technique that has been found to be useful in industry, and those altogether unfamiliar with statistics may find it heavy going. The algebra of simple and multiple correlation and regression, which the author considers in some detail, is tedious and requires close attention; moreover, the exclusion of all mathematics other than elementary algebra requires that certain important propositions be demonstrated by discussion, and some of these discussions are not easy to follow. Within the limitations of an algebraic treatment, the statistical quality of the book is adequate. * two interesting monograms....[are presented], one for t and the other for use in direct testing of null hypotheses on simple and multiple correlation coefficients. * Much attention is given to tests of hypotheses which seem to be of dubious economic significance; for example, testing the hypothesis of zero linear correlation with output-cost data. Such hypotheses seem merely to be straw men, and, whether the hypothesis falls or is left standing, little is learned about the economic nature of the situation. Another matter: the author's "preparation" of economic data for regression analysis is, at least, risky. The sample size is selected so as to exclude improvements in manufacturing technique which would introduce "biassed errors"; adjustments are then made for variation in wage levels, price levels, renewal of equipment, and repairs and for the effect of work-in-progress on weekly output. These and other adjustments are discussed, but there is insufficient information as to just how they are made. It is possible that these adjustments and allowances not only "cook" the data, as Lyle avers, but the analysis as well. I think that this is a useful book and that its principal value is as a good, detailed description of a successful application of regression and correlation technique to a difficult and important industrial problem. The reader who would like to learn the elements of correlation and regression would probably be better off to begin with a good general textbook, such as, say, that of Hoel or Yule and Kendall. The second and the first editions differ only slightly. The first edition was published in 1944 and was limited to 500 copies for sale in the world market; it was better printed on better paper.

J Am Stat Assn 42:475–7 S '47. Paul Peach. * Lyle....displays rather well the relationship between correlation and regression * Lyle has recognized a genuine need for a work on regression addressed to industrial readers, and has kept before his mind's eye the standards which such a book ought to meet. It should be modern, conformable to 1947 usage; it should be heuristic rather than rigorous; it should provide a basis for further study. On the whole, the work has been creditably executed. The notation is reasonably familiar, and the language is straightforward. The treatment is more mathematical than I should have used * there is quite a bit of algebra which....tends to impede the reading. Nevertheless, the exposition is in some parts really excellent, and the diagrams are likely to be especially helpful to students. Perhaps the highest praise I can give Mr. Lyle is to say that his book belongs definitely to the new order of statistical writing, and that any student who masters it will need to disencumber himself of very little deadwood if he decides later to study statistics seriously under good modern teachers. Unhappily, some deadwood is present, and the book's errors are serious enough to detract materially from its net worth. For example, there is no development of the idea of randomness as a *sine qua non* for the application of least squares techniques. Mr. Lyle's chief example of an exercise in fitting the straight line consists of a record showing total factory cost and total output for 40 consecutive weeks. He fits a straight line and calculates standard errors and fiducial limits using Student's distribution. But his errors of estimate (col. 4, p. 13) are obviously not observations on any random variable with zero mean; instead, we have long series of plus errors, followed by series of minus errors. We can thus assert with some confidence that the 40 residuals do not represent drawings from a bowl, and cannot be used for estimating variances and standard errors. Mr. Lyle attempts, I think unwisely, to explain the notion of fiducial probability. After telling how fiducial

limits are obtained, he says (p. 53), "These limits are called Fiducial Limits, and when they are calculated for the 5 per cent level we can say that the probability that the true or population value of the statistic lies between these limits is 95 per cent or 0.95...." This incorrect statement is almost certain to enlarge the penumbra of confused thinking on this subject which is, alas, already too extensive. The discussion of degrees of freedom is not to my mind very illuminating or convincing, and the statement on page 92 that "The median is obviously a most inconvenient form of mean to use, particularly if we have a large number of items" might be disputed. There are a few infelicities of expression, though on the whole the book is a literate work. I personally prefer to use *data* as a plural noun. I don't think the general subject of correlation "is discussed fully in Chapter III" nor indeed in any other publication I can call to mind. The appendices on "Meaning of Regression" and "Meaning of Correlation" hardly live up to their ambitious titles, more's the pity; for some competent discussion along these lines is desperately needed. Among other details, though, I must not forget a word of praise for the excellent typography and bookbinding. My main carp here is against the diagrams, which are bunched together in the back of the book instead of being scattered through the text. It may be fairest to appraise Mr. Lyle's book, not as if it were something irrevocable and final, but rather as the fruit of an attempt which has been partially successful, giving us hope of more ample success for the future. There is nothing wrong with the book that judicious revision and amplification will not remedy. The important fact is that Mr. Lyle has adopted a point of view which recognizes industrial statistics as a branch of applied statistics as we understand it today. The field wants such conceptual unification, and Mr. Lyle and his publishers have my own thanks for this contribution to that end.

J Bus 22:63–4 Ja'49. Geoffrey Beall. * The methods....are conceived as supplementary to those of the accountant or the engineer. The discussion is directed toward industrial workers, who, the author rightly feels, are often hardly aware of the existence of the simple and potential methods of regression. In industry the emphasis has been toward other branches of statistics, particularly quality-control techniques. * The treatment of multiple regression is a little awkward. On the whole, however, a very successful effort has been made to develop the ideas underlying the particular statistical techniques employed, but the theory has been carefully restricted to that necessary for the subject on hand. * The type of problem attacked is that of relating the total cost of operation to variations in output of a single product. * The relationship furnishes an estimate of fixed costs which includes, but exceeds, regularly calculated overhead. The difference, which the author terms "factory-fixed costs," arises principally from certain somewhat elusive operational costs, like that of closing and resuming operations at a week end. The estimation of these costs is one of the most notable achievements of the analysis. It is instructive to compare such costs from one factory to another. * The type of problem is extended to the case in which two products, one high grade and one low grade (or by-product), are produced and in which it is required to estimate the cost per unit of each. * This treatment, like that of multiple regression, is below the general high level of the book. The treatment is discretely illustrated by worked examples; it is supplemented by a glossary and appendixes on the details of operations; it supplies every possible aid for a novice.

For reviews of the first edition, see 210.

[212]

★McCormick, Thomas Carson. **Elementary Social Statistics.** New York: McGraw-Hill Book Co., Inc., 1941. Pp. x, 353. $4.00. * (London: McGraw-Hill Publishing Co., Ltd. 24s.)

Am J Sociol 48:263–5 S '42. Clark Tibbitts. [For joint review of *Elementary Social Statistics* and *Statistics for Sociologists* by Margaret Jarman Hagood, see 144.]

Am Sociol R 7:439–40 Je '42. E. P. Hutchinson. It might be questioned whether, strictly speaking, there is any such thing as social statistics. It certainly does not exist as a specialized field of statistics comparable to economic and educational statistics, for in spite of the considerable use of statistical research in sociology the subject has not as yet become identified with any particular statistical techniques, nor has it developed any uniformity of procedure for the treatment of quantitative data. * several statistics texts especially prepared for students of sociology have been published recently. To judge from these textbooks, social statistics is characterized by an emphasis on certain techniques frequently used in social research, a

substitution of social data in the numerical illustrations, and a suppression of almost all of the mathematical background of the techniques presented. McCormick's *Elementary Social Statistics* gives evidence of being based on considerable teaching experience. It is obviously designed for use as a textbook in introductory statistics courses for sociology students, and should serve this purpose well if used by a competent instructor. It does, however, put considerable demands on the instructor. It would scarcely be possible to write a statistics text that did not. * The bulk of the book consists of a presentation of a very considerable range of statistical techniques, each illustrated in its application to social data. * an exceptionally complete catalogue of descriptive and analytical techniques * Although simple correlation is covered in considerable detail, with not only the Pearsonian coefficient but also tetrachoric, rank, and biserial correlation, the subject of association is almost completely neglected, being touched only incidentally under the brief introduction to the theory of probability. There is certainly ample precedent for this omission of association, for few general statistics texts treat the subject, but social data being what they are, there is probably more occasion for analysis of the association of attributes than of the correlation of variables. It would seem that an introductory course would do well to ground a student in some of the fundamentals of association analysis before supplying him with formulae for the computation of the various correlation coefficients, whose derivation he does not understand and whose applicability to many social data is at the least doubtful. In the same vein, it is suggested that a fuller development of the elementary theory of probability would be advisable, inasmuch as it is basic to many of the analytical techniques that are presented. * It is unquestionably the duty of a statistics course to equip students not only with mechanical facility in the computation of statistical constants, but also with some appreciation of the uses and limitations of these constants and with some basis for their interpretation. This is evidently McCormick's view, for his discussion of the various statistical techniques includes some comment on their application and evaluation. One wishes, however, that he had developed the interpretive and critical aspects of his treatment even more fully.

Ann Am Acad Pol & Social Sci 221:244 My '42. Hugh Carter. * a remarkable achievement in condensation. With a minimum of waste motion, the conventional area of introductory social statistics is covered. The procedures are set forth clearly, and explanations are kept within the range of the student of limited mathematical background. The sixty excellent charts deal with data of interest to sociologists, and the student practice problems fall in the same area. * It is to be hoped that the writer will add further to the usefulness of this text by preparing an accompanying student workbook.

Rural Sociol 7:112–4 Mr '42. C. Horace Hamilton. * a short elementary text well-suited to a beginner's course * an excellent introduction to research method and procedure * simply written and organized * a compact, efficient aid in teaching the elementary course. The author has made effective use of well-designed graphs and tables. *

Social Forces 20:405 Mr '42. Carl M. Rosenquist. * Extension of the elective system makes such avoidance easy, with the result that many students turn up in statistics classes inadequately prepared. If the text used is too "mathematical," it cannot be understood; if it is too "practical," it will contain little of value. In steering a middle course safely between these two extremes, Professor McCormick has done a good job. Especially excellent is the introductory material (Part I), in which the objectives and procedures of statistical inquiry are explained. The various techniques of calculation are subsequently presented clearly, and as simply as the nature of the material will permit. And in the selection of subjects omitted, *e.g.*, partial and multiple correlation, the author recognizes the limitations of a one-semester course. The treatment of sampling is probably the outstanding portion of Professor McCormick's work. Here, in small compass, he has given his readers a comprehensive view of the problems involved and of the method of meeting them. The work is well written, satisfactorily illustrated and indexed. A collection of useful tables is found in the appendix. The examples and applications have all been chosen from the field of sociology. Here is a book which no teacher of social statistics can afford to pass by in making his choice of a text.

Sociol & Social Res 26:481 My–Je '42. G(eorge) B. M(angold). * As in the case of other texts in the field, the book gives scant attention to the methodology of social inves-

tigation. However, Chapter XII on "Sampling and Sampling Errors" is valuable in this respect, but the bulk of the text concerns itself with the tools used in the analyses of statistical material. * Six sets of valuable labor-saving tables, including a table giving squares and square roots, are found in the appendix. In spite of these aids much of the material presented is difficult, and the author's suggestion that some of it be omitted for beginning students is wise.

South Econ J 9:77–8 Jl '42. Edgar Z. Palmer. * Although the writing is simple and straightforward, there is a minimum of pedagogical devices and of approaches to the student point of view. The list of statistical techniques included is orthodox,—even a trifle old-fashioned. * The derivations of formulas are few and on the proper plane, but are usually introduced too abruptly. The instructions and illustrations relative to graphing are uninspired. This is not a book which will raise the level of statistical instruction, nor will it increase the desire among the students for the "quantification" of social theory.

[213]

★McNEMAR, QUINN. **Psychological Statistics.** New York: John Wiley & Sons, Inc., 1949. Pp. vii, 364. $4.50. (London: Chapman & Hall, Ltd. 36s.) *

Am J Psychol 62:461–2 Jl '49. Josef Brožek. * an *introductory* text....addressed to a student who seeks more than a smattering of knowledge * the presentation of statistical methods should include five steps: (1) The logic of a procedure, its place in the theory of inference; (2) Formulation in basic algebraic terms; (3) Derivation and presentation of "cook-book" formulae, recommended for actual practice; (4) Carrying out of the procedure on an actual example, together with conclusions to be drawn; and (5) Discussion of conditions which must be fulfilled before the procedure is applicable—*e.g.* its limitations, and the like. By and large, these points have been considered by the author. More rather than less emphasis on the rationale, logical and mathematical, of the formulae (such as the coefficient of rank-order correlation on page 97) would have been desirable. * The discussion of the limitations of the statistical techniques (see cautions and remarks on multiple correlation, p. 161, or limitations of *t* for differences between means, p. 231) constitutes valuable "stop, look, and listen" signals along the perilous road of statistical reasoning. The text covers most techniques likely to be needed in [illegible] research * The analysis of variance....has received a particularly extensive treatment (235–330). The problems of sampling and statistical inference are considered in two separate chapters (5 and 16); an arrangement which may be somewhat confusing to the student. The material of the final (16th) chapter could and should have been integrated with Chap. 5. No mention is made of factor analysis. The reviewer realizes that this topic presents difficulties of exposition and has only limited application. Nevertheless, the student who reads of "factorial design" of experiments and hears of "factor analysis" should be informed that there is little, if any, similarity between the two approaches. McNemar's book will serve well as a text for many a course on statistical methods and on their application in psychology. On the whole, psychologists are more appreciative of statistics than are workers in most branches of the biological and the social sciences, which is a good thing. But is it all calumny when physiologists and biochemists submit that the psychologists engage so vigorously in statistical gymnastics because they can not decently *measure* anything? On this point, McNemar *tacet.*

Harvard Ed R 19:231–7 fall '49. Merle W. Tate. * [The book's] most noteworthy feature is the emphasis upon the continuity and interrelationships of statistical concepts * The basic assumptions and limitations inherent in various techniques are stressed throughout. For example, the assumption of homogeneity of variance in variance ratio tests, so commonly ignored in non-mathematical treatments, is emphasized in no less than five places. * While the exclusion of factor analysis, on the grounds that it is too involved for adequate treatment in a general statistics text, seems entirely defensible, it is difficult to defend the omission of such practical techniques and topics as the combination of estimates of correlation, the combination of probabilities from independent tests of significance, tests of the homogeneity of more than two estimates of variance, the Kuder-Richardson method of estimating test reliability, the reliability of group predictions, intraclass correlation, and normalized transformations of the variance ratio distribution. * the author states that the book is a revision of a systematic syllabus which was developed over a fifteen year period * One would expect it to be illuminating, and on the whole it is. It is simply

and clearly written, ingeniously heuristic, and closely knit around the problem of statistical inference. Certain features are particularly commendable. Machine methods of computation are introduced as needed. The explicit treatment of standard scores both as comparable measures and as the unit of the generalized normal curve, although a small thing, will prove of great value to the beginning student. The treatment of sampling errors and statistical inference in Chapter V is particularly impressive, and the use of the binomial distribution in developing sampling theory differs from most treatments in that it clears up more difficulties than it creates. The troublesome notion of confidence limits is carefully rationalized. The interpretation of significance in terms of confidence limits and the two kinds of error is well done, and the traditional numerology in this connection is disposed of for what it is. * The chapter on Chi-square is unusually comprehensive. * Nearly one-third of the book is devoted to variance analysis, a technique which the author makes special effort to "delineate clearly," and, while more attention might well be given to the case of unequal subclass numbers. The treatment is perhaps the best of the semi-technical treatments published to date. * The consideration of test reliability both in the usual manner and as a function of true score and error variances is excellent, although some readers may regret that the easy extension to intraclass correlation was not made in this connection. Some exception will be taken to the statement on page 132, "By far the best method for determining the reliability of a test is to have two forms which have been made equivalent and comparable by careful selection and balancing of items." *Psychological Statistics* has several noteworthy faults, including writing which is occasionally unclear and careless. For the student, it leaves a great deal to be desired. * The discussions of Chi-square, small sample methods, and analysis of variance proceed without reference to more extensive or advanced treatment. In a few places the text, lacking reference and explanation, has the flavor of reminiscence. * In other places the text is magisterial. For example, in order to guard against practice which may capitalize on chance differences, the student is told, page 245, "After and only after it has been found that the overall F is significant can one safely use the t technique to test the significance of the difference between any two of the group means." Similar dicta appear on pages 210 and 276, and without additional explanation and qualification, they are misleading. The more subtle and important questions of possible qualitative differences in treatments or classifications, of homogeneity of variance estimates, and of appropriate error variance are neither considered nor suggested for the student's further examination. Although the experimental point of view and the ancillary nature of statistics are verbally stressed throughout the book, they are not sufficiently demonstrated. * The majority of illustrative problems are neither well selected nor adequately described. They tend to be intrinsically dull; the data for three of them are fictitious. In the reviewer's opinion, this rather common fault is never trivial, and here, since the book does not include problems for the student, it is more serious than usual. * Without being confused, *Psychological Statistics* is at times confusing. Although it stresses the continuity between large and small sample theories, it develops the two in separate chapters. The separate development, whatever its historical and pedagogical justification, leads to the usual notation trouble. * At several points the notation is awkward. The symbol d is used for the deviation of a variable expressed in step intervals, and the expression Σd for the sum of the products of frequencies times deviations. The explanation, page 16, "Obviously d may be positive or negative, and the term Σd is really equivalent to Σfd, which indicates explicitly that the d value for any interval is to be summed as many times as the frequency f in the interval," is capricious. In the treatment of variance analysis, a simplified scheme of notation with intermittent verbal explanation is employed. In the reviewer's opinion there is no substitute for precise subscript notation. Initial difficulty with it seems to be more than offset by increased clarity of perception of sources of variation, and by increased facility in handling conventional notation. The latter will stand the student in good stead when he attempts to consult more technical books or the original sources. In a few places the treatment is inadequate or the writing careless enough to cause the student difficulty. * In connection with proportions, E. S. Pearson's thumb rule for determining whether the normal probability scale can safely be used in interpreting the difference between two proportions is given, page 77, without reference to the magnitude of a_3^2 or, in the notation of the book,

g_1^2. The current notion among psychological statisticians that the null hypothesis involves a new way of reasoning about differences is perpetuated * The treatment of correlational topics, unusually good on the whole, is careless at a few points. The sentence, page 163, "....in general, the increase in the multiple correlation which results from adding variables beyond the first five or six," is an over-statement by two variables. The discussion of point biserial correlation is controvertible, and the statement, page 174, "In general the point biserial r....is not comparable to the product moment r," is confusing, since the point biserial r is the product moment r for the data as considered. The argument, page 179, "....it can be argued that the use of tetrachoric r automatically normalizes the distributions," is rhetorical. The real issue is whether the data can be made available in normal form. * It is to be regretted that no precise tests of normality, and of homogeneity of more than two estimates of variance are included, and it seems likely that the reasons for not including the tests may cause the student some confusion about statistical tests in general. * The final chapter deals with sampling techniques and their effects upon the reliabilities of observed statistics. On the whole the chapter is excellent. * The book is of attractive format and is remarkably free from typographical and computational error. * In summary, *Psychological Statistics,* on the whole, is a sound and comprehensive text. One would look far at present to find a non-mathematical treatise which more cogently develops statistical test rationale or more clearly tells what statistical methods can and cannot do. Only its lack of documentation and reference, shortage of live applications, and occasional incomplete or careless argument can be counted as serious faults. Where these can be offset by the resourcefulness of the instructor, it will be entirely satisfactory as a text, and the student who masters its contents will have an adequate understanding of the theory and application of elementary and intermediate statistics in psychological research.

J Am Stat Assn 44:572–4 D '49. Edmund Churchill. * The book, unfortunately, falls short of the author's aim to "provide a concisely, yet clearly written textbook which will lead to an appreciation of the place of statistics in psychological research." Conciseness is far from apparent at many places in the book, and neither the writing nor the logic behind it are always clear. This reviewer believes strongly that the student will best gain an appreciation of the role of statistics if clear, meaningful, and interesting illustrations are given as each technic is introduced. In this respect this book is decidedly weak. At least a dozen of the technics or procedures discussed in the book are not illustrated at all. Some are illustrated by fictitious data, others by data of the type: two groups classified according to 5 response categories (what groups? what categories?), 13 pairs of scores, IQ's of 161 five-year old boys, scores made by 50 college men on the Brown spool packer, etc. Here was an excellent opportunity both to enliven the text and to point the way to sound research practices by the frequent use of data from well designed (and well described) research. There is a fuzziness in the discussion at a number of points. The discussion of the null hypothesis (p. 223) as it relates to the difference between means is not only muddled but at variance with an earlier discussion. The hypothesis of equal means does *not* imply equality of the population variances nor does the hypothesis of equal means and variances lead to the t test. * The spirit of the null hypothesis is well violated in a procedure for testing the quantity $(p_1 - q_1) - (p_2 - q_2)$ where the p_i and q_i are non-exhaustive proportions in independent samples. Standard errors are obtained for $(p_i - q_i)$ on the basis of the null hypothesis: $p_i - q_i = 0$ $(i = 1, 2)$. These standard errors form the basis for testing the difference mentioned above, altho the hypothesis that this difference is zero is a far cry from that used in getting the standard errors. The concept of the quality of a statistical test or confidence limit is missing. * The square root of s^2 is, as usual, incorrectly described as unbiased. The sequence of histograms of $(\frac{1}{2} + \frac{1}{2})^n$ with fixed base length is asserted to converge to the normal curve; the sequence actually converges to a straight line. Sheppard's and Yates' corrections are given without hint that they can worsen instead of improve matters; this is especially true when Yates' correction is applied, as McNemar recommends, to 2×1 tables. The labelling of McNemar's graphs and the stubs of his tables, are, in several cases, atrocious and his treatment of approximate data is on the same level. There is no hint that in stratified sampling we might use samples in which the proportions are not in the same ratio as in the population, altho in general the best

design calls for different ratios in sample and population. The equating of stratified sampling with the quota method may well confuse the student who has understood the quota method to be the one used by Gallup. * it is difficult to understand why calculus is introduced to half-derive the linear regression equations when the elementary algebraic derivations of these equations are so simple and straightforward. Incidentally, a little of this algebra applied to the chi-square formula on page 207 would show that the maximum value of C for $2 \times n$ tables is $\sqrt{1/2}$ and hardly rates classification as "unknown" (p. 182). One can also demonstrate that the maximum value of C for any $m \times n$ table is the same as for an $m \times m$ or an $n \times n$ table, whichever is the smaller. The discussion of test reliability presents clearly some of the difficulties in estimating reliability, but its advice to base estimates on parallel forms is often completely unrealistic. The construction and administration of a second test form, if possible, would often represent an extremely inefficient use of research facilities. Split-half methods are mentioned but nothing is said about the effect of speed on these methods. The useful, reasonably sound, and rapidly computed Kuder-Richardson no. 20 is unmentioned. The simple derivation of this formula by Jackson and Ferguson might well have been included here. The importance of homoscedasticity is stressed thruout the section on correlation (and might well have been stressed more often in the section on analysis of variance) but McNemar gives no hint as to how one may test a set of data for this mouth-filling property. Nor is the warning that many of the technics discussed are applicable only to normal data accompanied by advice or reference to sources of advice for the non-normal case. Much of this reviewer's pleasure at finding a chapter on covariance analysis is offset by the omission of such things as the discriminant function and the equivalent T^2 test, more useful, to be sure, than used, and the growing body of rapidly computed "inefficient" statistics which can be of considerable value in the early stages of a research program. The above remarks are not intended to imply that there is not much which is clear and sound in this book. But statistics has reached a point in its development where we can rightfully expect that beginning texts have the clarity and thoro soundness that we expect and find in a college algebra text and do not find in this text.

J Consult Psychol 13:308 Ag '49. No statistics textbook is exactly light reading, but McNemar's is exact, concise and clear. Although higher mathematics is not used, he expects the student to have at least the vocabulary of elementary mathematics, and does not hesitate to use phrases such as "one can use a logarithmic transformation of such a variable," without further explanation. Sampling theory is treated with unusual accuracy, and the three chapters on analysis of variance and covariance are probably the best so far written on that topic. The implications for the design of experiments and the treatment of data are especially valuable for the types of experimental problems encountered in clinical psychology.

J Personality 18:267–8 D '49. Joseph A. Gengerelli. * a genuine contribution to the instruction of future psychologists in the field of statistics * The style is lucid and benign in both the descriptive and analytical aspects of the exposition and has the additional merit of avoiding the tendency to be cryptic, which is a not unusual failing of mathematical writers. * the most important merit of the present volume lies in the fact that while the author is completely at home in the mathematics of the subject, he is, above all, a research worker in psychology. This is evident on nearly every page of the text and amply justifies its title of *Psychological Statistics.* Not only are his examples chosen from experiments reported in the current psychological literature, the preoccupation with psychological problems permeates his treatment of the subject matter at nearly all points. * His chapters in the analysis of variance are particularly noteworthy. In one of these chapters there is a description and evaluation of seven alternative plans for the design of an experiment which serves to make the inner workings of the variance technique very vivid to the reader. The reviewer predicts many adoptions of this text, particularly at the intermediate level of instruction, and the book should serve as a convenient personal reference volume for any psychologist who uses statistics.

Q R Biol 24:180–1 Je '49. W. R. Garner. * this book....has included and emphasized those tools which are most useful to psychologists * The sequence of topics seems good, except that the chapter on small sample methods should have come earlier in the book. It could have followed the chapter on sampling errors with no break in thought. On the other hand, the dis-

cussion of probability and sampling errors early in the book is excellent, and should give the student a far better idea why he is learning some of the later techniques. There are many good things to be said about this book. Throughout the book, the use of statistics as a tool in research is emphasized, and many times the importance of the original experimental design is stressed. An entire chapter is spent on the interpretations of correlation coefficients, and on the assumptions which are made. Quite extensive sections are spent on the meaning of the analysis of variance, and possible interpretations. This emphasis is exceptionally good, and should give the student the proper perspective toward statistics. Derivations are included only when the author thinks that they lend to the understanding of the concept. Actually, there are plenty of derivations for the beginning and intermediate student; and in general it seems that the number of derivations is sufficient except for one. The use of degrees of freedom to offset the bias in estimating sigma is given to the student to accept on faith. The use of degrees of freedom in small samples is so universal and basic a procedure today, however, that the student should have a complete understanding of its purpose. It is, of course, central to all of the techniques used in the analysis of variance, and must be completely understood. In fact, the only chapter which seems inadequate is this one chapter on small sample methods. The notation is simple, clear, and consistent. The student should have little trouble following it from beginning to end. * The material is extremely condensed, and it is not clear that the book will be useful for all courses in statistics. The ideal use of the book would be for a continuous one-year course. It could also be used as textbook in a second-semester course, but the material is probably too condensed for most first-semester courses. Less than 200 pages are used, for example, to cover all forms of correlation. Nevertheless, in the ideal course this would be the ideal textbook. Everything useful is in the book, and all is clearly explained. In short, this is probably the best single book on psychological statistics available, and most psychologists will want it on their shelves. It is complete enough to be an excellent reference, particularly on the analysis of variance—a subject poorly handled in most books. The statistical problems of the biological scientist are similar enough to those of the psychologist that most of them will also want it.

[214]

★MAINLAND, DONALD. **Statistical Methods in Medical Research: I, Qualitative Statistics (Enumeration Data).** Reprinted from Canadian Journal of Research, Section E, Medical Sciences, Vol. 26, February 1948. Ottawa, Canada: National Research Council of Canada, 1948. Pp. 181. Paper. $0.50. *

J Am Stat Assn 44:148–9 Mr '49. John W. Fertig. * essentially an expansion of Chapters 2 and 3 of the author's *The Treatment of Clinical and Laboratory Data* * A detailed consideration is given to small samples of enumeration data in which the normal curve or chi square solutions are not completely satisfactory. Fifty-four pages of tables are presented giving confidence limits for a two-fold classification of enumeration data and probabilities or significant differences for four-fold contingency tables. * The text covers 103 pages and is divided into an introductory section of 11 pages, one of examples covering 54 pages, and one of explanatory semi-theoretical notes covering 36 pages. Most of the examples are concerned with the comparison between a sample and a population relative frequency and with the four-fold table, including numerous variations of these problems. The problem of non-dichotomous scales is only briefly considered, as is the problem of combining information from two or more samples. The suggested treatment of the numerous examples consist largely in aiding the reader utilize the tables contained in the article. Practically no treatment of the rationale of the method is given at the time of the discussion of the example. This is reserved for the section on notes. Each example is, however, followed by a series of helpful comments. While this reviewer recognizes that the investigators for whom this presentation is intended are often not very patient with a discussion of the reason for a certain statistical method, he still feels that the incorporation of the section on notes together with the examples would have produced a much better appreciation of the techniques. It is sometimes difficult to appreciate the reason for the author's preference for chi square, for example, on page 39: "Some investigators still use the standard deviation or standard error, $\sqrt{Npq}$, instead of chi square, for comparison of the sample. This is not to be recommended." It is not pointed out clearly that the correction for continuity can be used for the normal curve as well as for chi square. The author recom-

mends the summation of chi square values for combining information from several samples, but this method may at times be unduly conservative. The author has to some extent achieved his goal of classifying certain types of problems relating to enumeration data, and of telling the investigator how to find his problem and a suitable answer for it. The tables supplied are indeed very comprehensive and useful. However, it seems to this reviewer that the approach is too mechanistic and would be unsatisfactory for many investigators.

J Am Stat Assn 44 149–50 Mr '49. A. Bradford Hill. Dr. Mainland says that his article was devised "to meet the wishes of those who, in the words of one investigator, would say: 'I have a problem on hand....Must I spend a month of free evenings reading a book from end to end several times and mastering all details before deciding how to go about solving the problem? I hope not.' " He might have retorted that workers in the medical sciences would not expect to use, say, bacteriological or pathological techniques without mastering the details and is there any reason why statistical processes should be regarded differently? There is, perhaps, at least an excuse. Few workers unless trained in such subjects as bacteriology or pathology will be so bold as to embark upon them; almost all, whatever their subject matter, will sooner or later be faced with statistical data and have to interpret them. Often too, particularly in clinical medicine, their numbers of observations will be small. It is, therefore, legitimate to argue that it is better to give the worker easy access to tests of significance which he may imperfectly understand rather than to let him rely solely upon that "common-sense" which is, in fact, so uncommon. The serious danger of this procedure, which Dr. Mainland recognizes, is that the worker may come to regard the mathematical tests as the most important part of the statistical methodology and forget that of much greater importance "are, first, the planning of the experiment or observation so that valid inferences shall be obtainable, and, secondly, the interpretation of the results of the mathematical tests." In the experience of the reviewer the latter is the greater risk, that too frequently today there is a tendency to regard "non-significant" as implying guiltless rather than non-proven, "significant" as proven *and therefore due to* a particular causal factor. Dr. Mainland has certainly endeavoured throughout his article to guard against these very undesirable by-products of his plan of presentation. * some extremely useful tables. These comprise binomial confidence limits (with graphs as well) over a wide range of size of sample and of values, and also exact probabilities for small-sample fourfold contingency tables—the probabilities for equal samples up to N equals 20 and the significant differences for unequal samples up to N_1 equals 20 and N_2 equals 19. These latter should clearly be of great help to many workers, as will also a table of the logarithms of factorials of numbers up to 1,000 for the calculation of exact probabilities not tabulated. For samples not covered by the tables precautions and rules regarding the use of chi squared have been derived from more than five hundred comparisons between chi squared and the exact method. A criticism that might be made is that Dr. Mainland is rather inclined to overstate the case for using the "exact" methods he gives—how often, in fact, would the observer be misled by the cruder methods if he were cautious in borderline cases?—and to place considerably too much confidence in the results given by very small samples. While agreeing with him that "no sample is too small for statistical assessment" one may yet, for instance, with a mere handful of sick persons to compare remember their innate variability and Dr. Mainland's own emphasis on the importance of "the interpretation of the results of the mathematical tests." However that may be, this heavy piece of work should certainly help the medical investigator to apply without tears his tests of significance to small samples—though it is unlikely that he will do so intelligently unless he is prepared to take *some* trouble to understand what it is all about.

[215]

★MAKIN, F. BRADSHAW. **Practical Statistics, Second Edition.** London: Gee & Co. (Publishers) Ltd., 1950. Pp. 115 12*s.* 6*d.* *

For reviews of the first edition, see 38:B660 and 2:195.

[216]

★[illegible] KARL J. **Elimination of the Effects of Accidental Errors of Measurements in Statistical Investigations.** Uppsala, Sweden: Almqvist & Wiksells, 1941. Pp 13 75 ore.

[217]

★MANN, H B. **Analysis and Design of Experiments: Analysis of Variance and Analysis of Variance Designs.** New York: Dover Publications, Inc., 1950. Pp. x, 195. $2.95. *

Math R 11:262 Ap '50. A. M. Mood. This

little volume brings together most of the mathematical material associated with the analysis of variance and the construction of experimental designs. * the presentation is necessarily much condensed and in fact only the bare mathematics is given in most chapters. There is practically no motivation nor explanation and there is hardly a word on the art of designing experiments. The general components-of-variance model is not discussed at all. Also the book was hurriedly written and carelessly proof-read so that it contains many misprints, minor errors, and confusing notations. The overall result is a book that is difficult to read even for a person not new to the subject. Nevertheless, this book will be a welcome addition to the library of the mathematical statistician for it provides the first connected account of an area which is rapidly becoming quite important to statistics and to scientific experimentation in general. The best parts of the book are those devoted to the construction of designs, where the author uses the methods of the Indian workers. This part of the book is complete in that the necessary ideas from abstract algebra are developed from scratch and are well illustrated by simple examples. Most attention is given to the construction of orthogonal latin squares and balanced incomplete block designs. The author has asked the reviewer to mention that W. L. Stevens should have been given credit for the methods of constructing orthogonal latin squares, as well as R. C. Bose, who is credited in the book. They did the work independently at about the same time.

Q R Biol 25:265 Je '50. A Chapanis. * a complete, although brief, coverage of the field * a book by a mathematician....written for mathematicians. Its goal is to provide a rigorous mathematical treatment of the subject. The author has gone far toward achieving this objective but, in so doing, he has written a book far beyond the practical experimenter. The discussion is entirely at symbolic level, with no illustrative examples, problems, or guides to computational procedures. In short, this text is for professional statisticians and mathematicians. The biological scientist had best look elsewhere for help on analysis of variance designs.

[218]

★MATHER, K **Biometrical Genetics: The Study of Continuous Variation.** London: Methuen & Co. Ltd, 1949. Pp. 172. 18*s*. (New York: Dover Publications, Inc. Pp. ix, 158. $3 50. *)

Eug R 41:90–1 Jl '49. D. J. Finney. * a valuable account of the application to quantitative inheritance of methods of analysis deduced from ordinary Mendelian genetics on the assumption (which few to-day would question) that, except for variation attributable to environment, a quantitative character is determined as the resultant effect of a number of genes at different loci. The first chapter is concerned with general arguments for belief in this polygenic inheritance. Here and elsewhere, the insistence with which Mendelian and biometric genetics are contrasted is perhaps a little surprising: the difference seems one of statistical analysis rather than of fundamental nature, and the adoption of Professor Mather's biometrical techniques is an admission that effects of individual genes are too small and too closely alike to be separately observable, not a recognition of any essentially different hereditary mechanism. After a chapter emphasising the practical importance of the study of quantitative inheritance, especially in assessing the potential gains from a plant breeding programme, questions of scales of measurement are attacked. Analysis is much simplified if genes which effect the same measurement are additive in effect, a property which may not be true of the scale on which the measurements are made: the possibility of finding a transformation of the original measurements which will have this property is therefore discussed and illustrated. Statisticians will like to compare this problem with an analogous one of current interest, that of the choice of metameters in biological assay. In chapters 4 and 5 the partition of the total measurable variation between individuals into components attributable to differences between homozygotes, heterosis and environment is described. The details naturally depend upon the pattern of the family data available for analysis, but, in addition to illustrating the exact forms of computations for some cases, Professor Mather makes the general method very clear, both for independent genes and for genes as modified by the presence of linkage. Provided that the genes on which a character depends have approximately equal effects, their number may be estimated from comparison of components of variance in different generations. In practice, only the number of effective factors or segments of chromosomes can be estimated, and not the number of ultimate genes; accumulation of data from several generations, how-

ever, would give opportunity for many recombinations to be encountered, and might allow the limiting number of genes to be approached. From the numerical illustrations presented it will be apparent to the reader that mere abundance of data is not sufficient to give satisfactory information on all these matters. Even the extensive experiments on oats and barley discussed by the author are not ideal in respect of the evidence they provide on components of variation and numbers of factors. Professor Mather therefore includes a final chapter on experimental design, in which he discusses the relative merits of different breeding systems for future experiments. He points out that much must depend upon properties of the plant or animal species to be studied, but nevertheless establishes certain general principles. This book will be read with interest by all geneticists. Even those whose chief concern is with human inheritance, one of the most difficult fields for the adequate study of quantitative characters, should make themselves familiar with the principles of the new analytical methods. A considerable acquaintance with standard techniques of biometric statistics is necessary for complete understanding of Professor Mather's work, but readers who lack this should still be able to appreciate the purpose and interpretation of his analyses. The book is a summary of progress to date, not a treatise on a fully rounded theory. That it should stimulate others to extend the methods, to complete more complex experiments than have been attempted in the past, and to study further difficult problems such as the assessment of the precision of the various estimates, is much to be desired.

Lancet 257:420 S 3 '49. * Many readers may find themselves disagreeing with the author's assumptions about the nature of polygenes, and others will find the approach to the subject too formal for their taste. His work should, however, stimulate further investigation of the genetics of human metrical traits, which have been somewhat neglected in recent years.

Q R Biol 24:357–8 D '49. Earl L. Green. In the years immediately before and after 1900, two different approaches were made to the problem of heredity. One of these, based upon Mendel's concept of unit characters, dealt with attributes, such as black vs. brown. The other, begun by Galton and Pearson, dealt with metric characters which varied continuously from least to greatest in groups of plants or animals. The concepts necessary for a union of these two approaches, the genetical and the biometrical, were contained in the multiple factor hypothesis of Nilsson-Ehle and East. A modern statement of the theory, including the newer concepts and analytical methods, has been needed for some time. It is effectively supplied in this book by Mather. * Familiarity with the concepts of this book is necessary for anyone who proposes to analyse continuously varying characters in plants and animals. The paucity of adequate experiments in the past and the imposing number of quantitative characters yet to be analysed in experimental and domestic animals and plants indicate that this book is most timely.

[219]

★MATHER, K. **Statistical Analysis in Biology.** Foreword by R. A. Fisher. London: Methuen & Co. Ltd., 1943. Pp. iv, 247. * For latest edition, see 220.

Economica 11:160–1 Ag '44. E. Grebenik. * Mather's book....seeks to explain the application of statistical method to biological and agricultural problems, and its approach, based mainly on the analysis of variance, is unfamiliar to those who are used to economic statistics. That it should be unfamiliar is to be deplored. Statisticians working in the social field have much to learn from their colleagues who work in the natural sciences, but at present a great part of the latter's work is unintelligible to them. The theory of experimental design and the analysis of variance should, however, prove as useful a tool in economic and social investigations as it has in agriculture and biology. Unfortunately Dr. Mather's book will not fill the gap. Parts of it are very obscure and the book as a whole is marred by misprints. Moreover, in his anxiety to avoid difficult mathematical argument, most of the proofs on which the methods are based are omitted. Yet the reader is expected to have a fair knowledge of mathematics. * the whole work is full of cumbersome arithmetical formulae, many of which could have been simplified if more use had been made of the traditional notation. In a book addressed primarily to biologists most of the examples chosen to illustrate the argument are, of course, taken from the biological field and ignorance of the jargon adds to the non-biological reader's difficulties. It is a pity to find these blemishes in a work in which the method of approach is interesting, but the book will be of little use to students in the social sciences who wish to be informed about developments in other fields.

Eug R 35:17 Ap '43. H. Grüneberg. * This book is written for the users, not for the makers of statistics, by a biologist for biologists, and it may be said at once that Dr. Mather has succeeded admirably in his aim. In a previous book, *The measurement of linkage in heredity,* the author had already shown his powers of explaining simply the principles and the application of statistical methods to the biological reader. We are now presented with a book of wider scope, which is written very lucidly, and contains many numerical examples very fully worked out. The book is thoroughly modern in outlook and deals particularly well with the small sample analysis as developed by R. A. Fisher and his school. The work should have a wide appeal to the many biologists who find the more advanced texts heavy going. * The reviewer was particularly impressed by the clear exposition of the analysis of variance, a method which is acquiring increasing importance as a tool in analysis. To sum up, Dr. Mather's book is undoubtedly a very valuable addition to the statistical armoury at the disposal of biological workers and deserves a wide circulation.

J Am Stat Assn 39:525–7 D '44. W. G. Cochran. The author....presents, from the viewpoint of a biologist, most of the techniques developed in Fisher's *Statistical Methods for Research Workers* and some of those in Fisher's *Design of Experiments.* The exposition is lucid. * Inter- and intra-class correlations are described rather briefly. The analysis of frequency data and more particularly of contingency tables is developed in considerable detail, presumably in view of its usefulness in tests of Mendelian inheritance. Included in this section are the rules for the sub-division of the "goodness of fit" χ^2 into single degrees of freedom—seldom given in text books. * The rather free use of algebra in the later sections of the book is defended by the author, though it is doubtful whether some of the algebraic portions, *e.g.* the proof that one form of χ^2 gives results identical with another form, really contribute much to the reader's understanding of the subject. The defects of the book arise mainly from the limited range of the author's reading in statistical literature, and his limited knowledge of statistical theory. Thus, as evidence that non-normality does not vitiate the analysis of variance tests, it is stated (p. 35) that "Actual data have been analysed by Eden and Yates and the insignificance of these errors has been fully demonstrated." In fact, the data analyzed by Eden and Yates are only slightly non-normal, as Neyman has pointed out, while the question of non-normality has been the subject of at least fifteen papers which are ignored by the author. Fisher's z-distribution is said (p. 45) to be "independent of the two true standard deviations" which is incorrect unless the true standard deviations are equal. The pooling of mean squares which are not significantly different is highly recommended (p. 78), without a realization that this practice renders the use of a subsequent z-test invalid, at least to some extent. The discussion (p. 79) of a group of barley experiments where year and place interactions enter is much oversimplified, though the complexities involved in a realistic analysis of these same data have been investigated by Yates and Cochran. The recommendation (p. 175) that χ^2 should never be used where any class frequency is less than 5 is overcautious in view of recent work on this problem, and is not helpful, since the reader is not told what to do when a class frequency is less than 5. Actually the author breaks his own rule without comment (p. 191), where a χ^2 analysis is carried through with one frequency as low as 2. Similarly, the author's resolve to use Greek letters for population parameters and Latin letters for sample estimates is not well kept; thus p is used throughout for the parameter of a binomial distribution and λ is used for both population and sample weights in discriminant functions (p. 157). On p. 205 occurs the curious statement that Fisher's theory of estimation is independent of the theory of probability. In the glossary (p. 234), bias is described as "the average error of an estimate." The absence of an adequate discussion of transformations is regrettable. Too many significant figures are carried in almost all computations.

J Royal Stat Soc 106:68–9 pt 1 '43. D. J. Finney. * Mather has had the courage to depart from tradition both in the order and in the form of his presentation. This is particularly noticeable in his refusal to admit that biologists are incapable of understanding the simplest of algebraic demonstrations. Many readers will at first be deterred by the amount of algebra; those who take the trouble to study it will not find it difficult and will undoubtedly gain considerable benefit from the resulting clearer understanding of elementary statistical processes. This advantage will not be confined to the biologist for whom the book is intended, as

the mathematician should find in these occasional pieces of algebra familiar landmarks to guide him in his first approach to an unfamiliar branch of applied mathematics. "Statistics," says Dr. Mather, "is the mathematics of experiment," indicating an intention to limit his discussion to the analysis of experiments; such a restriction is legitimate, though it is not desirable to give the impression that this is the whole field of statistical analysis. While the analysis of experimental results is undoubtedly an important part of modern statistics, most statisticians have frequently to give their attention to data which are not the products of controlled experiments, and which, for that reason, have their own peculiar difficulties. Even accepting this restriction to one aspect of statistics, it is surprising to find in this book no mention of the sampling of experimental material, and the use of reliability of estimates obtained from such sampling. The main chapters on the analysis of variance and its ramifications are preceded by an excellent account of the inter-relations of the normal, t, χ^2, and z distributions, though this interesting section might be better deferred until the uses of the various distributions have been described. Dr. Mather's account of the analysis of variance itself is less satisfactory, as the facility with which his examples are presented may lead the unwary to believe that there is here a perfect guide for all such analyses. The suggestion that there is a limited number of ways of subdividing a sum of squares with several degrees of freedom into components with single degrees of freedom is an unfortunate, though probably unintentional, consequence of the listing of various symmetrical subdivisions for two, three, and four degrees of freedom. The inadequacy of the discussion of the barley yield data will be readily appreciated by those familiar with the detailed treatment of the same data given elsewhere by F. Yates and W. G. Cochran, while reference to the original paper will show the apparently remarkably high yields to refer to bushels per three acres, not per acre. Another error, common to many text-books of statistics, occurs in an example of regression analysis applied to the uptake of rubidium and bromine from rubidium bromide by potato slices, the lack of independence of the two sets of observations being ignored in the comparison of two regression coefficients. The sections on experimental design are a good elementary introduction to the various problems, especially in relation to confounding. A useful chapter on polynomial and multiple regression contains also a section on discriminant functions, a method not yet commonly found in books on statistics, but one which may become increasingly important. The subjects of the two final chapters, frequency data and the method of maximum likelihood, are those on which Dr. Mather's experience best qualifies him to write, and the discussion given is better and more complete than is usual in a book of this nature. The biologist who takes the trouble to study these chapters carefully, especially those portions concerned with the theory of estimation as developed by R. A. Fisher, should derive considerable benefit. In view of the difficulty found by many people in appreciating the precise meaning of a statement of fiducial probability, it would be desirable in future editions of this book to amplify the paragraphs dealing with this subject and to remove the grounds of possible misinterpretation. The book ends with a glossary of statistical terminology and a short series of tables. The shortening of tabulated values so as in general to show only two digits should encourage the user to make rapid tests of significance without laboriously calculating the exact value of the statistic to be tested. It is a common error to draw a sharp line of distinction between the "significant" and the "non-significant," as though truth and a twenty-to-one chance were precisely equivalent, and the retention in computations of more figures than the accuracy of the original data warrant is a fault more common, if less serious, than the retention of too few. Unfortunately Dr. Mather does not always adhere in the text to the policy suggested by the tables. The book as a whole is well produced and, for the most part, free from the minor typographical errors which are so irritating in a statistical work. The wide variety of sources of numerical examples should interest readers who are glad of a change from books more strictly concentrating on agricultural field trials.

Lancet 244:558 My 1 '43. This exposition of modern statistical methods is not easy reading but should prove useful to workers who are not daunted by algebraic manipulation and elementary differential calculus. * A great deal is....compressed into a relatively short space. The book is well illustrated by examples, naturally drawn mainly from the field of genetics, and as the author emphasises in his

preface it is only by working through these that most readers will learn what is being done, how it is being done and why, and be ready to apply the methods to their own material. There is no short cut to understanding and using them but plenty of hard work aided by such a guide as this.

Nature 151:654–5 Je 12 '43. J. B. S. Haldane. Dr. Mather's book begins with the remarkable statement that "Statistics is the mathematics of experiment." In fact, statistics originated in the spheres of demography and economics, where experiment is difficult, dangerous, and rarely scientific; and among their most successful spheres of application is astronomy, where it is wholly impossible. Perhaps it is for this reason that Dr. Mather completely ignores the construction and interpretation of life-tables, though these are not merely fundamental for human biology, but are assuming an ever-growing importance in animal biology also. Nor is there any suggestion for the treatment of statistics of fertility, such as are given in Salisbury's "The Reproductive Capacity of Plants." Yet any theory of evolution must be based on such data as these. In his mathematical analysis, "The primary concept of statistics," Dr. Mather tells us, "is that of the infinitely large hypothetical population of which the observed data form a sample." Certainly theoretical statistics can be built up around this concept. But they can also be built up around that of a random variable, or around that of probability in accordance with such axioms as those of Jeffreys. Many writers regard one or both of the latter approaches as logically sounder, if only because they do not necessitate the concept of likelihood, which is not derivable from that of an infinite population. The ground covered by Dr. Mather is much the same as that covered by Prof. R. A. Fisher in "Statistical Methods for Biologists" and "The Design of Experiments," and his debt to Fisher is obvious and fully acknowledged. As compared with these books, Dr. Mather's gives a fuller account of some arithmetical methods. His discussion of the interrelations of the normal deviate, χ^2, Student's distribution, and that of the variance ratio, is illuminating, as is his detailed account of the individuality of degrees of freedom. But, as might perhaps be expected from his opening paragraphs, Dr. Mather's treatment is sometimes logically incorrect. Thus, after finding χ^2 for a 2×2 contingency table on p. 193 to be 1.17, he adds that this shows "that there is no interaction between the classifications, *i.e.*, that the type of water does not affect germination." Actually it proves nothing of the kind. It merely shows that if loam water leads to better germination of seeds than rain water, or conversely, a test on a hundred seeds is inadequate to demonstrate the fact. But it is entirely possible that a test on several thousand seeds would have shown 15 per cent more germination with loam water than rain water. Perhaps if the author were accustomed to thinking in terms of probability rather than of infinite populations, he would not have fallen into this elementary fallacy. It is sometimes as important to realize what statistics do not prove as what they do prove. On the whole, Fisher's approach in the books mentioned is not only more logical than Dr. Mather's, but is also likely to be more intelligible to a beginner. Nevertheless, Mather has cleared up a good many points which Fisher treated rather rapidly, if at all. The ideal book on statistical methods for biologists has not yet been written, and perhaps never will be. But it is worth speculating on its contents. It would include the mathematical proof of the validity of all methods used. It is perfectly true that the majority of biological students are willing to take statistical methods for granted, as they take microscopes. But those who possess the scientific spirit in any large measure will certainly insist on understanding chromatic aberration, on one hand, and skew frequency distributions, on the other. Actually the necessary mathematics could be compressed into a smaller space than might be thought. Secondly, it would deal with the history of biometry, which has some bearing on its present situation. Forty years ago, a spectator of the controversy between Bateson and Pearson might well have said, "I don't know which is right, but it is certain that both of them can't be." As a matter of fact, both of them were so to a very large extent. To-day the views of certain statisticians appear to be quite irreconcilable. Yet a historical retrospect suggests that all may be of value. Thus Neyman and Pearson, Fisher, and Jeffreys, use different criteria of significance, each defending his own point of view with considerable force. They have been mainly concerned with industrial products, living organisms, and earthquakes respectively, and each may have chosen the best method in his own field; but these methods may be of some

value outside that field. Thirdly, it would deal with all the important applications of statistics to biology. A very brief survey would show how unevenly statistics have been applied. Thus, for obvious economic reasons, the preparation of life-tables now rests on a very complex and meticulous technique, while that of growth curves is in an embryonic condition. The book before us fulfils none of these conditions, nor of course does it claim to. The formulae of the main theoretical distributions are given, none the more intelligibly for containing factorials of fractions, the meaning of which is nowhere explained; and the statement on p. 35 that "moments of order higher than the second are not often used," if true, merely suggests that biometry is in a somewhat decadent condition. The assumption that any distribution may be treated as normal has led to serious errors in recent years, notably in the comparison of mutation-rates and the detection of linkage. Dr. Mather is nothing if not up to date. "The correlation coefficient," he tells us, "has occupied a very important place in statistics, but its use is gradually dying, as the method of regression will always offer as good a solution to a problem, and frequently better." No doubt in individual cases regression coefficients tell us a little more than correlation coefficients. But they do not enable us to compare the relations of different variates; for example, to answer the question whether we can predict brain-weight better from body-weight or head circumference. Also they are essential in the study of heredity, not only according to the methods of Pearson, but also to those of Sewall Wright, which are fully applicable to Mendelian cases. The broader the generalization reached, the more does correlation prove superior to regression. These opinions can be explained by the limited field from which Dr. Mather's examples are drawn. Grossly skew variation is found, for example, in the distribution of weights, of drug tolerance, of life expectations, and of fertilities, but these are not considered. When all these criticisms have been made, the book will be of value to a great number of biologists. The tables at the end are very succinct, and sufficient for many purposes. The treatment is often more detailed than in any other similar book. There is at least a fair probability that a research worker will find here, and nowhere else, a detailed description of a method suited to his or her particular problem. But just because "Statistical Analysis in Biology" will fill a gap, it is essential to point out its very real limitations.

Plant Breeding Abstracts 13:272 Jl 1 '43. *O. Kempthorne.* * a good introduction to the use of most methods of statistics which are required by biologists. The author has succeeded in reaching a satisfactory compromise between the type of book which is so mathematical as to be unreadable by the [illegible] and the opposite type which is a pure catalogue of methods to be used by rule of thumb. * The reviewer agrees with the author that the biologist should be able to understand a certain amount of algebra, and that some elementary algebra on topics such as the partitioning of degrees of freedom or the partitioning of χ^2 should be helpful towards understanding the general methods. It is thought, however, that the arrays of degrees of freedom given are needlessly long, and may quite easily put the reader off the subject. Secondly, if algebraic proofs are given, they should be as easy and concise as possible: in this connection the algebra of the partitioning of χ^2 presented on pages 177, 179, 198 and 199, is most laborious and inelegant. The examples chosen to illustrate the arguments are in general quite good, but the preponderance of examples from genetics in some of the chapters is unfortunate but perhaps unavoidable. It is felt that the inclusion of a chapter on the treatment of toxicological data by the method of probits would have enhanced the value of the book and a short section on other transformations of variates would be useful. Finally, in spite of the above criticisms, this book can be strongly recommended to all biologists.

Q R Biol 18:299 S '43. This book would be more appropriately entitled "Significance Tests for Biological Data" for it is limited almost exclusively to that subject. * When we consider the large body of work in physical biology, physiology, epidemiology, *etc.*, where rational equations have been developed from a study of the observations, the last stage seems a long way beyond significance tests, useful as they are along the way. In the last chapter the author mentions that these tests are actually only a part of the story, for he says, "Broadly speaking, statistical operations fall into two categories, *viz.* tests of significance and estimation of parameters" (p. 203). But even though he devotes a part of this chapter as well as some sections of the preceding ones to the subject

of estimation, the reader is left with the impression that when we have determined the probability that the parameters differ significantly, our problem is done. The significance tests are presented largely through applied problems which are very well chosen. The interpretations of the tests are not always justified, however. For example, in discussing the tests mentioned above, the author states, "Thus rigorous inferences may be reached from observational data alone, without involving any assumptions about the parent populations" (p. 49). What he should say is that no assumptions are made about the *parameters* of the parent populations, but since the distributions are assumed to be normal and it can not be known whether this assumption is correct, the inferences are not rigorous in the sense implied. There is some tendency to allow incorrect statements for the sake of simplification. * The book must....be read critically and the beginning student should be warned that he may have to correct some of the over-simplified interpretations as he increases his understanding of the subject, and will certainly have to enlarge his ideas as to what statistical analysis means.

Sci 102:161–2 Ag 10 '45. C. I. Bliss. * Some biologists are disturbed by the omission of statistical derivations and mathematical proof, as in Fisher's "Statistical Methods for Research Workers." They will have little complaint with the present book on this score. Mather's approach is primarily algebraic with some elementary calculus. He shows how most of the standard equations can be derived, although those for the basic distributions, including the tests of significance, are stated without proof. In developing the analysis of variance, randomized blocks and similar topics, he inverts the usual order. Starting with combinations and permutations, individual degrees of freedom and their variances are isolated, even though they may be added later to obtain mean squares with several degrees of freedom. In the reviewer's experience many biologists are content with learning how to use statistical equations and enough of their logic to avoid misapplying them. Mather's approach tends to bury the essential simplicity and logic of some of the techniques under the derivation of equations. Most of the examples in the present volume are new in text-books. Perhaps two thirds of them are genetic, with most of the remainder physiological or agricultural. Some of his topics occur rarely in text-books, such as the calculation of polynomial coefficients, the discriminant function, the method of maximum likelihood, the limitations of inefficient statistics and an extended discussion of the partitioning of χ^2. On the debit side, Mather uses N instead of n for degrees of freedom, which is the reverse of the convention to which many of us have become adjusted. Symbolism is not consistent through the book, although this is as difficult to attain as complete freedom from errors. Many calculations are carried to several more decimal places than have any meaning. Some statements are open to question, such as the one that "neither χ^2 nor the normal deviate should ever be used when any class frequency has an expectation of 5 or less." Cochran has shown that, in many applications, smaller expected frequencies still lead to satisfactory tests of significance. Data on the growth of maize are fitted with a polynomial curve, although the equation has no obvious biological interpretation. Because they are easy to handle statistically, polynomial curves are often computed without regard to their physical meaning. Their chief descriptive value is in indicating how many fitted constants may be needed in a rational equation which would define the relation. These limitations have been overlooked. A number of misprints have crept into the text, sometimes into equations. * It is to be hoped that later editions will include some of the important topics which have been omitted, such as the analysis of experiments with missing values, transformations to stabilize the variance, the χ^2 test for homogeneity of the variance, tests for normality and a more critical discussion of the errors which are pertinent for the different comparisons of a complex experiment.

[220]

★MATHER, K. **Statistical Analysis in Biology, Second Edition.** Foreword by R. A. Fisher. London: Methuen & Co. Ltd., 1946. Pp. iv, 267. 16s. (New York: Interscience Publishers, Inc., 1947. $5.00.) * [The third edition, published in 1949, is a reprint of the second edition.]

J Am Stat Assn 42:477–8 S '47. John W. Fertig. * The second edition is practically identical with the first except that Chapter XIII on transformations has been added. * The brief section on sampling distributions brings out admirably the relation between the normal, t, χ^2, and z distributions. The section on the analysis of variance and the planning of experiments should be interesting to most biologists. Of

particular interest in this connection is the detailed presentation on the partitioning of the variation among the individual degrees of freedom. Chapter XI, on the analysis of frequency, gives a very interesting discussion of χ^2 including general rules for partitioning it among the various degrees of freedom. In the application of the *t*-test to compare the means of two independent samples the author fails to mention the need for pooling the variation within samples when the samples are of unequal size. It seems to this reviewer that, for a book limited in size as this one is, the space devoted to the higher order polynomials and the mechanics of fitting them is out of proportion to their utility in the analysis of biological data. There also seems to be an inordinate emphasis on alternative methods of computation. Frequently a lot of algebraic manipulation is included to show the equivalence of various forms of computation. This is particularly apparent in the chapter on χ^2. The inaccuracies and ambiguities mentioned by Cochran in his review of the first edition have in general not been clarified.

J Am Stat Assn 42:478–9 S '47. Horace W. Norton. * The probit transformation is treated fairly adequately, though there is no remark to guide the reader in case the slope of the probit regression is not significantly different from zero. The angular transformation is presented with a worked example, and the square-root transformation is barely mentioned; no other transformation is discussed. Transformation is advocated to achieve constancy of error variance and as sometimes giving a simpler relation to some other variate. There is no discussion of other desiderata for transformed variates, such as normality of distribution or additivity of effects. The paragraph (p. 259) dealing with the ease of planning of experiments which are to be analyzed by means of a transformation will give a misimpression to those readers who do not realize that "any required level of precision" will usually refer to the untransformed variate and that there is some difficulty in finding the corresponding level for the transformed variate when the mean values to be observed are unknown. This book is unusually lucid and should be widely used. Nevertheless, it deserves criticism for insufficient attention to form of statement, for there are many inaccuracies and inconsistencies and statements which are too sweeping or too loose. As examples of inaccuracies, there are the old error (pp. 35, 255) that kurtosis measures fullness of center and tails as compared to the normal distribution; the statement (p. 59) that the same result is reached by the *t* of *n* degrees of freedom, with paired comparisons, as by the *t* of 2*n* degrees of freedom, if the paired observations are independent; and Section 58 on Fiducial Probability (pp. 231–233) which is based on sampling a normal distribution but contains several statements of the form of "....with no resort to hypothesis...." The usual statement is made that a variance ratio is always the ratio of the larger to the smaller, but Table 17 shows a variance ratio of only 0.316, and its significance level is found by changing to *t* (in the text) with no explanation of the departure from the stated rule. A fair sample of the sweeping statements is (p. 218) "Inefficient estimates....should never be used." There are many loose statements, such as (p. 30) "The normal curve is symmetrical and so the discrepancies cancel out" and "The....standard deviation is....markedly biased by grouping...." and that (p. 91) if a few observations are lost from an experiment "....its whole value will be forfeited." Also the statements about tests of significance often use "significant" or "highly significant" unconventionally. The discussion of Yates' correction for continuity would be improved by an explicit statement that it applies to any case of a single degree of freedom but does not always amount to half a unit and by deletion of the assertion that it always overcorrects. The analysis of variance is applied to discrete data in several worked examples without justification or apology. Conclusions which are invalid in the sense that the adduced data cannot support them are drawn in several cases as (p. 65) that one variety is more *prolific* than another, the data being fruit yield in kilograms, and (p. 122) that a linear regression must be nonlinear between the origin and the first observed point. It is regrettable that calculation of the error sum of squares by difference should receive such emphasis by repeated statement and example, and that the authors of the 0.1 per cent variance ratio table were not properly credited.

Math R 9:194 Ap '48. C. P. Winsor. * This text covers the same general ground as Fisher's well-known "Statistical Methods for Research Workers"....but with considerably more detailed explanation of the rationale of the methods. (This does not imply that mathematical proofs are given.) * A particularly valuable feature of

the book is the careful discussion of single degrees of freedom and the isolation of their effects. There are a few misstatements, due to failure to realize fully some of the mathematical limitations. For example, on page 212, it is stated that the variance of a maximum likelihood estimate is "always equal to the reciprocal of ni, where i is the amount of information," with no hint that this is a large sample property. Again, on page 231, there is evidence of confusion about sufficient estimates. Such misstatements are not likely to lead the user of the methods seriously astray, but will annoy the mathematical statistician.

Plant Breeding Abstracts 17:234 Ap 1 '47. * the appearance of a second edition so soon.... may be taken as sufficient indication of the very great usefulness of this book, which has in fact become an almost indispensable source of information on statistical methods for biological research workers * It may be possible to disagree with Dr. Mather on the mode of presentation of some parts of this book, but the whole forms such a useful guide both to biologists in general and to plant breeders and geneticists in particular, that it may be unreservedly recommended.

Q Appl Math 5:367–8 O '47. John W. Tukey. * written for biologists with a rather weak background in mathematics. This aim has been so well carried out that many mathematicians will find the lack of analytical short-cuts annoying. They have no ground for complaint. The book can be recommended to biologists as one of a small number with modern techniques and relatively little mathematics. It can be recommended to mathematicians interested in how statistics is actually used—in biology at large, and more especially, in the author's field of genetics. * The book's special features include (*i*) the only available careful, elementary account of single degrees of freedom and (*ii*) the use of small sample tests before their large sample brethren. The book seems remarkably free of typographical errors * Although it is a revised edition, there are ten or a dozen points with which the reviewer differs. Some are errors of fact, others are differences in philosophy. Some of the most important seem to have arisen by incautious reading of R. A. Fisher—paying heed to what Fisher's words seem to mean rather than to what Fisher was very careful to say. The "rigour" of statistical inferences is emphasized at page 11, without any warning that the exactness of these Fisherian procedures (which the reviewer uses himself) depends on the exact normality of the distributions found in practice —something difficult if not impossible to verify by experiment. A minor point on page 35 concerns kurtosis. Here overprevalence in the center is given equal weight with overprevalence in the tails as a cause of kurtosis. This is only half the classical error, which emphasized the center even more. The reader is advised on page 45 to put the larger mean square in the denominator of F. This is not consistent with the modern attitude toward the analysis of variance (*e.g.* Eisenhart, *Biometrics* 3(1947), pp. 1–21). On page 58 the reader has completed the first analysis of the tomato data. He has found that $\bar{A}$ "must be supposed to....(be) greater than 1," that $\bar{B}$ "does not....differ significantly from 1," and "that there is no reason to suppose that a real difference....exists (between $\bar{A}$ and $\bar{B}$)." (Parenthetic words ours.) The reviewer feels that the reader deserves to have the situation clarified. The reader who reads on page 76 "is....appropriate....in this case, it being usual to take the highest order interaction for this purpose, unless...." will be surprised to learn nine pages later, on page 85, that he should use a different error term. The reviewer cannot combine the comments on pages 78 and 131 on pooling estimates of error into a coherent philosophy. His own philosophy is not coherent either, but he would do the opposite in both cases. Perhaps Mather's third edition will clarify this problem for all of us. The trout fly example on page 123 seems somewhat incautiously chosen—the distributions seem so far from normality as to make the author's concern about differences between significance at the 4%, 2% or 1% level somewhat exaggerated. The data thus do not make an important point with the definiteness the point deserves. A major error of fact occurs on page 205, and again on page 212, where Mather states that maximum likelihood estimates have variances *equal* to $1/ni$ in samples of n. The example of the Cauchy distribution for $n = 1$ or $n = 2$ shows the falsity of this statement—here i is finite but the variance is infinite. It is known that as $n \to \infty$ the variance is *asymptotically* $1/ni$, but this is all. On page 213 we are told that "It will be readily appreciated that inconsistent statistics are utterly misleading and should not be used under any circumstances." This seems exaggerated, in view of such incon-

sistent statistics for the mean of a normal distribution as the following: "Take the mean of the sample, or, if there are more observations than electrons in the metagalaxy, take twice the mean." (This is essentially due to Mosteller.) On page 222 we find n turned into $n - 1$ in a most *ad hoc* way. It is regrettably true that the maximum likelihood estimate of the variance of a normal population involves division by n, and not $n - 1$. Regrettable, since this encourages n-dividers in their recreant ways. But since it is so, it should be admitted. On page 239 we are told that the variance of $x^{-\frac{1}{2}}, x$ Poisson, is exactly independent of the mean. Asymptotic and exact statements are confounded here, as are the means of the population and sample.

Sankhyā 8:389–90 Je '48. Purnendu Kumar Bose. * the author deals in a simple manner with the various statistical methods used in biological investigations and shows keen practical grasp of the essentials of good experimentation. This book is expected to be a very useful adjunct to those of Fisher, Paterson and Goulden. * In chapter XI and XII he gives a very interesting discussion on χ^2 including general rules of partitioning it among the various degrees of freedom and a brief outline of Fisher's theory of estimation. * the book has a few notable shortcomings. In this book the author explains not so much the statistical principles as the practical procedures for solving the problem and thus the whole treatment has become perhaps a little more mechanical than it need have been even under the restriction of simplicity. In this connection mention may be made in particular of chapters VI and XII. There are a few statements about which the author should perhaps have been a little more cautious. One or two instances may be cited. On page 35 chapter III occurs the remark, "It is nearly always assumed that the data fall on a normal distribution and though the fact that the skew curves are not too uncommon shows that this assumption is not generally justified, the errors introduced into second degree calculations by such departures from normality are small and may be neglected." It might seem from the above statement that non-normality (without any qualification as to the degree of it) does not vitiate the results which, however, as is well-known, is not a fact. On page 175 Chapter XI occurs another remark, "Neither χ^2 nor normal deviate should ever be used where any class frequency has an expectation of 5 or less," but on page 191 the author has actually solved a problem where the cell frequency is 2. It is suggested that, specially for a book of this type, chapter VII should be enlarged. It should cover the general cases of total and partial confounding and also the problems on non-orthogonal data, *i.e.* the cases where the field results are incomplete.

Sci 106:154 Ag 15 '47. Earl L. Green. * The mathematical models of frequency distributions which arise most often in practice are explained rather thoroughly. * The author has placed emphasis on the advantages of planning experiments in order to extract maximum information from the observations. More emphasis might be placed upon the principles and methods of estimation, carrying the exposition of these methods along with the discussion of tests of significance rather than relegating them to a late chapter. An introduction to the concepts of the power of a statistical test and of errors of the first and second kind in testing statistical hypotheses might not be amiss in a volume of this sort, although an exposition for students in the nonmathematical sciences might present a considerable problem.

For reviews of the first edition, see 219.

[221]

★MAVERICK, LEWIS A. **Economic and Social Statistics.** University of California, Syllabus Series, No. 279. Berkeley, Calif.: University of California Press, 1941. Pp. viii, 173. Paper, lithotyped. For latest edition, see 222.

[222]

★MAVERICK, LEWIS A. **Economic Statistics, Revised Edition.** Carbondale, Ill.: the Author, 1949. Pp. viii, 171. $3.00. *

[223]

★MAVERICK, L. A. **Time Series Analysis: Smoothing by Stages.** San Antonio, Tex.: Paul Anderson Co., 1945. Pp. x, 153. $3.00. *

J Am Stat Assn 41:254–5 Je '46. Leonid Hurwicz. * The author does not use any of the tools of modern statistical inference. There is no explicit statement of the properties of the universe or precisely what it is that is being estimated or tested. Sampling problems are ignored. Apparently in ignorance of the work recently done in the field of time series (von Neumann, Koopmans, Haavelmo, Mann, Wald, and many others), the author repeats, without taking sides, the once widespread fallacy of nonapplicability of correlation methods to time series. There was a time when the economist's distrust of statistical procedures was amply

justified. But the well-founded objections which had been raised against mechanical application of least squares regressions to economic data have stimulated the development of new methods which utilize economic theory and follow the principles of statistical inference (*cf., e.g.,* Tjalling Koopmans, "Statistical Estimation of Simultaneous Economic Relations," this *Journal,* December 1945 and references cited therein). It may be that some elements of the author's method will turn out to be acceptable, if not optimal, for certain purposes. But a proper appraisal must await rigorous formulation of the model to which the method is to be applied.

J Royal Stat Soc 110:72–4 pt 1 '47. D. G. C(hampernowne). * the book is clearly written and explains in detail just how to break a series up into trend, long-cycle, short-cycle, seasonal variation and residuals, and even how to make a forecast by extrapolation. Your reviewer armed with a pencil and graph book spent a happy evening in a deck chair trying out the method. On the basis of the figures of "San Francisco Real Estate Activity," 1900–1930, he achieved [a forecast for the years 1931–1949] * A comparison with the actual figures shows that it was not a very lucky forecast, but no one in their senses would expect to be able to make a useful forecast merely on the basis of such data. * Or would they? The danger in publishing this book is that they might, in spite of the repeated warnings that such forecasts are "not infallible." Statistical clerks on the average would probably apply the method no more successfully than your reviewer, and yet in some cases important decisions might be based on their forecasts, and what is worse, many valuable statistical-clerk-hours would have been wasted on a pointless task. The main defect of this book is that it may lead the unwary to suppose that the past figures of a single economic time series *alone* provide the material for forecasting its future. A secondary defect is that no reference is made to the possibility of using correlograms in such analysis. Assuming, however, that analyses of time-series into trends, cycles, *etc.,* do have, for some unspecified reason, to be made, are the methods here suggested good ones? The answer is that the suggested methods do provide a practical compromise between the arbitrariness of freehand graphs and the rigour of least-squares procedures. Any qualified reader is likely to have various improvements to suggest, but on the whole the methods chosen are sensible ones. There are, however, one or two minor criticisms which can yet be made. The author overestimates the extent to which the statistical clerks will agree in their estimate of the "business cycle." It is notorious that different statistical techniques applied to twentieth century data can reveal short cycles of any length from three to twelve years, because, of course, there seldom is really any regular cycle at all. "Smoothing by stages" suggests a first approximation by a freehand curve to smooth away the business cycle: the clerk then proceeds to a better approximation by a moving average of varying period based on an estimate of the trade cycle period, itself depending on the freehand curve. This means that the clerk's freehand curve has a lot to do with the length of business cycle which he will eventually detect. Again, insufficient attention is paid to seasonal variation. The author is to be congratulated on recognizing that cycles are unstable phenomena, and therefore allowing the length of his moving average to vary when separating the cycles; but why does he not instruct the clerk in allowing for variations in the seasonal pattern as well? It is a grave [illegible] that no indication whatever is given of how to gauge the margin of error of a forecast; nor does the author compare any forecast with subsequent events. His methods always involve investigating the short cycles first; it is not altogether clear why this order has been chosen, yet there may be good reasons. However, the estimate of the short cycles would often be made much easier, if as a *preliminary* step a freehand (long-term) trend curve were fitted by using a flexible metal rule and the data all measured as deviations from that trend. Ripples, very difficult to detect on a steeply-rising curve, may thus be brought into perspective. The book is well provided with applications of the method to actual series, and can be recommended to those who often need to analyse time-series into their supposed components, and require clear instructions for performing the task.

[224]

★MERRINGTON, MAXINE, AND THOMPSON, CATHERINE M. **New Tables of Statistical Variables: (1) The Percentage Points of the Inverted Beta (*F*) Distribution, (2) The Probability Integral of the "Studentized" Range in Samples From a Normal Population, (3) The Percentage Points of the "Studentized" Range.** Introductory matter by E. S. Pearson and H. O. Hartley. Reprinted from *Bio-*

metrika, Vol. 33, Part 1, April 1943. London: Biometrika Office, University College, [1943]. Pp. 73–99. Paper. 5*s*. *

[225]

★Mode, Elmer B. **The Elements of Statistics.** New York: Prentice-Hall, Inc., 1941. Pp. xvii, 378. Text edition, $3.50; trade edition, $4.65. * [Pocket attached to inside cover contains a 15-page booklet *Prentice-Hall Mathematical Tables Chiefly to Four Significant Figures: To Accompany The Elements of Statistics* by Elmer B. Mode.]

Accounting R 19:93–4 Ja '44. R. Parker Eastwood. * the author set out to write an elementary text and in this he has succeeded * intended more for those who expect to be consumers....of statistics than for those who desire to become technicians [illegible] the use of the methods in some particular field * the value of this text....is definitely enhanced by the fact that the author favors no particular field of interest. By drawing his illustrations and problem material from a great variety of fields he is able to create in the mind of the student an appreciation of the universal character of the statistical tools. No more powerful incentive for the study of statistics can either author or teacher awaken than that which springs from the student's realization that through statistics he is being introduced to methods that embrace life at so many points cutting across practically all of the sciences and even some of the arts. * On no topic which the author takes up for discussion does he linger long, yet his treatment is far from superficial. * One of the desirable features of the book is the discussion on computation which is the subject of Chapter II. Here the author very wisely makes a distinction between precision and accuracy. Both the time graphs and the problem material of Chapter III could have been brought more nearly up to date. The data of a time series tend to become ancient history soon enough when put in printers' ink, even when the information is the most recent that could be obtained at the time of publication. A minor inconsistency crops up in Chapter IV in the author's treatment of the frequency distribution charts. On pages 66, 68, and 71 a break of the horizontal scale is indicated yet in representing similar data on pages 72 and 73 the break is omitted. The discussion of the types of averages, their characteristics and uses, is unusually complete. However, the practice followed by mathematics textbook writers, and observed by the author, of giving theorems followed by proofs is not well suited to a textbook in statistics. The proofs should not intrude upon the text material but should be relegated to a mathematical appendix where the students who might desire them could find them. The use of the arithmetic mean in preference to the median as the value from which to measure deviations in computing the mean deviation appears to be a departure from a fairly standard practice and the reason given by the author for the departure is far from convincing. The material of Chapter IV on moments could have been deleted without any loss in value of the book as an elementary text. The treatment of the frequency curve in Chapter X is likely to give the student who has never had calculus an unnecessary fright. Since the author presupposes "no mathematics beyond the usual secondary-school geometry and algebra" it would seem that his introduction of the symbols from integral and differential calculus is definitely out of place. Another example of the author's tendency to provide fairly simple concepts with a needlessly forbidding mathematical attire is afforded by his use of Greek letters in place of the familiar Arabic notation in the chapter on curve fitting. In general this text is likely to find its best market among those colleges and universities that offer a one-semester course in statistics under the auspices of the mathematics faculty. The author's omission of any discussion of either sources of data or methods of their collection may or may not be regarded as a defect since it is a moot question whether a knowledge of sources and means of assembling data can be successfully taught. The importance of this knowledge, however, in carrying on the great bulk of daily activities in which statistics play a part is beyond any shadow of a doubt.

Am Econ R 31:880–1 D '41. Harry Pelle Hartkemeier. * There is no mention of seasonal variation or the methods by which it may be measured. Secular trend is very briefly presented as a special case of curve fitting. * The business cycle is not discussed. Such a treatment of time series analysis renders the book somewhat less suitable for use in an elementary course in business or economic statistics. Another disadvantage for such use is the absence of any mention of modern methods of recording and analyzing statistical data by the use of punch-card equipment. * Except for quotations, at the beginning of each chapter, from *Alice in Wonderland, The Pirates of Penzance,* magazines, history books, and other sources, the book is not unusual or radical. The author realizes

this * This book will probably serve very well as a textbook for an introductory course in mathematical statistics or a general course in statistics taken by students in different fields who expect to take advanced statistics courses in a special field.

Am Math Mo 49:50 Ja '42. Hilda P. Geiringer. In the announcement of a recently published work on Statistical Bibliography, the author states that the first objective of his book is: "To make students and teachers of statistics more keenly aware of the inadequacy of much of what is now presented in textbooks and classes despite the fact that such statistical techniques are incorrect, inefficient, and obsolete." By stressing these shortcomings, he expresses exactly what so many research workers and teachers in statistics are feeling today. All the more do we welcome a book like that by E. B. Mode which, elementary as it is, gives a clear and correct presentation of the problems it deals with. * The use of various sorts of graph paper is as welcome as the valuable introduction to approximate computation. The exercises accompanying the different chapters, "none of which have been borrowed from other textbooks," are interesting and stimulating. * The book will certainly be very useful for all statisticians not primarily interested in theoretical statistics.

J Am Stat Assn 37:150–1 Mr '42. Frederick R. Ottman. Many teachers of statistics must be conscious of the desirability of introducing into their beginning courses more extensive mathematical treatments of the subjects than often have been employed in the past. One deterrent has been the lack of suitable textbooks that are at once adequate and still simple enough mathematically to be used with classes in which the students have a mixed (and usually minimum) mathematical training. To many instructors Professor Mode's book may offer a solution. It presupposes no mathematics beyond secondary school geometry and algebra, and yet it is comprehensive and contains much material of value in the study of the elementary mathematics of statistics. Although the author employs an elaborate symbolism it is always carefully defined, and the subject-matter is explained in great detail so that small points which often trouble the beginner are not overlooked. * Fundamentals are not neglected in this textbook. The chapter on computation, dealing with limits of accuracy, the elimination of unnecessary calculations, and the use of the slide rule, should prove helpful to beginning students to whom these are often small but vexing problems. There are many worked examples to accompany the discussions of methods, and there are an abundance and a great variety of exercises for solution. Somewhat more attention might have been given to the technique of chart construction in the chapter on that subject; but the charts and graphs of the book itself must be cited as excellent examples of statistical draftsmanship. The chapters on averages and those on dispersion and moments are very well done, and provide material on the mathematical properties of these measures not usually included in an elementary text. Other chapters of outstanding merit are those on frequency distributions, the frequency curve, and curve fitting. On the other hand, the treatment of index numbers seems rather narrow and limited since it is confined almost entirely to the matter of formulas. A feature of the book is the introduction at an early stage of the concept of probability and the development of it throughout the text. The student is led gradually and carefully to the final chapters in which the topic is brought to culmination in the discussion of binomial distribution, and in which he is given an introduction to sampling theory. Discussion of measures of reliability is confined principally to large samples. The treatment in relation to small samples is of necessity somewhat limited, in keeping with the scope of the text. The Chi-square function, however, is given more than passing attention, and a number of examples of the practical application of the Chi-square test help to explain the concept. In general, the book is very well written, and is marked by a clear, lucid exposition of the mathematical principles involved. It is a book that may require close application from the student, but also one that will repay him for the effort.

South Econ J 9:78–9 Jl '42. Robert J. Monroe. * one of the better of the many recent works which attempt to clarify the subject of introductory statistics. The author succeeds very well in integrating the many different statistical techniques as well as describing clearly the actual manipulations and computations involved. Proceeding from the very commendable viewpoint that the arithmetic of statistics cannot be separated too widely from its mathematical background, the author has cleared up many details of theory without making the book a mathematical treatise. Of much interest also is the use

which is made of the various types of graph paper especially the logarithm and probability paper. It is indeed gratifying to find a rather complete description of the uses of these methods which incidentally are in many cases not only sufficient but also by far the most practical approaches to certain types of problems. This book can be readily used as a text for almost any classes which have a previous knowledge of high-school algebra, and the examples used in illustrating principles are drawn from a wide variety of subjects. In this writer's opinion the book may well serve as a reference too—the kind of text you can pick up and find in a moment just how to proceed in a given statistical analysis. The author does not discuss the "analysis of variance" which is being used considerably at the present time but he does present the other fundamental operations of statistics in a clear and concise manner. The chapter on index numbers is particularly worthwhile. Even to a conservative person, this book should represent a contribution in the field of presentation of ideas and will certainly not "collect dust" on a statistician's bookshelf.

[226]

★Mode, Elmer B. **Prentice-Hall Mathematical Tables Chiefly to Four Significant Figures: To Accompany The Elements of Statistics by Elmer B. Mode.** New York: Prentice-Hall, Inc., 1941. Pp. 15. Paper. Text edition, $0.25; trade edition, $0.35. *

[227]

★Molina, E. C. **Poisson's Exponential Binomial Limit.** New York: D. Van Nostrand Co., Inc., 1942. Pp. vii, 47, 47. Paper. $2 75. (London: Macmillan & Co. Ltd., 1943. 15s. *)

B Am Math Soc 49:678–9 S '43. S. S. Wilks. * These tables have great value in probability and statistical problems. They have been used very extensively, for example, by mass production quality engineers in the development of sampling inspection plans. The sampling inspection tables published by Dodge and Romig in the January, 1941, issue of Bell System Technical Journal were calculated primarily from Molina's tables. Because of the frequent occurrence of the term $a^x e^{-a}/x!$ in various functions, the tables will probably also be found very useful in the tabulation of such functions.

J Am Stat Assn 38:134–5 Mr '43. J. Neyman. * the present table is more extensive than any other table of the Poisson Law in existence * a most welcome addition to the growing arsenal of statistical tools. There is no doubt whatsoever that in a relatively short time it will find its place on the shelves and desks of all statistical workers, exhausting the first edition. We may hope that then the Van Nostrand Company will become convinced of the importance of this particular publication and will re-issue it in a proper printed form. The present edition is lithoprinted and, in places, regretfully, none too well.

J Appl Physics 14:222 My '43. Chaim L. Pekeris. * will be useful to the expert who is already using the Poisson distribution in sampling problems and, it is to be hoped, will also help to acquaint the non-expert with the wide applicability of the Poisson distribution theory to industrial problems. From the latter point of view the two-page introduction by Molina and the following one-page discussion by H. F. Dodge on the "Application to inspection problems," excellent though they are, might have been n-ply amplified without detracting from the value of the book. The references to treatments of the subject in standard text-books on probability can hardly satisfy the reader whose curiosity is merely aroused by a short glimpse into the vast experience of these engineers accumulated over a period of forty years. It need hardly be emphasized that the tables are especially welcome in the present emergency when quality control in production is of paramount importance. The practice of publication of tables of proven utility by an industrial research laboratory is to be fully endorsed by all applied mathematicians. *

J Inst Actuaries 72:135 Je '44. H. L. S(eal). It is believed that theoretical developments in actuarial theory will cause the Poisson law....to be of increasing interest to those concerned with mortality, sickness and accident statistics. Thus Molina's present collection of tables of the individual and cumulated terms of Poisson's distribution, although designed for use in connexion with quality control, may well prove useful to actuaries. * It is well known that if individual function values are recorded on punched cards the standard six-counter Hollerith Rolling Total Tabulator can be plugged to print off the successive fifth differences at a rate of 1000 an hour. The reviewer used this method to check Molina's tables of the individual terms from $a = 40$ to $a = 100$. In this range of values of a the fifth differences of the Poisson series only amounts to a few units in the sixth place of decimals, so that any error of 2 or more in the last place retained would have

been located at once, and even errors of a unit in the sixth place are very likely to have been detected. Some 20 possible cases of last figure misstatement were tested and, with one exception, were found to be the result of "forcing" the last figure retained. The exception was the ordinate at $x = 53$ with $a = 62$; the printed value is .027516, the true value to ten decimals being .0275154996.

J Royal Stat Soc 106:171 pt 2 '43. M. G. K(endall). * reproduced from typescript, but.... fairly readable and conveniently laid out. The range of the tables is considerably greater than that of previously published work, and they should be very useful in investigations concerning the happening of comparatively rare events.

Math R 4:18–9 Ja '43. W. Feller. The lack of really extensive tables of Poisson's distribution function has been felt badly by many statisticians and engineers. The present tables will be particularly useful since their range is extremely wide. *

[228]

★Mood, Alexander McFarlane. **Introduction to the Theory of Statistics.** New York: McGraw-Hill Book Co., Inc., 1950. Pp. xiii, 433. $5.00. * (London: McGraw-Hill Publishing Co., Ltd. 42*s.* 6*d.*)

[229]

★Morrell, A. J. H. **Introduction to Index Numbers.** London: H. F. L. (Publishers), Ltd., 1948. Pp. 48. Paper. 4*s.* * [The contents of this booklet are also included as Chapters 9 and 10 in A. Lester Boddington's *Statistics and Their Application to Commerce,* Ninth Edition.]

[230]

★Moskowitz, David R. **Assistant Statistical Clerk.** New York: Arco Publishing Co., 1942. Pp. 130. Paper. $1.50.

[231]

★Moskowitz, David R. **Junior Statistician (Junior Professional Assistant Examination).** New York: Arco Publishing Co., 1940. Pp. 131. $1.50.

[232]

★Narain, Brij. **Curve Fitting for Students of Economics.** Lahore, India: S. Chand & Co., 1944. Pp. viii, 197. Rs 10/-. *

[233]

★Neiswanger, William Addison. **Elementary Statistical Methods: As Applied to Business and Economic Data.** New York: Macmillan Co., 1943. Pp. xix, 740. $4.75. * (London: Macmillan & Co. Ltd. 36*s.*)

Am Econ R 34:374–7 Je '44. J. E. Morton. * The approach made by Dr. Neiswanger in his *Elementary Statistical Methods* is obviously based on the assumption that such method, having become almost a part of general education, should be taught to a wide variety of students at as early a stage as possible. It is this pedagogical purpose of the book that characterizes it from the point of view of language and style as well as from that of the topics included. In this respect it presents an original and successful addition to the existing textbook literature. * the first three chapters discuss the problem of collecting and preparing the data. The material is arranged in such a way that the student's attention is forcibly drawn to the extremely important principle that a question should first be asked precisely before the attempt is made to answer it. This principle seems, unfortunately, not so obvious as one might hope; the author's endeavor to stress again and again the question of the prospective interpretability of the data before the data are actually collected and digested is a feature of the book with which any statistician will heartily agree. Instead of following the conventional outline of many textbooks—first, technique of collection of data, then their interpretation—this one reverses the order in a most fortunate way. This arrangement makes it possible to discuss some general aspects of the problem of statistical induction at the very beginning of the course instead of having to wait until the technically much more complicated treatment of statistical inference is reached. Another gratifying though unorthodox aspect of the organization of the material is the discussion in Chapter IV of probabilities and of elementary sampling procedures before even the chapter on measures of central tendency. It is most desirable that the student have some notions of stochastical processes at the very beginning of his study of statistics. The common practice to defer such discussions is one of the reasons why so many students never fully grasp the truly statistical implications of averages and measures of dispersion in spite of the fact that most students are usually quite proficient in the numerical techniques involved. The analytical distinction of idiographic and nomographic methods (to use Chuprov's terminology) in statistics that underlies the outline of the classical treatises in this field, hence the postponement of the discussion of probability theory, is justifiable if the purpose of the book is only to develop a *system* of statistical method. The textbook has primarily a pedagogical function and suffers if the student who is supposedly entirely un-

familiar with the topic has to wait for the logical bases of the method he is studying until the very end of the course. Unfortunately the chapter in question is the weakest in the book. This weakness is due to the fact that the simplification of statistical patterns of thought so skillfully accomplished by the author throughout this text has been somewhat overdone in the present case. The cause may have been partly an effort to keep the book from becoming too bulky. It is of course a matter of subjective judgment where to draw the boundary of what is considered strictly necessary. In the eyes of this reviewer it is, however, regrettable that some more precise elaboration of the underlying models and the essentials of their logical bases could not have been found more space in the book. The following chapters give a good description of tabular and graphic devices that are applied to time series and frequency distributions. Via such a "visual" description of distributions the student is introduced to his first set of analytical tools: the averages (Chapter IX) and the measures of dispersion (Chapter X) together with a simple, rather untechnical treatment of testing their statistical significance (large samples only). The results are again immediately exploited in the next chapter. Beginning with it, the following 240 pages or about two-thirds of the book are occupied with what is usually described as economic statistics in the narrower sense: index numbers and time series analysis. These chapters are among the best elementary introductions that are known to the reviewer. The style is throughout lucid and simple, the development of the statistical model, its application and interpretation are closely interwoven, and the illustrations are well chosen and illuminating, *e.g.*, the pig iron example in the case of trend analysis (p. 517). Chapter XII is given to a description of the technique of index numbers and Chapter XIII to a well done application to the major U. S. indices. The material is brought up to date by a discussion of the effects of wartime changes on the interpretability of some of the current index series. Critical evaluations at the end of each section should greatly help in making the student understand the practical importance and the theoretical implications of some of the analytical patterns involved in index number construction. Chapter XIII, analysis of time series, discusses the conventional methods of trend fitting and includes a short description of the Gompertz and Pearl-Reed curves. As previously, not much space is given to the underlying stochastical models which might prove disturbing, especially in discussing the least squares method. Chapter XIV on seasonals contains a useful and more than usually complete discussion of changing seasonals and short-term variations. In Chapter XV the author shows the isolation of the cyclical component, adding as case-material a section on the cycle in American business. (The relationship between the different components is assumed to be entirely multiplicative and other possibilities, such as additive or additive-multiplicative relationships, are not mentioned.) The last two chapters are given to the technique and application of simple (linear and nonlinear) correlation analysis. Here the underlying statistical assumptions are more fully treated than in previous instances. Some teachers may miss the description of rank correlation methods. The appendix brings a most useful section, one bashfully omitted by most textbook writers, on simple arithmetic and the usual glossaries and tables. The style of the book is clear. The material is well arranged with recipe-like summaries and short (perhaps too short) bibliographies at the end of the individual chapters. The goal of the book, as stated by the author in the preface—to deal with "first principles in simple terms" so as "to give the relatively immature students an understanding of basic concepts"—is successfully attained. To make them "intelligent consumers of statistical data" (p. ix), however, will require additional schooling in the handling and understanding of stochastical models beyond the short treatment that is offered here. Both teacher and students will find this a most useful textbook, especially if used in a basic course for underclassmen that is to be followed by more thorough and specialized training.

J Am Stat Assn 39:260–1 Je '44. Herbert Arkin. * The author's intention was to "emphasize the basic concepts of statistical methods so that certain principles will endure long after details have been forgotten." While this objective is entirely worthy,....the resulting emphasis upon broad generalizations may readily defeat the aim by the very vagueness of the generalizations. * The treatment of subjects such as the steps in conducting a statistical investigation, the preparation of questionnaires, and graphic presentation is not well organized or systematic. * there is considerable emphasis

upon index numbers and methods of their construction and time series analysis. The exposition of these subjects is adequate and the approach systematic. * The scope of the volume is usual for the texts of this type, the differences being largely matters of emphasis. The illustrative computations are typical of the application of statistical techniques to broad economic problems rather than problems relating to the individual business enterprise. The volume is written clearly and lucidly, and since the instructor in a course of the type for which it is intended is at liberty to leave out of the directed reading much of the non-essential materials and can change the emphasis at will, the book will serve as an adequate text when judiciously applied.

J Am Stat Assn 41:411–2 S '46. [For critical comments not excerpted, see Jerome C. R. Li's letter to the review editor.]

J Bus 17:197 Jl '44. L. Derrick. * With few exceptions, the author has followed the usual pattern in presenting the basic concepts. One deviation: a chapter on "sampling and the concept of error" was placed immediately after the chapter on "initiating and conducting a statistical investigation," which included collection of data from original sources. From the standpoint of logical arrangement, this plan has much to recommend it; but its weakness lies in the fact that at this point the student is not prepared to comprehend these ideas. He has not yet been introduced to the concept of a frequency distribution and certainly not to that of a sampling distribution. In the author's desire to simplify the concepts for the student, a necessary rigor of exposition was relaxed. * The author has successfully emphasized the usefulness of statistics as a tool by his free and frequent use of realistic examples. His first chapter is an excellent beginning for this approach. There are some instances, however, when direct proofs substituted for illustrations might prove more satisfying to the analytically minded student. This author, like most of the other writers of similar textbooks, placed a chapter on misuses of statistical tools early in his book. A more positive approach at the beginning might have much to recommend it. Skepticism, no doubt, is healthy, but it could be introduced at the proper time and place throughout the course, thus adding to the unity of the whole. In the author's zeal to emphasize certain points to his students, he has resorted to much repetition. Greater directness of approach could be gained without too great sacrifice.

Pub Personnel R 6:66 Ja '45. * this effort at an introduction to statistics is among the more successful * The text is notable for its concern with the theory of statistical operations, and many of the 740 pages are taken up with simple explanations of the conditions under which one or another operation is suitable and with elucidations of the significance and limitations of the various statistical measures. * This text, more than most in the field, appears to have good possibilities as a self-teacher. *

South Econ J 10:316 Ap '44. E. Z. Palmer. This is another step along the pathway toward a meaningful course in statistics. The author recognizes the need for the study of uses rather than of techniques, but his book is still technique-centered. The elementary student, before he learns the methods, needs all the "why and when" of statistics that is given in this book, but he needs more—more philosophy of science, more integration with business practice and with accounting, more review of secondary source data, and more motivation. The first and second chapters might be called the uses and abuses of statistics, respectively. They are the best and longest chapters on these topics available. One feature is the early introduction of a chapter on sampling. Stratified sampling is discussed, but without reference to its dangers. It is unfortunate that in such an early chapter, a complex subject such as the Gaussian curve should be mentioned. The emphasis in the chapter on averages is upon the comparative advantages of the various measures. This emphasis rapidly diminishes as other types of technique are introduced. The selection of methods is conservative. Thus the older harmonic mean, ogive, and coefficient of variation take up space that could be used in an expanded discussion of the frequency table with a geometric interval, the "z" test of correlation, etc. A good bibliography and set of problems is furnished with each chapter. * The style is meant to be clear and easy to read, but it has the usual faults of abrupt transition and of technical introductions to new topics. Altogether, this is one of the better texts, and should be considered seriously by every teacher of economic statistics.

[234]

★NEISWANGER, WILLIAM A., AND HAWORTH, FLOYD B. **Laboratory Manual for Elementary Statistical**

Methods. New York: Macmillan Co., 1944. Pp. 121, 35 leaves. For latest edition, see 235.

[235]

★NEISWANGER, WILLIAM A.; HAWORTH, FLOYD B.; AND LEAVITT, WILLIAM L. **Laboratory Manual for Elementary Statistical Methods, Revised Edition.** New York: Macmillan Co., 1950. Pp. iii, 159 plus 48 leaves of graph paper. $2.50. *

[236]

★NEYMAN, J. **First Course in Probability and Statistics.** New York: Henry Holt and Co., 1950. Pp. ix, 350. $3.50. *

[237]

★NEYMAN, J. **On the Problem of Estimating the Number of Schools of Fish.** University of California Publications in Statistics, Vol 1, No. 3, pp. 21–36. Berkeley, Calif.: University of California Press, 1949. Pp. ii, 21–36. Paper. $0.25. *

[238]

★NEYMAN, JERZY, EDITOR. **Proceedings of the Berkeley Symposium on Mathematical Statistics and Probability: Held at the Statistical Laboratory, Department of Mathematics, University of California, August 13–18, 1945, January 27–29, 1946.** Berkeley, Calif.: University of California Press, 1949. Pp. viii, 501. $7.50. (London: Cambridge University Press. 42s. *)

J Royal Stat Soc 112:339 pt 3 '49. P. A. M(oran). This splendid volume....contains 29 papers, on a wide range of subjects * Hotelling is represented with a paper on the teaching of statistics....and also by a very valuable survey of various practical methods of matrix calculation. Pólya contributes two characteristically elegant notes, one dealing with inequalities for the normal distribution and the other with some properties of characteristic functions. Neyman has a long paper on the theory of the χ^2 test, and Hsu one on the limiting distributions of functions of sample means in multivariate analysis. Barankin has a paper on the Romanovsky-Bartlett-Scheffé test. A number of smaller papers deal, in a general way, with biometric problems, but perhaps the most interesting part of the book consists of a series of survey articles on subjects of topical research interest. V. F. Lenzen outlines the method of applying statistical ideas in physics, and E. Brunswik has a long paper on psychological experimentation which is probably of more interest to the psychologist than the statistician. There are two very valuable papers on stochastic processes. The first of these, by Doob, surveys the theory of stationary processes with a continuous time and continuous variate, and their generalized harmonic analysis. This is particularly valuable in that it gives one of the few accounts of the subject which is clear and easy to read. W. Feller surveys the theory of evolutive processes in which the time is continuous, but the variate takes integral values. This subject is interesting both to biologists and physicists, and has been extensively studied in recent years by Arley, D. G. Kendall, Feller himself, and others. Feller's paper contains some new results, and although a good deal of work has been done since it was written, it does not give any impression of being dated. In another paper Wolfowitz gives a general discussion of non-parametric inference which contains some new results. It is a pity this book was so long in publication, but every mathematical statistician will find it highly stimulating and suggestive.

Nature 164:764–5 N 5 '49. M. G. Kendall. * the theme is so wide that the papers have little in common, ranging in length from six to sixty pages and in subject from the philosophical foundations of probability to the sampling of rainfall in mountainous areas and the biological association of insects * a handsome volume * A paper by Hotelling, with discussion, on "The Place of Statistics in the University" is of general interest to all teachers of scientific subjects. Hotelling can be read with pleasure on any subject; but on none more than this, in which authoritative American and British ideas seem to be in line, but in which American performance is substantially ahead. The reviewer also found of great methodological interest Brunswik's long paper on the design of psychological experiments, which foreshadows the approaching crisis in the philosophy of experimentation. Is the laboratory or the field the right place for an experiment, and how far should research be operational? Several of the papers are in the nature of surveys of particular fields: Wolfowitz on non-parametric inference, Doob on time-series and harmonic analysis, and Feller on stochastic processes. Although written four years ago (a long time on the current statistical time-scale), they are very useful and must have done much to further the objects of the symposium.

[239]

★NOBLE, MARY ALFRED. **Factorial Differentiation by Maximal Differences.** Catholic University of America, Studies in Psychology and Psychiatry, Vol. 4, No. 6. Washington, D.C.: Catholic University of America Press, 1940. Pp. vii, 40. Paper. $1.00. *

[240]

★"OCCAM." **Hints on the Study of Elementary Statistics.** London: Gee & Co. (Publishers) Ltd., 1946. Pp. 52. Paper. 4s. *

[241]

★ODELL, C. W. **An Introduction to Educational Statistics.** New York: Prentice-Hall, Inc., 1946. Pp. xiii, 269 Text edition, $3.50; trade edition, $4.67. * (Answers to Exercises and Problems in An Introduction to Educational Statistics. Pp. ii, 9. Apply. *)

Ed Adm & Sup 32:319–20 My '46. A. S. Edwards. For the student who knows little mathematics and who desires a brief introduction to the elements of statistics, here is a book planned for him. Written with simplicity and clearness, and in short and compact form, it probably contains what is most essential for the beginning student in the biological and social sciences and education. * Excellent references indicate further reading and more advanced books. * An adequate seven-page index includes definitions of many symbols and thus adds to the easy availability of the material in the book. This is especially useful for the student who has forgotten or has not read earlier pages, for he can immediately find in the index the meaning of any symbol used in the text. Useful exercises and problems are found at the ends of chapters. Excellent references put the reader in touch with the best in the extensive literature of statistics. The appearance of the book is pleasing, the page larger than in Odell's (1935) *Statistical Method in Education,* the type larger and clearer, and the presentation as a whole very attractive. The advanced student of statistics will need a more advanced and complete text; but the advanced student may find this text helpful for review of fundamentals he has forgotten; and the beginning student will find a more than ordinarily good text in the elements of statistics. The student who masters this text will be able to handle most of the problems students are ordinarily required to work in all but the more advanced and more technical problems which call for a more complete and thorough knowledge of mathematics. This text may well be found to be one of the most useful of the comparatively brief treatments of the elements of statistics.

J Am Stat Assn 41:255–8 Je '46. Paul J. Blommers. * The difficulties experienced by those who have undertaken the task of preparing nonmathematical textbooks on statistics are generally recognized and appreciated. Wordiness is almost inevitable, and rare indeed is the book of this type which has escaped without some involved and awkward sentences—not to mention involved and awkward expositions. Professor Odell's book is somewhat less mathematical than most volumes of this type and consequently it is not surprising to find such sentences and expositions occurring in it. * Sampling error theory is discussed in the book's final chapter. The treatment is brief. This is surprising in view of the importance of the theory in educational statistics and in view of the liberal amount of space devoted to topics much less complex. * It seems unfortunate that at least a portion of....[the material on sampling] was not introduced earlier in the volume so that advantage could have been taken of every possible opportunity for applying the theory in a variety of situations. It is also invariably true, when sampling theory is thus postponed, that the student must cope with problems in which sampling is implicit without benefit of a preliminary discussion of the theory. * In the....use of chi-square as a test of the hypothesis that a given set of measures is a random sample from a normally distributed universe....Odell chooses to ignore the work of R. A. Fisher, and to use the number of classes less one as the number of degrees of freedom despite the fact that both the sample mean and standard deviation were used to obtain the theoretical frequencies. * When the discussion of sampling theory is finally reached, one learns (p. 250) that the author does not approve "the use of degrees of levels or confidence in stating the significance of results." Instead he prefers to state the number of chances to one that the obtained statistic is within a specified distance of the corresponding hypothetical value. In making such statements, several instances occurred in which the "chances to one" phraseology was improperly applied. To illustrate, on page 244, the discussion of an example is concluded with the statement that the chances are 3.7 to 1 "that there is a real difference in the direction indicated." In this connection it should be observed that Professor Odell advocates the use of the area under only one tail of the distribution in stating "chances." * his position is inconsistent, however, for in the case of the *t* test applied to means, he employs the area under both tails. * in Professor Odell's opinion most of the measures used in education are reported to the next smaller unit rather than to the nearest unit. * this view cannot be reconciled with present day theory of educational measurement. Some prospective users of this text may find to their liking the author's attempt to "enrich" the students' statistical vocabulary.

On page 83, for example, he introduces the need for a measure of *variability,* "also called *variation, dispersion, deviations, departure, discrepancy, spread, scatter,* and *fluctuation.*" In the opinion of the reviewer the value of this practice is questionable. * A few final objectionable features will be cited briefly: (*a*) The author departs from accepted notational practice and uses to represent standard error (Chap. 14). (*b*) The correlation ratio is said to "summarize the deviations of the data from the curved line that *best fits* (italics mine) the means of the rows or columns...." (p. 179). (*c*) the median deviation is said to share many of the merits and weaknesses of the standard deviation because it "is regularly found by multiplying the standard deviation by a constant" (p. 100). (*d*) A scheme for changing ordinary ranks to the "same basis" (*i.e.,* to percentile ranks) is presented as the sole requirement for making ranks comparable (p. 77). (*e*) The averaging of percentile ranks is presented as leading to the "average rank." That this "average rank" may not correspond to the percentile rank of this average is not mentioned (p. 78). (*f*) A procedure for correcting the standard error of the mean for the effect of errors of measurement was presented, and the corrected value used in a test in which the fact that errors of measurement were also involved in the obtained mean was ignored (pp. 238 *ff.*). (*g*) It is suggested that bias in sampling may be revealed by drawing, "in the same manner, but independently, several samples of equal size," and comparing them (p. 230).

J Am Stat Assn 41:258–9 Je '46. P. E. Vernon. From many points of view this is an admirable book. The reviewer cannot call to mind any other which contains so complete a collection of statistical formulae, with precise directions as to their applicability. The conciseness and clarity of the definitions are a joy to the reader. As a textbook for beginners, however, there is more room for doubt. * Possibly the teachers and students whom Professor Odell has in mind are more highly selected than the reviewer's psychology and education students, the great majority of whom would be confused and put off by the very abstractness, precision and comprehensiveness of his treatment of the subject. Standard books such as Garrett's and Lindquist's are perhaps more verbose and in many respects cover less ground, but they would appear to provide the beginner with a better understanding of the uses of statistical methods. In the reviewer's opinion, therefore, this book should chiefly be employed by the research worker for reference, when he has already gained some general comprehension of statistics from other sources. Professor Odell does, of course, restrict his field to some extent by omitting, for example, analysis of variance and covariance and factor analysis, and by giving only very brief accounts of multiple correlation, small sample formulae, principles of experimental design, test reliability, item analysis, and other topics outside the usual run. But surely it is more important for the "consumer" to possess some understanding of just these topics than to know, say, the formulae for the standard errors of thirty statistical measures, or several ways of correcting r, $S.E._m$, *etc.,* which very possibly should be but seldom are used in everyday practice. A few more detailed points may be picked out for comment. Although chi-squared is one of the most important, and most widely applicable weapons in the statistician's armoury, it is only introduced, in a limited way, towards the end of the book. Actually the coefficient of mean square contingency is described in an earlier chapter without resorting to chi-squared —a coefficient which has little if any practical value, since product-moment r based on mean class values is greatly preferable. The simplest method for the beginner to calculate product moments from grouped data is probably Godfrey Thomson's, which involves the variance along the diagonal of the correlation table; this is not mentioned. The stock method for biserial r, using p, q and z, would seem considerably easier than the method Odell provides. The quadratic formula for tetrachoric r is given without sufficient warning as to the inaccuracy of its approximations. Cyril Burt's trigonometrical approximation is probably closer, and certainly quicker when graphs are not available. It would be unfair however to list these criticisms without acknowledging how frequently Professor Odell provides novel and extremely useful variations of standard formulae. The reviewer was interested also in his advocacy of the 10th-90th percentile range as one of the best indices of dispersion, for it turned out to be a particularly valuable measure in vocational work during the war in the British Forces. Several of the statistical tables, again, are rearranged in convenient forms, though they tend on the whole to be too coarse for the practitioner; thus

the normal curve table only gives heights, areas, *etc.* for abscissae from 0.0 to 5.0 by intervals of 0.1. There are good exercises and problems at the end of each chapter, but no answers. The typography is extremely clear, and only two misprints have been noted *

Sci Ed 31:40 F '47. R(alph) K. W(atkins). * Notable features are to be found in its conciseness and clarity. Some teachers will find it difficult to cover as much material as this book provides in a beginning course. In some respects the arrangement is unusual. For example, the treatment of sampling and the fundamental assumptions involved are reserved until the last chapter. The author is aware of these points and has made suggestions for possible omissions and rearrangements in his preface. Some of the technical terminology seems unnecessary in a beginning text. To meet this problem the index is arranged to serve the dual purpose of index and a very concise glossary. In addition to its merits as a text, the book is to be recommended as a practical handbook and desk reference work for educationists frequently needing quick and convenient help with statistical problems.

Southw Social Sci Q 27:107–8 Je '46. Helen Tomlinson. * this is a textbook prepared for beginners....who want to develop some elementary statistical skills within the scope of a semester college course. The method of condensing is to give rather full treatment to the discussions of tabulating data, plotting curves, measures of central tendency and measures of variability, with corresponding skimping of the material on correlation, reliability, and applications of the normal curve. This makes the first part of the book essentially of textbook character, the latter part a handbook. Most of the illustrative material is of a character that doesn't limit its setting to the field of education, and much of it has the complete anonymity of a mere series of numbers. This weakens its appeal to students of education, but it thereby becomes appropriate for workers in other social science fields. Problem settings such as investigation of wage distributions, quantifying of rating scales, correlating have-or-have-not attributes are found in most social science areas. The discussion of problems of sampling is fuller than in most introductory texts on statistics. It says things that the worker with even the simplest statistical problems needs to take into consideration and that apply to data-gathering in any science. * Format and typography of the book are appropriate. It handles well. Chapter bibliographies are generous without being overwhelming and footnote references will guide the student or instructor to other material on specific points. The index approaches adequacy, which makes this volume almost unique among statistics textbooks.

[242]

★PARTEN, MILDRED. **Surveys, Polls, and Samples: Practical Procedures.** New York: Harper & Brothers, 1950. Pp. xiii, 624. $5.00. *

Am J Sociol 56:200–2 S '50. Nathan Keyfitz. * arranged roughly in the order in which a survey is conducted. Anyone using it to carry out a survey for the first time could read the successive chapters as he went along. * one wonders if an academic course could not make better use of the extensive theory and data available on many of the topics treated by the author. For example: "In designing schedules that are to be filled out by farmers, housewives, employers, or any other group, the level of education, the biases, and the interests or other characteristics which affect the ability and desire to fill in the form truthfully and correctly should be taken into consideration" (p. 158). Phenomonenological psychologists have much to say on the way in which objects such as questionnaires come into the field of perception and are integrated with the subject's interest and preconceptions; their methods could help in decisions ranging from the physical form of the schedule to the questions (p. 175) that separate informed respondents from uninformed. Again, theory and empirical data on costs which Hansen, Mahalanobis, and others developed are ignored, the main contribution being a listing of survey costs and suggestions that they be kept to a minimum. Five chapters deal with samples: chapter iv on their role, chapter vii on their types, chapter viii on procedures for drawing them, chapter ix on their size, and chapter xvi on their evaluation. But, while these cover many important points, they hardly give the reader an understanding of what sampling can and cannot do. A single chapter on the principles of probability sampling would have given the reader the necessary grounding to make effective use of the services of an expert. On many other points no theory exists, and the guidance provided is practical to the point of being superfluous. For example, on respondent's sex: "This item can be secured without asking questions if recorded for the informant

only" (p. 165); on legibility: "If the manuscript is handwritten, the writer will save himself much grief if his writing can be easily deciphered by the typist" (p. 528); on ringing doorbells: "The interviewer should ring the bell or knock on the door rather briefly. He should not act impatient but should give the inhabitant sufficient time to answer. While waiting for a response, he should note the address, time of day, or other facts which he may need to record on the schedule or on his report" (p. 349). Several pages are devoted to sampling from lists. Though the checking of lists to find out how complete they are has its place, the fact that lists which are incomplete may be made a frame for unbiased sampling by some device for picking up omitted addresses is much more important. Among the devices available are the use of the list merely to give measures of size of blocks, etc., with selected blocks to be relisted, and the taking of intervals between addresses as the sampling unit. This textbook will undoubtedly be widely used. Its timeliness, covering as it does the 1948 election and more recent events, makes it a live piece of instructional material. It is helpful in describing devices such as code cards and hand tallies, which are the standby for the many surveys which are not backed up by a mechanical installation and which may sometimes be more efficient than those produced with mechanical equipment. It gives useful advice on the general administration of surveys, on wording and editing of schedules, and on preparation of reports.

[243]

★PEACH, PAUL. **An Introduction to Industrial Statistics and Quality Control.** Raleigh, N.C.: L. B. Phillips Co., 1945. Pp ix, 150. Paper, lithotyped. * For latest edition, see 244.

J Am Stat Assn 41:133–5 Mr '46. J. H. Curtiss. * The presentation of the rationale of acceptance sampling is very well done. * distinction is not carefully made between the control of quality of the process and of the individual lot * A novelty then appears in the form of a quality control method for short runs. It essentially involves the use of the sample mean and standard deviation to control the proportion defective, assuming a normal distribution. It might be advisable to use the noncentral t distribution for this purpose * At this point in the book, a certain evidence of haste seems to make its appearance in the organization of material. The list of contents from here on in reads as follows: The Chart for c; Multiple Sampling; AOQL Inspection; Acceptance Inspection by Variables; Specifications and Tolerances; Trend Control; Gages, Sampling, and Scientific Measurements; An Introduction to the Analysis of Variance; General Remarks on Raw Materials Acceptance; Organizing the Quality Control Department. Each topic receives a good, although brief treatment, but the net effect is a little bewildering. Undoubtedly the problem of organization and emphasis will be solved more satisfactorily in the final edition. There are very few really misleading statements. Perhaps the reviewer's chief criticism would be that no connection is established between the *a priori* definition of probability used to introduce the topic and the frequency ratio definition which underlies much of the applications. A few statements need a little qualification: on page 9 it is stated without mention of independence that the variance of a sum is equal to the sum of the variances; on page 18 it is alleged that it is impossible to gage the quality of a lot by a sample (which denies the theory of statistical estimation); and on page 75 it is observed that the theory of double sampling is incomplete and existing tables are empirical, which is perhaps a little misleading. These minor blemishes do not really mar a very accurate and readable book. Indeed, this work is exceptionally well written from start to finish. It is one of the best elementary expositions of statistical methods which the reviewer has ever encountered. The author is apparently a very fine teacher in his chosen field. He shows a grasp of the theoretical background which is particularly commendable in view of the fact that much of the attention in the exposition is necessarily centered on keeping the text strictly down to earth.

[244]

★PEACH, PAUL. **An Introduction to Industrial Statistics and Quality Control, Second Edition.** Raleigh, N.C.: Edwards & Broughton Co., 1947. Pp. xv, 236. $5.00. *

Ind Qual Control 4:25–6 N '47. Martin A. Brumbaugh. * operators will not find the statistical development burdensome; likewise statisticians will not find the presentation of technique diffuse * One statement....may become a subject for argument. To quote: "—the vendor should know what value of p_1 (acceptable quality level) has been set. This does not apply to p_2 (rejectable quality level); indeed, as a

matter of policy, information about p_2 should never be given to an outsider." This reviewer is familiar with many cases in which the consumer has given his supplier full information concerning his acceptance plan; indeed, in many cases the supplier is encouraged to use the same inspection plan before shipping that the consumer uses in receiving inspection. Perhaps the point of view on this subject is directly related to the vendor-purchaser relations existing in a particular case. Chapters III, IV and V contain the complete explanations of the principles, construction and interpretation of control charts. * Although condensed into fifty pages, this core subject is completely and clearly presented. The analysis of various double and multiple sampling plans in Chapter VI is excellent. * Chapter VII dealing with significance tests is well done in general, but the sections explaining the meaning of significance tests and acceptance inspection by variables deserve special mention. Some special quality control methods are presented in Chapter VIII, but this Chapter is considerably less informative than Chapter IX, which presents ably (1) the method of setting specifications when several mating tolerances are involved, (2) gage tolerances, (3) the distinction between precision and accuracy of measurements, and (4) sources of error in measurements. * written in the easy to read, easy to remember style for which the author is well known. The pithy comments thrown in at well chosen points act as catch phrases to fix in the reader's mind important principles and conclusions. At no point is the presentation beset by excess verbiage; in a few places the presentation might be benefited by additional explanation. Certainly the preceding comment should not be interpreted as derogatory to a sound, interesting, elementary presentation of quality control principles and the background of statistical technique necessary to an understanding of these principles. There are a few points to be mentioned on which there will not be universal agreement among readers: (1) At the bottom of page 63 it is suggested that $(1 - \bar{p})$ may be ignored in the formula $n\bar{p} \pm 3\sqrt{n\bar{p}(1 - \bar{p})}$ so long as $\bar{p}$ does not exceed 20%. (2) On page 74 the factor $1/d_2$, ordinarily employed to estimate universe standard deviation from average sample range, is used to make this estimate from the range of a single sample of 5 items. (3) On page 124 a similar procedure is presented for estimating universe standard deviation from the standard deviation of a single sample using the factor $1/c_2$.

J Am Stat Assn 42:332–3 Je '47. Paul C. Clifford. * While a few new sections have been added, the text in general is that of the preliminary edition, but the material has been rearranged and reorganized * The book is a well-written, generally accurate, and very readable introduction to the elements of statistical method as applied in industrial control and experimentation. The mathematical theory is kept at a minimum, but where it is needed for precise statement the author has not hesitated to use it. The book should be very useful as a college text where omitted material can be filled in and the problem material can be supplemented, but as a reference manual its usefulness suffers from the omission or brief treatment of certain topics and from the absence of an index. The material on acceptance sampling plans for attributes is based on an ingenious use of the ratio p_2/p_1, which is an original contribution. The tables needed for this method are comparatively simple, and by means of them one is able to establish quickly single, double, or sequential plans that will serve a wide variety of problems. The author, while stating the fundamental purposes, does not attempt to discuss the various published sampling plans in any detail. The theory of the control chart is well presented, and the general types of problems encountered on such charts are discussed. There is also a section on the use of charts with modified limits and the use of trend charts. The question of what constitutes a rational subgroup from the engineering viewpoint is not adequately discussed, and there are not enough actual case histories of the control chart to exhibit its full usefulness. Only two sets of control chart data are given. The control chart for SX and the gridless control chart which the author favors appear to have some psychological advantages. There is also a brief but succinct development of acceptance sampling by variables, assuming a normal distribution with known standard deviation. In the remaining chapters there is an introduction to the theory of statistical estimation, tests of significance, analysis of variance, and the design of experiments. This part of the book still gives, as the previous reviewer reported, a rather bewildering effect. The last chapters on industrial management are clear and concise. * There are few misleading statements; these are in the

main a matter of emphasis. The recommendation given on page 87 that representative sampling be corrected by randomization might cause an incautious operator to lose the order of observation and never detect differences in spindles. Since good lots are defined on page 31 as fraction defective p_1 or less, the careless student may, and in some cases does, assume that p_1 and $\bar{p}$ are the same, thus leading to a conclusion to reject average material 5 per cent of the time. Despite these minor criticisms I know of no single text more useful for a college class in engineering statistics and quality control. The main flaw with the book in this regard is the lack of sufficient problem material. As a reference manual for quality control, such topics as the Poisson distribution, the theory of runs, serial correlation, and the Dodge continuous sampling plan might well have been included. As a work for the practical man in industry, more emphasis might have been given the economic aspects, even at the expense of some of the statistical theory.

J Am Stat Assn 42:333–5 Je '47. Bernard P. Dudding. * the author calls attention....to the use of the sums of results rather than averages as an original contribution to applied statistics * this claim is surprising because once statistical methods are regularly used, then many similar devices are introduced in the normal course of events. While the idea of introducing statistical principles to engineers by a game of chance has much to commend it, the choice of a peculiarly American game will, for British readers, greatly reduce the appeal of this teaching device. Although the rules are enunciated, this will not greatly assist the appreciation of the statistical principles involved until the reader has practical experience of the game. This comment is made because it emphasizes a basic principle in the application of statistics, namely, that until the industrialist has tried to play the game of "applied statistics" in the familiar environment of his daily work, he will not appreciate fully its appropriateness, its power, and the help it provides. Further, apart from a reference to Fisher's book, there is little reference to the considerable contributions made in England both before and during the war. These two features detract from the value of a book which would otherwise have been widely acceptable. * the author is to be congratulated on the balanced review he has made of the various types of acceptance sampling. This review provides the right kind of assistance needed by engineers wishing to determine, in the light of the conditions and specifications which govern their activities, the procedure to follow when seeking initial experience. The fully worked out examples are important additional aids. The chapters referring to quality control and the discussion of the organization of the work will do something to redress any lack of emphasis the order of presentation places on this more economically useful aspect of applied statistics by which the production of rejectable product can be minimized. The writer would have liked to have seen some reference in the discussion on short runs to the utility of cataloguing average ranges for small samples as measures of the performance of a machine, process, or an operator. When control chart methods are well established, it is these data which provide "information from earlier job studies" so useful to the designer, the production planner, and the production supervisor. Reference is made to control charts involving trends. This type of problem has received theoretical treatment in Britain, but the statistical solutions proved to be of academic rather than practical importance. The introduction of modified limits, which is illustrated in the book, has usually met practical requirements. The brief chapters on specifications and measurement can only serve to whet the statistical appetite of the engineer who has gained experience with the elementary statistical methods described earlier. Additional guidance would have to be sought elsewhere. The desirable procedure of tabulating the symbols used has been followed, and the author's suggestion that the symbols and notation of quality control should be open to revision is specially commended. * In a book containing so much evidence of balanced judgment, it is a shock to note a table giving factors to five significant figures for use in estimating a population standard deviation from the range in one small sample. The more usually accepted procedure is to utilize the average range derived from a number of small samples, and even then the factors need only to be known to two or three significant figures. * Chapter 7, "Tests of Significance," tends to destroy the link between acceptance sampling and quality control methods. Would it not be more appropriately placed next to the chapter "Scientific Experimentation"? The value of the book would be enhanced if it were provided with an index as

well as the detailed table of contents. Paul Peach has succeeded in writing a readable and instructive manual on the application of simple statistical principles to industrial problems. The book fulfills its purpose and will serve as a valuable introduction to industrial statistics both for the engineer and the college student. Elementary textbooks yet to be written will place emphasis on different aspects of industrial applications because of the experience of their respective authors, but they will certainly contain much that is well stated and illustrated in the book reviewed.

J Bus 21:60–1 Ja '48. Albert Bowker. * Control charts are introduced by a thorough discussion of the chart for controlling fraction defective, followed by a less detailed treatment of charts for defects per unit. * Useful tables to facilitate construction of single, double, and sequential sampling plans for the case of producer's and consumer's risks both equal to .05 are included, along with references to more comprehensive sets of tables. There is a valuable discussion of continuous sampling plans. A novel feature of the book is the inclusion of solutions of several problems in variables inspection, along with a discussion of the general idea of a test of significance from the power function point of view. * The part....dealing with industrial experimentation is rather short and admittedly introductory. The t test and the analysis of variance are discussed, but the power functions are not used except to distinguish between one-and two-sided tests. Since the noncentral t distribution was introduced in connection with variables inspection, its application to tests of significance would not present much additional work. Further, the mathematical assumptions underlying the analysis of variance are not clearly stated. The section on specifications and tolerances discusses only the case of setting a tolerance on a sum of dimensions. * One of the desirable features of the book is its comprehensiveness. The material on sequential analysis, on variables inspection—especially the fraction defective application—and on continuous sampling plans is particularly useful, as the impact of these recently developed techniques is just beginning to be felt in applied work. It is desirable to keep a college text within reasonable bounds as to both length and level. On the whole, the author's choice of material has been good. Remarks on confidence intervals and on sequential sampling by variables might have been added without undue expansion. The author recognizes that economic considerations are of major importance in industrial statistics. An interesting problem deals with choosing a machine setting to minimize costs of re-work and scrap. Application of accounting data to selection of risks in sampling plans, to selection of control limits, and to the planning and analysis of experiments is a legitimate goal of industrial statistics, but at the present time there are many open questions. Such considerations might lead to achieving reduced inspection by lowering sample size rather than by shifting acceptable quality level, as is recommended in the book. On the whole, the book is a clear and accurate exposition of the application of statistical techniques to practical industrial problems. Some instructors may find it helpful to supplement the book by explaining the underlying theory in more mathematical terms. While it is undesirable to teach statistics as a mathematical abstraction and it appears to be necessary to go into applications relatively early in order to sustain interest, most students of engineering have considerable mathematical equipment at their command of which the present text does not make use.

J Royal Stat Soc 110:368–9 pt 4 '47. D. N. This book is based on a ten-day course on quality control given just after the end of the war in the U.S.A., and most of its short-comings can be attributed to this fact. It deals at some length with quality control and sampling inspection, but the rest of the extensive field of statistical methods in industry is dealt with only cursorily. * many procedures recommended in this particular book will find very little sympathy with practitioners in this country. Certain points in the presentation of the subject are worthy of commendation. An attempt is made to give an outline of the theory fundamental to the subject by discussing some elementary ideas of probability. The relation between populations and samples is also treated, and the brief sketch of some of the general ideas underlying the theory of testing hypotheses could be very profitably expanded, even in a book of this type. The book is not a theoretical treatise, but it does try to illustrate the relationship between theory and practice by considering such points as the cost of various statistical procedures from the view points of both buyers and sellers. The chapter on gauges contains much good practical advice, and the author fully realizes the various

errors that occur in gauging, errors that are far from being widely recognized. The problem of measuring these errors is, however, treated too superficially to be of much practical guidance. The book also contains some novel methods, and in particular a graphical method of determining the significance of Student's *t* should prove very acceptable in factories, particularly to engineers addicted to the use of nomograms. Such aspects of the book are perhaps of considerable help to the beginner, but there are some methods outlined which, although they may have proved useful in the U.S.A., are not generally accepted here. A new-comer to the subject, trying to apply these without proper understanding, would encounter many difficulties. This is particularly true of tables recommended for obtaining various types of sampling schemes. Some of these are not available in this country, while others are inferior in flexibility to tables and charts already published here. The terminology of this book differs in many respects from British terminology. For instance, the term "control chart" is used to cover almost any chart plotted in the factory, whereas in this country the term is used only to designate charts used specifically for production control. There are a number of techniques widely used in England of which the author seems completely unaware. Group control charts, which have proved quite useful here, are not mentioned, but instead, the method recommended for the joint control of a number of machines consists of pooling together the samples taken from each—a practice which most British authorities on the subject recommend for only very special cases. Although the inclusion of the discussion of fundamental ideas is to be welcomed, in many respects it is far from adequate. Ideas of the location and spread of a distribution, independence of variables and bias are treated very loosely. The omission of a fuller discussion of the implication of the conception of significance is particularly grave, as the book includes what is intended to be a guide to experimental design. The Neyman-Pearson conception of power is introduced at one stage, but its practical implications are not developed to any extent. The author fails to see that by using this important idea the choice of the size of sample in control chart work need no longer be an arbitrary decision, and that further there may also be an advantage in using more than the one set of control limits (of unspecified significance) derivable from his Table VII. By implication the author seems to favour natural control limits and deprecate modified control limits as an expedient to be used only when nothing better is available. This is an unrealistic approach to the problem, as there is no particular virtue in a product being in statistical control; all that is required is that it shall be produced within specification, and modified control limits ensure this. In any case the methods outlined for calculating modified control limits (there are no tables given) would be considered meaningless in this country, and no explanation is given of their theoretical basis. In dealing with fraction-defective charts the author recommends using the Poisson approximation to the Binomial for probabilities as great as 0.2. There will be little approval of this here, as it is not usual to use this approximation for probabilities greater than 0.1. The discussion of sampling inspection schemes is mainly sound, and lacks clarity only on some finer points. The distinction between the risks offered by a scheme and those experienced in practice and the relationship between average sample size and costs are two points which merit more elaborate treatment than they receive. One weakness of this section is that it fails to show how the various types of scheme arise from different practical situations, and how, in fact, with the necessary mathematical equipment it is possible to devise special schemes to meet special situations. The latter part of the book attempts to give the reader a guide to the use of more advanced statistical methods in industry, and in the opinion of the reviewer fails completely. On the one hand the author considers that the discussion of correlation is outside the scope of his book, but on the other hand he attempts to outline some methods of experimental design and analysis. In opening the discussion of this subject, however, one feels that a more appropriate example than the pig-feeding experiment should have been available from industrial experience to illustrate some elementary ideas on design. Two pages are devoted to the Latin Square experiment, and these cover little more than an outline of the computational procedure to be followed in analysing the experiment. In view of the many difficulties that can arise with this type of experiment in industry this treatment must surely be considered too superficial. This is also true of the author's treatment of the idea of the interaction of two

factors—the understanding of which is of great importance in industrial experimentation—which he deals with in four lines. The inclusion of this wholly inadequate discussion of so vital a subject as experimental design can find little justification. The beginner in the application of statistical methods to industrial problems will get no benefit from it, while the more advanced student should be well enough equipped to read a more complete account of the theory elsewhere. The book is, of course, intended only for the practical man in industry, and makes no claim to give the theoretical basis of statistics; but the theoretical short-comings of the book could lead the practical man into many serious practical errors. From the viewpoint of the industrialist it must be pointed out that the book has a strong bias towards light engineering, and deals very little with statistical problems arising in the chemical or other industries. Undoubtedly those concerned with applying statistics in industry will find some useful ideas in the book, and it is to be regretted that the author did not think them worthy of a proper index.

Mech Eng 69:843–4 O '47. Louis C. Young. * By....sidestepping the complicated mathematics which so often confuses and discourages beginners in quality-control work, the author both maintains interest and opens the door to distrust of his final precise conclusion. Inasmuch as many quality-control problems admit only two alternative solutions—action or inaction—it may be that skepticism is thereby relegated to a separate part of the procedure. Although a liberal bibliographical appendix is included for the benefit of those readers who wish to pursue the subject further, reliance upon other viewpoints and terminology is as likely to impair the force of an argument as to strengthen it. * Peach leans somewhat toward the practical side and draws well upon his extensive experience in industry * the added weight of practical views and comments may be confidently expected to increase the interest of all groups * the author starts....by establishing the general concept of probability, using dice games and coin tossing in several illustrations * the author wastes no words on irrelevancies * If he understates anything at this somewhat fundamental phase, it is the viewpoint that dice and coins are more definite in their marking than are most measures of quality, and consequently less subject to the variations of judgment. * he reverts to the dice game in order to demonstrate the meaning and purpose of control limits, in a way which no one could fail to understand * Both practical men and students will find interest in the author's experience with specific arrangements of averages and ranges of samples and the conclusions reached. * In chapter 8 on special quality-control methods, and chapter 9 on industrial and scientific measurements, the author interrelates control methods and tolerances with less precision than he used in his preceding chapters. Although the first of these two chapters deals with short-run production and various forms of modified "control" limits, it is somewhat arbitrary in definition and gives little of the quantitative economic aspects which so influence this field. The tolerance relationship in the second of these chapters is subjected to a restrictive assumption which could not be met easily—if at all—by the example employed to demonstrate the relationship. Yet the author gives no quantitative measure of the leeway which may be used or of the penalties to be expected with misuse. In the following pages, Professor Peach presents the case for designed scientific experimentation simply, briefly, and clearly. Although only the most elementary forms of variance analysis are presented, it will be easy for the reader who has application for them to see the possibility of further methods and to pursue them in the advanced literature which is recommended in the appendix. * In conclusion....Professor Peach has designed his text to give a maximum of information and aid both to practical men and to students, with a minimum of confusion and discouragement. A complete list of symbols in the introduction, with generally clear statements, definitions, and formulas throughout, assists in this direction, as does an appendix containing an example of each type of problem encountered in the text. The book contains several quality-control shortcuts which will be of benefit to practical users and many remarks on the practice of quality control which will be of interest to the industrial-statistics student.

For a review of the first edition, see 243.

[245]

PEARL, RAYMOND. **Introduction to Medical Biometry and Statistics, Third Edition.** Philadelphia, Pa., and London: W. B. Saunders Co., 1940. Pp. xvi, 537. Out of print. *

J Am Stat Assn 37:145–7 Mr '42. Joseph Berkson. A few months after publication of this book and after I had accepted an invitation to

review it, the author, Raymond Pearl, died. I regarded Pearl as my most influential teacher as well as a good friend. It is natural, therefore, that the task of reviewing his last edition of a book which was the foundation of my own statistical meanderings should invite a somewhat different treatment from what ordinarily is due another edition of a well known text. Pearl never did anything in a way that anyone else would do it, and the trait is exemplified in his *Medical Biometry and Statistics.* It is a good solid elementary text—the best in its field twenty years after its first issue—but it is more; it is Pearl's personality. In it the scholar, the prolific reader, the wit, the English stylist, are on exhibit, as well as the pontiff and the paradoxer. * as revealed in the incisive introductory chapter of this book, his fundamental view was that the statistical method is only ancillary to the experimental. Characteristically one can find in his work a parallel series of investigations, on the one hand strictly statistical, on the other experimental. * The second chapter ....deals with land marks in the history of biostatistics. While the author himself disparages the dry method of tabular historical outline which is the basis of the chapter, the selections for emphasis, the quotations, the comments, as well as the illustrations, furnish an entertaining as well as informative *aperçu* of the high points in the development of biomedical statistics. Chapters III–VI deal with the raw data of biometrics, their selection, and tabular and graphic presentation. Beginning with Chapter VII the analytical technic of statistical methods is dealt with. Here students of statistics who have entered the field in recent years, and especially those who have been influenced by the ideas of R. A. Fisher, will find an unfamiliar approach, and even what they may consider to be erroneous. Pearl was well aware of relatively recent "revolutionary" changes in statistics, and the failure to modify his text extensively in accord with them, wise or not, was deliberate. There is in the book no "theory of small samples," no "analysis of variance," no great emphasis on the "testing of hypotheses," nor any great show of the new statistical vocabulary currently in the making. These omissions are, in my opinion, in the main sound. The eighth chapter, on life tables, is the best brief presentation of the subject of which I am aware, and in some respects the best regardless of length. The title of the book would seem to limit us to medical biometry, but this chapter exhibits the Pearlian touch, and the life tables of flies, roaches and automobiles are also dealt with. Here, as elsewhere in the book, crops out that, to Pearl, man was just another organism, though withal an extraordinary one, which a biologist could examine with interest. In the ninth chapter, on adjusted death rates, Pearl comes near to losing his sense of humor over the existing confusion in terminology. (Or is it that this reviewer lost his?) He says in effect that since the statistical world has not had the sense to adopt his terminology, he will follow the rather inept official recommendations. Then he proceeds *not* to follow them! The tenth chapter deals with the sampling error concept and presents some new tables for determining whether an observed difference between means is significant. The eleventh chapter on the theory of probability deals with the binomial expansion, its approach to the normal curve, and the estimation of the variability of a rate, while the following chapter presents the chi-square test and four-fold table. In Chapters XIII and XIV on measurement of variation are taken up the calculation of moments and the derived statistics, the mean, median, mode, standard deviation, skewness and kurtosis, as well as some other matters such as class limits, the retention of decimal places in published constants, the comparison of groups with regard to composite items and graphic presentation of variability on the basis of range. These chapters are not happily headed so far as indicating their contents is concerned, and the soundness of some of the new suggestions contained in them is debatable. Chapters XV, XVI, and XVII deal with correlation and simple curve fitting. The last chapter, XVIII, deals exclusively with the logistic curve, and here the guiding hand of Professor Lowell J. Reed can be discerned. It contains a clearly presented example of the fit of the curve by least squares using successive approximations to a Taylor expansion, and a bibliography on the logistic curve which we may consider definitive. Thus the last book of Pearl ends with a subject for which Pearl is perhaps most widely known, the logistic curve and population growth. * [*See* the complete review for obituary comments.]

For additional reviews, see 2:220.

[246]

★PEARSON, E. S.; HARTLEY, H. O.; AND MERRINGTON, MAXINE. **New Tables of Statistical Variables:**

(1) The Probability Integral of the Range in Samples From a Normal Population, (2) The Percentage Points of the Range, (3) The Percentage Points of the *t* Distribution. Reprinted from *Biometrika*, Vol. 32, Parts 3 and 4, April 1942. London: Biometrika Office, University College, [1942]. Pp. 301–11. Paper. *2s. 6d.* *

[247]

★PEARSON, E. S., AND WISHART, JOHN, EDITORS. **"Student's" Collected Papers.** Foreword by Launce McMullen. London and New York: Cambridge University Press, 1943. Pp. xiv, 224. *15s.*; $3.00. *

Am Math Mo 51:341 Je–Jl '44. J. F. Kenney. * It was his second paper (1908), *On The Probable Error of a Mean,* that made "Student" famous. Apart from its own merits as a notable piece of research, it played an important role in stimulating further contributions. This paper may be said to mark the beginning of the modern theory dealing with small samples and tests of statistical hypotheses. * We are....indebted to the editors for making possible a balanced appraisal of the work of a versatile pioneer by collecting these papers into one volume. The central theme of his contributions was the application of statistical method to the research and routine problems of industry and agriculture. It would be surprising if the work of a pioneer did not occasionally seem open to criticism to the reader of to-day. But any such criticism would be overwhelmingly outweighed by the simplicity and directness of his methods of attack and his clear grasp of practical issues. His work was intimately related to the historical development of the new statistics. Americans and others who were not acquainted with Mr. Gosset but who admired "Student" will welcome the Foreword which gives an interesting biographical sketch of this remarkable man and the Frontispiece photograph of him in informal pose.

Ann Math Stat 15:435–8 D '44. W. G. Cochran. * Student's name is almost universally attached to a single discovery, the *t*-test, which requires for a complete proof more powerful mathematical methods than he devised. These facts may cause his papers to be regarded as museum pieces by people who have not read them. Actually, in many respects no better model than Student could be suggested for a young statistician today. Since we sometimes speak derisively of courses of lectures in statistics where the methods and ideas are "20 years out of date," it is interesting to find that many of the fundamental ideas considered most in need of emphasis by forward-looking teachers today were in fact emphasized by Student in his writings over 30 years ago. * Re-reading of Student's papers has been a keen pleasure. It is hoped that the volume will enjoy a wide circulation amongst statisticians.

J Royal Stat Soc 106:278–9 pt 3 '43. L(eon) I(sserlis). * "a happy project" conceived in 1938 * well arranged and printed * "Student" was a pioneer in the application of statistical technique to practical problems and in devising the appropriate statistical tools. Most readers will turn first to "The Probable Error of a Mean" published in *Biometrika* 35 years ago. The present-day grandiose structure of small sample theory owes its origin to this path-breaking paper. In this as in other papers a very modest use of algebra is mated with careful experimental work and deep insight into the essentials of theory. The younger statisticians of to-day, overawed by texts bristling with existence theorems proved for Borel measurable sets, may take comfort in the thought that Gosset's *"t"* test was founded on an inspired guess for the form of the distribution of variance. * This is a book that all who knew "Student" will wish to have. It would make a charming prize to be awarded, if such things are done nowadays, at the end of the first year of a course in statistics.

Math Gazette 27:225–6 D '43. Frank Sandon. "Student" was William Sealey Gosset (1876–1937). He was a Scholar of Winchester and of New College, Oxford, and took a First in Mathematical Moderations and in Natural Science. From 1899 till 1935 he was with Messrs. Guinness in Dublin, from 1935 till his death in charge of their new brewery at Park Royal, London. He studied for a short time with Karl Pearson in 1906, and published his first paper (on a Poisson distribution) in 1907. In all 21 papers are here reprinted, with a few miscellaneous contributions, and the book is of value in relation to the growth of statistics in one of its vital periods. His best-known work is "The Probable Error of a Mean" which he published in 1908. In this he obtained the distribution of z and gave tables always associated with his name for this distribution, z being the value of x/s. * This work is fundamental in connection with the theory of small samples, and the tables, in one form or another, appear in practically every publication containing statistical tables. As a brewer, "Student" was interested in barley, and in consequence much

of his statistical work was done on the testing of this cereal. He was a vigorous supporter of Beaven's Half-Drill Strip method, the claims of which he preferred for some work to Fisher's Randomised Blocks or Latin Squares. He was working on an important paper on this topic in the summer before his death, and the final revision was never completed. A few papers on more general problems of statistics indicate alike his versatility, as when he devises an experimental method of guessing a formula when considering, in 1908, the probable error of a correlation coefficient, and his common-sense, as when he deals with matters of routine analysis such as those of the daily work of an analytical chemist's laboratory. His t and z tables should be of special interest to teachers, for the classes of pupils for which they compile their marks are usually of the same order of magnitude as the small samples investigated particularly by "Student." But there are two papers which may be of more general interest to teachers in schools. In one of these he gives an experimental determination of the probable error of Spearman's Footrule R. This was read before the valuable but now defunct Society of Biometricians and Mathematical Statisticians in 1920, and printed in *Biometrika* in the following year. He concludes this work with the warning that psychologists and teachers have often failed to notice that "R is not worth determining in any serious work." In the other paper, he criticises the Lanarkshire Milk Experiment, which is so often quoted as evidence of the value of the issue of pasteurised milk in schools. For four months in 1930 ten thousand school children had three-quarters of a pint of milk per head per day, in sixty-seven schools in Lanarkshire, at a cost of about £7,500. "Student" points out that the conclusions reached by the experimenters are at the best non-proven, and that the whole experiment is an example of bad lay-out of experimental design where the statistician can give much useful advice beforehand. Not only, does he say, did the experiment as planned fail to estimate the difference between raw and pasteurised milk but it also failed to produce a valid estimate of the advantages of giving milk to children. By the death of "Student" statistics lost a vigorous, original and valuable worker in its field.

Math R 5:126 My '44. H. Scheffé. * Mathematically naïve. Student's writings nevertheless have already taken their place among the classics of mathematical statistics. The reasons lie not only in the historical importance of the pioneer papers on small sample theory, but also in Student's fine sense of the interrelation of theory and practice. Besides this there will grow on the reader a pleasant and unusual experience from a collection of scientific papers: an awareness of a likeable, modest and humorous human being.

Nature 152:551–2 N 13 '43. K. Mather. * The reader....cannot fail to be impressed by the way in which most of the papers, including, we venture to say, all of first importance, are concerned with problems encountered by the author while engaged as a scientific worker in the Employment of Messrs. Guinness. * Herein we can find the clue to "Student's" success; he was an experimental scientist who knew what he wanted statistics for, and when existing methods failed him, undertook for himself the development of new ones which would work. His mathematics was not always of the most elegant, indeed it was on occasion neither fully rigorous nor wholly successful; but he always tackled the problems which faced him in a downright fashion, using experiment and arithmetic to check his algebra, by methods which must appeal to all those of us who, like him, are not professed mathematicians yet find statistical analysis essential in our experimental work. "Student" ushered in the new era of collaboration between statisticians and experimenters. But his work was not only hampered by the statistical conventions of his early days; it seems also not to have been fully appreciated by some of his statistical associates, for so late as 1931 we find him defending his small sample test against criticism by Karl Pearson. * It would....be surprising if "Student's" papers did not in places seem open to criticism by the reader of 1943. Nor can such criticism detract from the value of a volume of this kind. These papers are primarily "Student's" record of his results and findings; but they also reveal to us the needs which prompted his work and the way in which he set about it. Few experimenters can fail to derive a new confidence for the attack on their own problems from seeing how his clear recognition of the statistical needs of experiment, and his practical approach to their satisfaction, enabled "Student" to mark the way to the new statistics, the benefits of which we can now enjoy.

Plant Breeding Abstracts 14:82–3 Ja 1 '44.

J. O. Irwin. * Nothing....could be more welcome than this beautifully produced and carefully edited collection of...Student's papers. Prof. Pearson and Dr. Wishart merit the gratitude of all those interested in statistics for this worthy memorial to a modest and charming personality who was also a great and inspiring man of science.

Sankhyā 7:331–2 Ap '46. K. R. N(air). It is a service of lasting value to all serious students of statistics that the Biometrika authorities have rendered by re-issuing in a single volume the scientific papers which Mr. William Sealy Gosset (1876–1937) had published between 1907 and 1937 under the pseudonym of "Student." * It is impossible in this brief review to attempt any evaluation of "Student's" work. Suffice it to say, he may be called the father of the "small sample theory" and the originator of what has come to be known as "Studentised statistics." In the design of field experiments in which Professor R. A. Fisher introduced revolutionary techniques, Mr. Gosset made notable contributions by way of expository articles, though the proviso of randomisation required in the Fisherian technique remained a bone of contention between them. The masterly way in which he led the defence for balanced arrangements and in particular for Beaven's halfdrill strip method may confound the learned judges of posterity and more so because death removed the counsel before he could conclude the arguments. The book has two additional attractions of a personal nature in a photograph of Mr. Gosset and in the foreword by Mr. McMullen, one of Mr. Gosset's Colleagues in the Dublin Brewery.

Trans Actuarial Soc Am 46:186 My '45. * a fitting tribute to an outstanding scientist.

[248]

★Pearson, Frank A., and Bennett, Kenneth R. **Statistical Methods Applied to Agricultural Economics.** New York: John Wiley & Sons, Inc., 1942. Pp. vii, 443. $4.50. (London: Chapman & Hall, Ltd. 36*s*.) *

J Am Stat Assn 38:265–6 Je '43. E. L. Butz. * a valuable book for the practical agricultural economist. It combines in a single volume nearly everything of a practical nature which the average student of agricultural economics needs to know about statistical method. The authors have illustrated the various statistical techniques with numerous examples taken from practical problems largely in the fields of farm management, marketing, and prices. Statistical theory is subordinated to its practical application to real problems, but the student should easily get the theory from study of the specific examples to which it is applied. The language of the text is fairly non-mathematical. The interest and attention of the agricultural economist reader will be held by the wide variety of well chosen practical problems which illustrate the statistical procedures discussed. * Nearly every chapter has a very helpful section near its end entitled "Uses," and/or "Comparison," in which the authors summarize in a non-mathematical and practical manner the meat of the chapter. Two excellently prepared chapters on the tabular analysis of relationships cover a field which has been neglected entirely too long in agricultural statistics books. This method has been and will continue to be the most widely used method of analyzing relationships. Perhaps its general usage and apparent simplicity have prompted statistical writers to dismiss it lightly. Yet it is well for the student of agricultural economics to know its uses and limitations. The manner in which the authors develop the treatment of tabular analysis provides an easily understood introduction to the theory of correlation in the following chapter. Regression and correlation are treated in a more understandable manner than is true in many textbooks. There is considerable material of a practical nature in these chapters that is frequently omitted from books of this kind. Some readers may feel that the authors have placed too much emphasis upon the analysis of data already collected, and too little emphasis upon the theory of sampling and the planning and collection of an adequate and representative sample. Agricultural economists too frequently follow some variation of the "hit or miss" method in the collection of sample research data, and then go to great pains to be "accurate" in its summarization. It is essential that agricultural economics students and researchers alike be made increasingly aware of the importance of proper sampling technique. Other readers may notice the omission of an introductory chapter explaining the general relationship of statistics to science and research. Statistics are a very useful tool, and it may seem that any statistics textbook should attempt to orient the beginning student in an appreciation of the contribution that statistics can and should make to the advancement of knowledge.

Q R Biol 17:282 S '42. * The illustrations are largely drawn from the fields of farm management, marketing, and prices. However, these illustrations are similar to those which might have been taken from other fields in agricultural economics and business, so that the usefulness of the book to the general statistician is thereby much enhanced. * The book differs from most textbooks in that it contains two chapters on the tabular analysis of relationships—a subject ignored in many texts. * This volume makes a significant contribution to literature in the statistical field, and should serve as a useful tool for research workers, students and teachers alike.

Rural Sociol 7:455–6 D '42. C. Horace Hamilton. * a much needed contribution to the statistical training of agricultural economists. It includes all of the conventional, statistical methods of the older, general statistical texts and in addition brings in an up-to-date treatment of newer developments, such as the analysis of variance and improvements in correlation analysis. Another distinctive and worthwhile feature is the careful treatment given to the methods of using simple tables as a basis for analyzing relationships. This feature will appeal to those students and research workers who deal with variables of a nonquantitative character and who wish to present the results of statistical analysis to the layman. This text gives unusual space and emphasis to methods of correlation analysis as well as to tests of significance. The treatment of these two fields covers 158 and 121 pages of the text, respectively. Unfortunately, no attention is given to the practical problems of selecting a sample. Judging from the sampling methods which have been used by agricultural economists and other social scientists, the authors of this text overlooked here a great opportunity to be of real service to students and research workers in agricultural economics. The method of presentation of difficult statistical formulae is simple, clear, and straightforward. * well illustrated with neat, well-designed charts. The tables are also well arranged.* For the information of rural sociologists, it should be pointed out that this text does not offer applications in their field; except in so far as economic and sociological problems are very closely related; *viz.:* farm labor, incomes, levels of living, land tenure. Many sociologists, however, will find this text a useful research tool and reference work.

[249]

★PEARSON, KARL. **Early Statistical Papers.** London and New York: Cambridge University Press, 1948. Pp. viii, 558. 21*s.*; $6.50.

Biometrika 36:236–8 Je '49. G. Udny Yule. This volume should find a place on the shelves of every statistical library. * Messrs. Bradford and Dickens can be congratulated on the excellence of the printer's work, and the price of the volume is astonishingly low for a quarto volume of over 550 pages. The one disadvantage of the process used, which necessitates a coated paper, is that the volume is very heavy (4½ lb.), but this is hardly a serious fault in a volume not intended for idle hours. * The first memoir reprinted here is inevitably the rather insufficiently entitled "Contribution to the Mathematical Theory of Evolution," which actually deals with the problem of dissecting a distribution assumed to be compounded of two normal curves. The memoir is of historical interest, apart from its special problem, as the method of moments is used for fitting and the term "standard deviation" is introduced, I think, for the first time in print. * The second memoir reprinted is the well-known initial memoir (1895) on Pearson's family of skew curves, "Skew Variation in Homogeneous Material," which was supplemented later by two further memoirs, published in 1901 and 1916, dealing with certain subtypes which had escaped attention. Each of the three memoirs is characteristically and very fully illustrated by examples, so fully that it is hardly too much to say that these memoirs created a revolution in the general view as to the characteristics of frequency distributions. Previously, the "normal distribution," as implied by its name, had been regarded as the common type and other forms as somewhat odd and aberrant types. Henceforward, skew distributions of various degrees of skewness had to be recognized as the common forms, and the normal distribution as a highly exceptional limiting type. * Enough has been said to show the high value of the volume, which is a real "treasury" of Pearson's work.

J Inst Actuaries 75:147–8 Je '49. W(illiam) P(alin) E(lderton). * The volume gives in one collection a remarkable series of papers that did so much to develop statistical technique and to encourage further development. Naturally the reader will find that in places the papers may seem to call for some corrections, that the accent on some parts of the subject has changed and

that many valuable new methods have been developed since the papers were written but he cannot fail to appreciate the great achievement they represent, their historical interest and also their remaining practical value.

[250]

★PEASE, KATHARINE. **Machine Computations of Elementary Statistics: With Special Reference to the Friden, Marchant, and Monroe Calculating Machines.** New York: Chartwell House, Inc., 1949. Pp. xii, 208. Paper, spiral binding. $2.75. *

J Consult Psychol 13:309 Ag '49. A very clear elementary manual for computations on common models of the Friden, Marchant, and Monroe calculating machines. * The simplicity of description, and the numerous exercises with answers, make the manual suitable for self-instruction.

Q R Biol 24:181 Je '49. A. Chapanis. * The instructions are clear and liberally illustrated with examples and problems. The student and investigator who have never learned to use computing machines will find this manual of immense help. It will also be an indispensable teaching aid in any statistical laboratory.

[251]

★PEATMAN, JOHN GRAY. **Descriptive and Sampling Statistics.** New York: Harper & Brothers, 1947. Pp. xviii, 577. $4.50. *

Am J Psychol 61:295–7 Ap '48. Quinn McNemar. * The book is well written and relatively free of typographical errors. The discussion of categorical data is superior to the usual treatment. Chapter 2, the introduction to sampling, and Chapter 16, on the predictive meaning of correlation, are excellent. In general, the problems of statistical inference and tests of significance are well presented, as is also the reliability of tests. The reviewer prefers a text which introduces sampling earlier, and he does not like the idea of splitting the discussion of ordinary correlation, as it seems much easier to proceed directly from regression to accuracy of prediction. Six pages are obviously inadequate for multiple and partial correlation, and the chapter on factor analysis, with 9 of its 14 pages devoted to cluster (Tryon's profile) analysis, is too sketchy to serve even as an introduction to the problem. There is no excuse for confusing the first-course student with 10 variations on methods for computing the product-moment correlation coefficient. Now to some factual points. It is not stated that the correction to the phi coefficient (p. 93) holds only for 50–50 cuts; an inadequate correction (97–98) to the coefficient of contingency is suggested (*cf.* T. L. Kelley, *Statistical Method*, 266–268); and three assumptions are given (443) as underlying the coefficient of contingency but reference to Pearson's original article shows that none of the three is required. It is erroneously implied (165–167) that formula 7:6a (gross-score formula for computing the S.D.) holds only for "positive integral" measures. A tetrachoric r of 0.73 is mistakenly given (279) as 0.91 which, along with the discussion, leads the reader to the false notion that tetrachorics tend to be higher than product moment r's. The proper r for evaluating the difference between correlated proportions (408) is not the tetrachoric coefficient but the fourfold or phi measure of correlation. (This had not been demonstrated when Peatman's book went to press.) The right-hand r's in formulas 16:1 and 16:2 (447) should be deleted, and the parenthesis terms of formula 14:14 (417, 561) should all have an exponent of 2. Regarding chi square, there is no justification for combining hypothetical frequencies at one end of the distribution (435) and not at the other, and one finds (436) a propagation of the falsity that one may choose either of two values for the number of degrees of freedom when testing the fit of a normal curve; with the hypothetical distribution made to agree with the observed in three ways (same N, M and σ), three degrees of freedom are definitely lost. In discussing the effect of range on correlation, Peatman gives an erroneous formula (480), which may also be found in at least two other texts on psychological statistics. It is stated (324) that, "for a series of samples of less than 25 or 30 cases each, the form of the sampling distribution of *any* statistic derived therefrom will *skew* more and more from the normal probability curve, the smaller the size of the sample" (reviewer's italics). This is simply not true of all statistics. Examples of statistics known to have symmetrical sampling distributions even for very small N's : correlations for uncorrelated variables, proportions when the universe value is 0.50, means for samples drawn from a normally distributed supply. Actually, the sampling distribution of means for small samples drawn from a normally distributed variate not only possesses normal symmetry but also normal kurtosis. It is, however, repeatedly stated (333, 340, 348, 349, 353, 355) that sampling distributions for small N's are leptokurtic. This false

generalization is based on reasoning via the point binomial with $p = q$. Since the measure of skewness for the binomial, $g_2 = \beta_2 - 3 = (6 - 6pq)/npq$, is negative for values of p up to 0.7886, it follows that the distributions being discussed by Peatman are platykurtic, not leptokurtic. The small sample t-ratio is leptokurtic in distribution, but the author was not discussing the distribution of ratios. Although tables are included for the t distribution, the discussion of small sample techniques is not only totally inadequate but also misleading in that (see 356) the t distribution is used for determining probabilities for the sampling distribution of proportions based on small N's. For instance it takes only a little arithmetic to show that the limits $0.50 \pm 3\sigma_p$ include *all* possible sample proportions when N's are less than 9, hence the probability figures given in Table 12:3, p. 356, are decidedly inappropriate. Regarding the required size of T (ratio of deviate to its standard error for large samples) for the 0.05, 0.01, and 0.001 levels of confidence, it is confusing to find (366–367) that the T for the 0.001 level is based on only *one* tail of the distribution, whereas the values for 0.05 and 0.01 involve both tails. Later (406), a T of 4.1 is interpreted via only one tail, and on p. 416 a T of 2.0 is likewise interpreted. Unfortunately, the appendix table for T involves one tail and that for t involves both tails, hence they are not comparable.

Am J Sociol 53:412 Mr '48. Ethel Shanas. * clear and authoritative * The sociologist will find this book deficient in its lack of discussion of statistical methods in the study of population. Further, the section on sampling statistics gives no adequate consideration to the theory of small samples. In spite of these defects, however, psychologists teaching elementary statistics, and many workers in the field of social research, will find Peatman's a useful workbook.

Col & Univ 23:645–8 Jl '48. W. Edwards Deming. * The book will undoubtedly enjoy popularity and good reviews because of the widespread but uncritical clamor for texts in statistical techniques which has accompanied the recent unprecedented expansion of activity in this subject. The methods of inference which are explained, however, are mostly long out of date or disturbingly faulty. In the past 20 years the underlying principles of scientific method and statistical inference have been developed and applied to the design of experiments and sampling in social, economic, and opinion surveys, as well as in the control of quality of manufactured product. These new principles are now being applied to the problem of attaining maximum efficiency of estimation and prediction, and to the economic control of the sampling errors and other types of errors that creep into all experiments and surveys. The statistician has turned probability theory into certainty and tremendous economic gains. These aspects, which should be the only excuse in this day for writing a new book, seem to be wholly lacking in the book under review. This is so, despite numerous references to recent papers and books, and to statistical techniques of lofty vocabulary including factor analysis, efficiency of predictions, likelihood and confidence criteria, centiles, tercentiles, vigintiles, deciles, quintiles, and (I suppose) tiles ad infinitum; biserial, quadriserial, quintiserial correlation coefficients, triserial skewness. The basic reasons for using these or any other techniques (*viz.*, to design experiments and interpret data economically, with the aim of providing rational grounds for decision or for increase in knowledge) is not made clear. Some of the fallacies in the book should be illustrated and the following references are cited, although the one on p. 376 or that on p. 310 would be sufficient by itself to destroy confidence in the entire book. (P. 291) A sample is a replica of the universe, and therefore *representative,* provided that the distribution of the observations or measurements under investigation is identical in both sample and universe. (Comment: a representative sample is a will o' the wisp: there is no way of drawing a representative sample so defined. Statistical inference, at least in its present-day form, deals with representative *methods,* not with a representative sample. The distinction is fundamental.) (P. 299) Stratification consists in the drawing of samples in such a way that the representation of the stratifying factors in the total sample corresponds to their respective proportions in the universe. (Comment: very confusing. In stratified sampling, the sample-design calls for the separation of (*e.g.*) the counties, tracts, or other areas into various "strata," each to be sampled. The basic aim is to separate out the assignable causes of variability, examples being rent-level, proportion nonwhite, urban-rural, all of which sometimes affect the characteristic being studied, which might be the proportion of men who go

to college somewhere to study science. Why and how to stratify, and what size of sample to draw from each stratum are the important questions but none of these is discussed.) (P. 301) The chance error effects caused by too many males or too many females in a single random sample can be avoided. (Comment: the reviewer would like to know how.) (P. 307) A great deal of the empirical progress that has been made during the past ten years in sampling statistics in the social sciences has been in the fields of public opinion and market research. (Comment: public opinion and market research organizations have indeed contributed greatly to the techniques of questionnaires, field practice, and—most important—to public acceptance of sampling. Every statistician owes a heavy debt to Dr. George Gallup and others for popularizing the idea of sampling and the usefulness of timely quantitative information. But contribution to the theory of sampling is another matter.) (P. 310) We randomize the best we can; and to the extent that we fail, we hope that stratification will compensate for the errors. (Comment: this is a common fallacy held by many laymen, and is indeed the practice all too common in a great deal of commercial and private research, but no real progress in sampling practice is possible so long as such ideas are held and propogated. One cannot blame the economist, sociologist, public opinion expert, psychologist, *etc.*, but he who would propagate the faith in statistical method should point out that this is *not* the way to get reliable information.) (P. 376) The best estimate of the standard error of a sampling distribution of means is given by the following: $\sigma_M = \sigma_\mu/\sqrt{N_s}$, where σ_μ is the standard deviation of the measures of the universe from which the sample was drawn and, as usual, N_s is the size of the sample. This formula ordinarily cannot be used, however, because the standard deviation of the universe being sampled is usually not known. Consequently, the estimate of the standard error of a mean must be based on the standard deviation of the distribution of a sample result. The formula for the standard error of a mean therefore becomes $\sigma_M = \sigma/\sqrt{(N_s - 1)}$ where σ signifies the standard deviation of the distribution of the sample result. (Comment: the first formula is not an estimate at all, but actually *is* the standard error of a mean. The effect of sidetracking a serious student so early in his thinking can easily be conjectured. Beginning at the word *Consequently* the quotation is so confused as to defy either interpretation or comment.) On p. 374 the author makes an attempt to calculate a standard error for an opinion poll in which the quota method of selection has been used; moreover, he uses the sadly overworked pq/n formula which is hardly ever the correct one to use even in the elite random sampling that is carried out by government agencies. The pq/n formula is in fact given on p. 375 without any reservation or warning that n is hardly ever the number of people in the sample, but is the number of sampling units, and that the formula hardly ever applies even when n is known. For every random sampling plan there is a formula for the variance of any estimate made from the sample. The particular formula quoted refers to a particular plan of sampling which is not the one under consideration. This citation demonstrates the necessity for a [illegible] understanding of statistical theory before indulging in applications. In contrast to the foregoing criticisms it is a pleasure to find such excellent advice as is contained in the following statements: (P. 295) To the extent that samples are not random we cannot have confidence in generalizations about universes made in the light of an analysis of sample results. (P. 297) It should be emphasized in this connection that merely increasing the size of the sample will not eliminate any biases inherent in the general sampling technique used. Nor will the replication (or repetition) of a sample increase the soundness of the result if the same defective sampling method is employed for both samples. (P. 329) When we speak of the probability of a single event, we use the singular only metaphorically. From the point of view of the frequency theory of probability, a single instance or occurrence has no probability value. There is now a plethora of recent statistical texts on the market which have contributed nothing new to statistical theory, which have propagated most of the errors of the past, and whose authors have ingeniously albeit unconsciously created new ones. It is time to enquire where publishers are leading us to. The science of statistics is undergoing rapid and revolutionary changes. Research and understanding are necessary as never before to anyone who attempts to work in applied statistics and certainly to anyone who attempts to teach or write on the subject. As Hotelling remarked in a paper on the teaching of statistics delivered at the Rutgers meeting of

the Institute of Mathematical Statistics in September, 1945, "no skill in pedagogy, no lustre of personality, can atone for teaching errors instead of truth. Errors are very likely to be taught by those who do no research, and then the more skillful the pedagogic indoctrination, the greater the harm." Let it be hoped that in the near future, publishers if not authors will see fit to discharge their responsibilities to science and in particular to the science of statistics by devolping aims and standards of publication, as by discovering in what areas of the subject, theoretical and applied, textbooks are needed, and then, above all, seeking competent people to write on them. Fortunately, some publishers are already alive to this opportunity and responsibility; some important improvements in quality are already obvious, and more are on the way.

Col & Univ 23:648–50 Jl '48. John Gray Peatman. [A reply to W. Edwards Deming.] * Mr. Deming has misinterpreted the intent and scope of my work. It is an applied, introductory text written primarily for students in education, psychology and sociology and those aspects of market research related to these areas of study. My emphasis throughout is on the logical and applied aspects of statistics for these fields, rather than on the mathematical bases thereof. I did not write the book for the purpose of developing statistical theory, as Mr. Deming infers I should have done; nor to involve the beginning students in the many refinements of statistical theory. The methods of inference I develop are well-established for the sampling of infinite or very large populations. The reader of my book will also find that I do not agree with Mr. Deming's proposition that "the statistician has turned probability theory into certainty," even though he may have achieved "tremendous economic gains." As for some of the specific criticisms Mr. Deming makes, I would like to refer first to those on p. 310 (should be 311) and p. 376, which have evidently so undermined the reviewer's confidence. The quotation from p. 311 is out of context. It appears in a short section entitled "Chief source of error in stratified sampling." And that source of error I underscored as follows: "The chief source of error in stratified sampling is the failure to obtain a truly random sample of observations or measurements for each control stratum of the universe sampled. We cannot overemphasize the fact that *randomization is the primary control factor in all sampling.*" The "we" of the reviewer's quotation refers to what sometimes occurs in consumer and public opinion research. I agree heartily with the reviewer that it is not thereby to be condoned. As for the quotation from p. 376, Mr. Deming is right in criticizing my use of "best estimate" which inadvertently crept into my discussion of how to estimate the standard error of the mean of a random sample. However, the formula given for the basic estimate is correct, being algebraically the equivalent of

$$\sqrt{\frac{\Sigma x^2}{N-1}}\Big/\sqrt{N}$$

A "representative sample" (p. 291) is a matter of definition. I like mine. In view of the reviewer's interest in methods, I am surprised that he did not also quote the following which is on this same page: "In practice, therefore, it is rarely possible to describe a sample as truly representative of a population. Instead, the character of a sample is usually described in terms of the methods used in obtaining it rather than in terms of its representativeness of the statistical population. By this criterion of *method,* samples may be classified as follows: (1) Random samples; (2) Stratified-random samples; and (3) Accidental or uncontrolled samples." The quote "Stratification" (p. 299) is part of a section on Stratified-random Sampling, consisting of thirteen pages on the "whys" and "hows" with emphasis on the fact that stratifying factors to be useful need to correlate positively and high with the trait or behavior to be studied, and a section on the inter-relation of stratifying factors. This is much more than most introductory texts have to say on this subject. The quotation from p. 301 is again taken out of context, as the reader is invited to ascertain for himself by examining the entire section. The quotation from p. 307, which is roundly condemned by the reviewer, specifically refers to *empirical progress* rather than to the theory of sampling. But Mr. Deming's criticism refers only to theoretical progress! I am at a loss to understand Mr. Deming's reference to "lofty vocabulary." Evidently, some of the statistical concepts, including centiles, commonly used in educational and psychological statistics are unfamiliar to the reviewer. But this in no way detracts from their usefulness for these fields of research. ("Triserial skewness," by the way, is a concept with which I am unfamiliar and can-

not locate in my book.) Finally, I am intrigued by Mr. Deming's reference to "the elite random sampling that is carried out by government agencies." A truly random sample is random, whether made by government or by private agencies.

Ed Adm & Sup 34:60–1 Ja '48. A. S. Edwards. * will be of interest to workers in a number of fields: psychology, biology, education, and sociology, especially. Some attention has also been given to the statistics of public opinion and market research. * The author does not attempt to deal with his material from the point of view of pure mathematics; but rather to discuss it in a brief and clear manner with many concrete illustrations as a tool for research. * In general the subject-matter includes what is commonly found in recent textbooks * One will also find treatment of some subjects more or less commonly omitted such as the working of percentages, ratios, index numbers, cluster and factor analysis, for example. One of the main points of value is found in the fine selection of examples that are worked out for each rule or formula and the large number of tables which are useful, both for learning in the first place and for reference in all later statistical work. A number of appendices are especially useful because of the valuable working tables which they contain * The index....is well made and gives sufficient reference to the material in the text. References are copious at the bottoms of pages with the rather quaint old system of stars, daggers, etc. * It appears that time and space are not wasted in too long, drawn-out explanations, but are very well condensed, and the reader can hardly claim that he has to read too much to get too little. For added ease in the use of tables, graphs and formulas, a double numbering system is used; for example, the first figure in Chapter 8 is numbered Figure 8:1. * The book indicates various special efforts for the attainment of clearness and of ease in the use of the volume for reference purposes. * It should find a useful place among the new texts in elementary statistics.

J Am Stat Assn 43:335–7 Je '48. Leon Festinger. * The first part of the book, entitled "Descriptive Statistics" is, with respect to the content it covers, rather comprehensive. * There is no doubt that a student who has carefully digested the material in the book will be able to compute the various measures which are presented. * There is some doubt, however, whether this student will have an adequate enough understanding of what he is doing and why to insure the use of the proper measure where alternatives are available, and to insure adequate interpretation. In most places the book goes quite thoroughly into what to do but skims very lightly over the "why." * The second section of the book, entitled "Sampling and Analytical Statistics," is of quite different character from similar sections in other textbooks. * The present book is one of the very few which have attempted to include a discussion of sampling problems in public opinion research. The discussion is relatively brief, occupying only fourteen pages, but nevertheless does present the major techniques such as stratification, area sampling, and quota sampling. There is perhaps not sufficient critical evaluation of these techniques and not sufficient discussion of the problems of each. There is also, unfortunately, no presentation of sampling error formulae for dealing with these various kinds of samples. Another feature of the book is a short but relatively good discussion of discrete probability distributions. * Unfortunately, the remainder of the second part of the book is of rather inferior quality. The presentation consists almost exclusively of tests which might be justifiable when the number of cases in the sample is sufficiently large so that anything and everything distributes itself normally. The only exception made is for correlation coefficients where Fisher's z transformation is given. The t test is dismissed in one page with the idea that it is not very useful in psychology and the social sciences; the F ratio for significance of difference between variances is never mentioned; the techniques of analysis of variance are entirely omitted and the discussion of the chi-square test is rather poor. It may be that this selection of material was determined by the idea that this was to be an elementary text, but the reviewer finds difficulty understanding why outdated and inferior procedures are more elementary than newer and more adequate procedures. * there seem to be many inaccuracies which could be easily removed * Whether or not readers will find *Descriptive and Sampling Statistics* a worthwhile text to use will undoubtedly depend largely upon their personal preferences as to what should be taught in an elementary statistics course and how it should be taught.

J Am Stat Assn 43:337–9 Je '48. Frederick F. Stephan. * Compared with other texts in cur-

rent use, this book has several commendable features that will appeal to some teachers and students. For the most part, these features consist of interesting discussions of the meaning and applications of statistical methods in psychological testing and public opinion polls. Among them one may mention an interesting sketch of the historical background of statistics and several passages in the sections on sampling, test validity, and correlation that reveal considerable skill and ingenuity in presentation. However, there is another standard by which a textbook may be judged, namely, its effectiveness in remedying the defects of other books and bringing the teaching of the introductory course abreast of recent developments in basic theory and method. On this standard, the book does not appear to be satisfactory. To too great an extent it seems to be a rewriting of the content of familiar textbooks, principally Peters and Van Voorhis, and parts of Croxton and Cowden, and Yule and Kendall, rather than a fresh and modern formulation of the introductory course based on current research applications and methodological advances. It even falls behind these books (published some ten years earlier) in many respects. For example, the reviewer could not find as much as a casual reference to the analysis of variance. * While the book is intended for research workers in the social and biological sciences, it neglects important parts of these fields and emphasizes psychological and educational testing and public opinion polling. It slights psychological experimentation, genetics, and other major regions of the application of statistical method to research in these fields. * the normal distribution and correlation are discussed extensively before sampling and probability. This separation is harmful, in the opinion of the reviewer, for it obscures the extent to which statistical theory has been unified. * The author took pains to avoid sacrificing accuracy in attempting to write clearly but there are a number of places at which statements are confused or incorrect when read literally. * There is a meager one-page bibliography. It does not include such books as Snedecor or Lindquist, which are needed to cover important fields that this book slights. The appearance of books like this emphasizes the importance of more effective communication between statisticians in various fields and improvement in the teaching of statistics, two functions in which the American Statistical Association should be increasingly active.

J Consult Psychol 12:61 Ja–F '48. * A feature, found in relatively few familiar texts since Yule, is a fairly full treatment of the statistics of attributes or categories, with applications to problems of recent interest in opinion and market research. Although applied and not basically mathematical, the treatment is more symbolic and systematic than most elementary texts. Students with little mathematical preparation will be frightened. For the able, the book gives an adequate introduction to all but the most complex statistics used in psychology. *

Psychol B 45:380–1 Jl '48. Jane Loevinger. The outstanding virtue of this book is the profuse use of interesting illustrative data, presented not in a perfunctory manner, but with genuine concern for the real problems of research. If it is possible to communicate a feeling for the relationship of statistics to data, such a book as this will do it. Mastery of formal statistics without such a feeling is a poor asset to a psychologist. The table of contents is much more detailed than usual. Glossary of symbols, glossary of formulas, and a considerable number of tables add to the usefulness of the book; however, the inclusion of four separate tables of areas under the normal curve seems excessive. Finding errors in the book is not difficult. On p. 259 biserial r is erroneously stated not to assume a normal distribution for the continuous variable. A scattergram on p. 203 illustrating non-linear correlation is more notable for the fact that the lines that are supposed to go through the means of the two variables do not. Computational use of a table with an open-end interval, on p. 154 and elsewhere, is misleading. The same illustration is unfortunate for another reason, namely, that the mean comes out even, giving the student an erroneous impression of the amount of computational labor ordinarily involved in subsequent operations. Typographical errors occur in formulas on pp. 165, 219, 418, 447, and 560. The most serious of these is an error in the formula for the standard deviation on p. 165, repeated on p. 560, since it coincides with a common student error, using coded data in part of the formula and decoded or deviate data in another part. The same error is encouraged by an awkward choice of notation in some of the formulas for correlation, as on p. 238. A number of terms, including "normal curve" and "central tendency," are used more

as in everyday speech than as in mathematical statistics. The terms "variable" and "representative sample" are not consistently defined. Categorical data are called "non-variable," and whether ranked data and discrete measured data are included in the term "variable" along with continuous measured data depends on which page you are reading. In chapter 11 the term "representative sample" is used repeatedly to mean an unbiased sample and also to mean a sample such that the statistic being studied has zero sampling error. Obviously, the whole study of sampling errors is based on a distinction of these two meanings. "Chance errors" are characterized as "just as likely to affect the results positively as negatively" on p. 286 and as "just as likely to occur as not to occur" on p. 332. Neither statement is exactly correct. In drawing frequency polygons the convention of bringing the graph down to the x-axis on each end is ignored. The idea that area represents frequency is thus obscured, leading to difficulty in explaining the relation of frequency polygons to probability curves. Indeed, the ordinate of probability curves is labelled "frequencies." The "principle of equiprobability" invoked in the discussion of the binomial distribution and the normal curve is not needed in deriving the normal curve as a limiting function of the binomial. The book, however, is not characterized so much by an excess of errors as by a style at worst inexact, at best diffuse and repetitious. It must be admitted that to more students than not, this characteristic may seem more a virtue than a defect. Certainly this book is a valuable addition to the library of any teacher of statistics. It seems adequate as a text of descriptive statistics; treatment of categorical data is outstandingly good. As a text of sampling statistics it is deficient, especially the chapter on probability and statistical inference. Nowhere, for example, are there definitions of "random variable," "mathematical expectation," or "biased statistic." The two types of errors in testing statistical hypotheses and the basis for selecting best statistical tests are not mentioned directly. The book is made vulnerable by being so inclusive as to serve as a reference manual; for example, specialists will certainly object to the chapter on factor analysis. There is some danger that this book will be adopted by instructors in statistics who are themselves long on interest in data and short on precise knowledge of the logic of probability and statistical inference, and an equal danger that it will be ignored by those who are rigorous in notation and definition but do not integrate statistics with the content of research. Without urging that instructors adopt the text that they like least, one may at least admit that no elementary statistics text now available compensates for all possible deficiencies in the instructor's presentation.

Psychometrika 13:119–21 Je '48. Lloyd G. Humphreys. * a non-mathematical treatment of the subject matter usually included in the first-year course in psychological statistics. Computations and applications are stressed throughout. To the reviewer, this approach seems highly desirable. The result is a teachable book (exceptions noted later) for beginning students that is ample for a year's work. The book is divided into roughly equal halves: descriptive statistics, and sampling and analytical statistics. It is debatable, however, whether this logical division is best from the pedagogical point of view. Many instructors would prefer to teach chi-square, for example, at the same time that the descriptive statistics of categorical data are discussed. The reviewer was impressed by the following sections of the text: an initial chapter sketching the history of statistical methods; an assortment of useful statistical tables; an unusually ample treatment of categorical data and appropriate statistics; and a reasonably complete section on sampling theory and procedures. The latter features should make the book unusually useful to the student and instructor interested in public opinion polling. The author, as a matter of fact, draws many of his illustrations from this area of research. The illustrations, incidentally, are generally well chosen. An exception (admittedly petty) is the too frequent use of Bernreuter scores. There are some psychological tests that one would prefer to see ignored, rather than publicized, by our text-book writers. Entirely omitted is any discussion of the analysis of variance. It was presumably considered to be beyond the scope of the volume. From the same point of view, the inadequate chapter on factor analysis might well have been omitted. The text is marred by an unexpectedly large number of errors of a statistical rather than typographical nature. The treatment of the phi coefficient and point biserial, while not out of line with most standard texts, is inaccurate. Neither statistic positively assumes point distribution. Both should be used without corrections, even if the distributions

underlying the dichotomies can be assumed to be continuous and normal, if the data have to be used in the categories correlated. Both the tetrachoric and continuous biserial correlations give an *estimate* of what the product-moment correlation would be if the data were continuously and normally distributed. Phi and point biserial *are* product-moment correlations. This fundamental error in the treatment of these statistics leads to others. The correction applied to phi when continuity and normality can be assumed (p. 93) gives an inadequate estimate of the tetrachoric correlation and furthermore should not be applied simply because the assumptions can be made. In the formula for the standard error of the difference between proportions from correlated variables (p. 408), phi should be used in place of the tetrachoric correlation. In estimating the reliability of a test by the method of item intercorrelations (p. 476), phi coefficients should again be used rather than tetrachorics. The situations used to illustrate the continuous biserial (p. 260), prediction of a dichotomous criterion and internal consistency of test items, are actually, for most purposes, better treated by the point biserial. Other errors noted are listed briefly below: (1) The coefficient of mean square contingency (p. 86, also p. 433) does not necessarily make the assumption of continuity. (2) Rectangular distributions (p. 115) are caused by a relatively constant level of item difficulty and relatively high item intercorrelations, neither of which can easily be associated with selective factors, the explanation advanced by the author. (3) The coefficient of relative variability frequently can not be used when the data are for the same test (p. 171), since a relatively small number of test items distorts the expected relationship between the mean and standard deviation. (4) The shape of a distribution of a sum of several parts is not determined primarily by the shape of the distributions of the parts (p. 270). The number of parts and the intercorrelations of the parts are more important. (5) Errors of measurement are not reduced by increasing the size of the sample (p. 313, also p. 326), and they do affect many statistics besides correlation coefficients, *e.g.*, differences between means, and standard deviations. (6) Comparison of the shape of the distributions of I.Q.'s and height is hardly warranted (p. 331), since any similarity is more coincidental than fundamental. (7) The sampling distribution of t is indeed leptokurtic, but not for the reason given. The expansion of the binomial when n is small gives a distribution that is platykurtic (p. 348). (8) The standard error presented for phi coefficient (p. 389) is incredible; the relationship to chi-squares gives the reciprocal of the square root of N for a test of the null hypothesis. (9) The coefficient of relative variability is misused on page 419, and the wrong conclusion is drawn from the statistics presented. (10) The author implies (p. 474) that the relationship between length of test and reliability is restricted to the split-half procedure, and he fails to warn against the use of split-half methods for speeded tests. (11) The formula given for correcting a correlation for restriction of range (p. 480) is applicable only when the standard deviations in the restricted and unrestricted ranges are obtained for the variable not primarily restricted. (12) If an item is significantly related to total score on a test (p. 481), the test and item are necessarily reliable. (13) A partial correlation (p. 485) does not assume that any of the variables represent unitary functions or traits, and the technique is applicable and useful even though a given variable could not be held constant experimentally. The reviewer is not an efficient proof or copy reader. For what it may be worth only one such error was discovered. On page 387 a z-value of .87 was substituted for .81, and the error was carried through the rest of the problem. The errors listed, while unfortunate, may not entirely destroy the usefulness of the book. An instructor can sometimes impress his students by pointing out errors in the text, and the volume does contain most of the material most frequently covered in a first year course in statistics. The sections on dichotomous data and sampling, after correction of errors, would constitute valuable collateral reading in any event.

Q R Biol 24:276 S '49. W. R. Garner. * In two appendixes many different tables useful in statistical work are given * These tables provide a far more complete set of tabular material than most introductory textbooks provide. * Coverage of the traditional statistical techniques is very complete—the student should be able to find a formula for almost any situation he might encounter. On the other hand, there is no discussion of the more modern techniques, which would presumably be taught in a more advanced course. There is no mention of the analysis of

variance and covariance, and small sample theory is covered essentially by telling the student to use different tables when N is less than 30. This is the kind of book which is useful in those courses which do not anticipate further advanced work. For the student who needs to know some statistics, but who is not capable of handling the basic theory of the subject, it should be a good textbook. * For a course taught as an introduction to advanced statistics, however, the lack of derivations and the arbitrary statements of procedures characterizing this book will probably not make it particularly useful. In fact, a great deal of such "statistics" must probably be unlearned before the student can go on to advanced material. As a practical matter, however, the complete coverage of the traditional techniques makes this book a good textbook for most elementary courses. * Even for the student who will go farther, the completeness of this book may well offset the disadvantages of the kind of treatment it gives.

Sci 106:329–30 O 3 '47. J. R. Wittenborn. This book recognizes the dilemma of social science students who need certain statistical knowledge and skill, but for whom the time requirement of mathematical training is either discouraging or prohibitive. In his attempt to meet the needs of this particular group, the author has made commendable use of ordinary English prose for the presentation of various statistical devices and the illustration of their uses. The text is entirely free from elaborate formulas and derivations. Its content is well supported by timely and appropriate illustrations, and excellent pedagogical value may be anticipated for the exercises at the conclusion of each chapter. This very practical book will probably enjoy a wide demand as a text for undergraduate and first-year graduate students in education and sociology. It should provide a useful background for some kinds of research and will greatly facilitate the comprehension of those who must read the current literature in education, sociology, anthropology, and psychology. Although the author has realized most of his expressed aims, his work is not without serious fault. The problem of nonlinear correlation receives a most summary dismissal; for example, Eta and Epsilon are ignored. The use of the important F test and the simplest illustrations of analysis of variance and covariance are omitted. A chapter on cluster and factor analysis is included, but the discussion is misleadingly inadequate. Neither the assumptions of factor analysis nor their implications are given. Spearman's two-factor theory receives one paragraph. All multiple-factor theories are lumped together in one paragraph. The rest of the chapter is concerned with a little-used, casual method of cluster analysis. Despite the omission of certain important topics, the book has a broad scope and may create the illusion in the student that the treatment is comprehensive. This would be regrettable, because in general the assumptions underlying the development of the various statistics and governing their appropriate use are poorly defined or omitted. Equally serious is the presentation of a large group of standard-error formulas with the instruction that the statistics in question are essentially normally distributed. In the case of sample sizes commonly encountered, this assumption is questionable for some of the statistics, and for other statistics, *e.g.*, the standard deviation, it is known to be incorrect. With few exceptions, the student is encouraged to regard his samples as large samples. These limitations are not unique to this textbook, but they are regrettable in that they may encourage a "cookbook" approach to experimental design and the testing of statistical hypotheses. The sequence of topics is unusual, and many things which ordinarily go together are widely separated and treated in a piecemeal fashion. Although there may be good reason for this, its merit was not apparent to this reviewer. The simplicity and rigor of modern inferential statistics, particularly for small samples, may not be discerned by the student who uses this textbook, and he will have little opportunity to be discouraged by either the mathematical or logical rigor which features many textbooks in statistics. Nevertheless, in terms of the aims of this textbook, its positive features greatly outweigh its shortcomings.

[252]

PETERS, CHARLES C., AND VAN VOORHIS, WALTER R. **Statistical Procedures and Their Mathematical Bases.** New York: McGraw-Hill Book Co., Inc., 1940. Pp. xiii, 516. $5.00. * (London: McGraw-Hill Publishing Co., Ltd. 32*s.* 6*d.*)

Am J Sociol 47:243–4 S '41. Robert F. Winch. While probably too advanced for beginning students, the above volume is invaluable for those acquainted with the fundamentals * the authors provide a number of special formulas for use where the better-known pro-

cedures are inapplicable. This feature makes the book unusually valuable as a research manual. * While the examples and problems are drawn almost entirely from psychology and agronomy, there is from the sociologist's point of view only one serious criticism, namely, that there is no discussion of time series. *

Am Math Mo 48:694–6 D '41. F. F. Stephan.

* The authors appear to regard statistics as merely a collection of formulas the derivations of which are not understood by relatively untrained persons largely because of "the omission of steps which are supposed to be obvious." They seek to supply these steps. The first 39 pages present "A Little Calculus." After this beginning, the book follows a more or less familiar course with preponderant emphasis on correlation. * The book is intended for students of psychology and education, and assumes that the reader is familiar with their jargon (*e.g.*, "samples matched on an infallible criterion"). * Many of the techniques developed by R. A. Fisher are included. The authors "have attempted to take the magic out of them," and bring them into "synthesis with classical statistics," but they do not appear to be happy with the result or entirely successful in it. May this not be because they have been blind to the forest of statistical theory in their concentration on the trees of specific formulas? The book is uneven in quality from page to page and chapter to chapter. In many ways it compares favorably with other text-books now in use. It has a number of general defects, however, that are serious liabilities for student and instructor alike. The first general defect is careless use of language. This may be a byproduct of the authors' attempt to write a "chatty, leisurely volume." * Inaccurate statements abound in the text * A second general defect is the weakness of the treatment of probability. The authors frequently confuse or obscure the relation of sample and population. They do not define or explain, except by casual and incomplete references, the meaning of independence, random sampling, the point binomial, and many other fundamental concepts. The general concept of a probability function is not developed. The normal probability curve is presented after, not before, chapters on correlation, standard errors, and factor analysis, and then it is given primarily as a function for graduating or describing frequency distributions. The pages fairly bristle with formulas for probable errors, but almost no attention is paid to the theory of tests of significance. The authors badly misinterpret significance tests on pages 119 and 137. A third general defect is the fondness of the authors for certain of their own contributions to statistics. (In this they are not unlike a number of other authors.) Seventeen pages are devoted to tetrachoric and biserial correlation formulas for "widespread classes." No table or z or F is given for use in analysis of variance because the authors believe ϵ^2, Kelley's modification of the correlation ratio, is superior to the analysis of variance. Instead, Snedecor's table of F is transformed into a table of ϵ^2 which is reproduced. The probabilities given for this table (p. 494) are only half the correct values since negative values of ϵ^2 are to be interpreted as arising by chance (p. 355). The statement that "The distribution is of the same shape oriented toward negative values as toward positive," (p. 355) is incorrect. It is stated erroneously (p. 334) that the class frequencies must be equal if an analysis of variance is to be valid. The assumption implicit in equation 177 that the ratio of two unbiased estimates is unbiased is false. A fourth defect is to be found in the treatment of assumptions underlying several of the derivations. Often they are stated correctly but not in a prominent position, and frequently they are not satisfied by the examples that the authors present. The example given for biserial r is drawn from a study of 100 children that left school and 200 that did not leave. Apparently each of these numbers was determined arbitrarily by the investigator, but the authors proceed to treat them as if they fulfilled the assumptions stated on page 365. Again, they illustrate tetrachoric correlation by the relation of teaching success to hours of courses in pedagogy, dividing the latter into "six hours or less" and "more than six hours." Hours of credit in pedagogy certainly is not a continuous normally distributed variable; the illustration could not have been much poorer in relation to the assumptions stated on page 370. The reviewer fears that the authors may befuddle or mislead more students than they rescue from the mystery and magic of text-books that do not present the mathematical basis of statistical procedures. Their purpose is a worthy one, their conception of the difficulties perhaps too narrow, their performance too badly marred by inaccuracies and mistakes. The book would be more useful if greater care had been given to fundamentals and less to formulas.

Am Sociol R 6:618 Ag '41. Myron S. Heidingsfield. * unique in the sense that it outlines many of the less familiar methods for measuring relationship, *e.g.*, biserial correlation, tetrachoric correlation (cosine pi formula), and mean square contingency correlation. * Another unusual contribution is a chapter on multiple factor analysis. * an excellent chapter on the reliability of differences as well as one on the normal probability curve. * this book....[is] one of the outstanding contributions to the field of statistical literature. Its presentation is lucid, comprehensive and extraordinarily stimulating to the teacher as well as to the practicing statistician. The reviewer would heartily recommend its use as both a classroom and reference text. *

Eug R 33:50 Jl '41. P. F. Miller. * gives the derivations of formulae in great detail and thus makes a real understanding of the working tools of statistics easy. A particularly useful idea was to open the book with a chapter on "A Little Calculus," which is a model of simplicity and clearness. The book deals with statistics mainly on the classical large-sample lines, an understandable procedure, as it is mainly addressed to workers on educational and sociological research, where samples are rarely small; but some space is also given to the more modern treatment of small samples so often encountered in experimental work. Thirty pages of statistical tables conclude the work. If I were asked which of the two books to buy, R. A. Fisher's *Statistical Methods for Research Workers* or this book, I should answer: both. They are in many ways complementary, and there can be little doubt that Peters and Van Voorhis's clear exposition of the origin of statistical procedures will help the research worker to apply the formulae more safely and intelligently than if he is taking them for granted.

J Royal Stat Soc 104:175–6 pt 2 '41. M. G. K(endall). This book is written largely from the angle of educational psychology. There is a great deal on correlation analysis, and chapters on significance of means, analysis of variance, factor analysis and experimental design. Unfortunately it contains a great many mistakes. There is not space here to record all those noted on a first reading, but the following will serve as examples: On page 411 the authors give their first illustration of the use of the χ^2 distribution by applying it to a series of 14 cells in each of which the expected frequency is 2. Since they state later that "the chi-square technique is not sound unless the numbers in the cells are reasonably large," this cannot be attributed to ignorance alone. A section on pages 84–89 is headed "Proof of Sheppard's Correction Formula." Only the correction to the second moment is derived, and then only for a normal population. In any case, the proof is not sound, depending on various slipshod procedures, such as the term-by-term integration of infinite series without reference to questions of uniform convergence. The extent of the authors' grasp of statistical principles is, however, revealed most clearly by the following gem on pages 299–300. "Let us assume that our errors make a normal distribution. Then the frequency of occurrence of a particular error would be given by the normal equation $y = y_0 e^{-Cx^2/2}$. The probability of the occurrence of a particular error would be y/N." Hence the probability of simultaneous errors $x_1 \cdots x_n$ is

$$P = \frac{{y_0}^n N^{-n}}{e^{\frac{C}{2}(x_1^2 + x_2^2 + \cdots x_n^2)}}$$

This equation "shows that the value of P is a fraction whose value depends upon the sum of the square of the errors. Since the value of the fraction is the greatest when the denominator is least the value of P will be the greatest when the quantity within parentheses is least. That is, we must minimize the sum of the squares of the errors in order to obtain a maximum probability of the concurrence [*sic*] of these errors. From this standpoint, therefore, we have a partial explanation of the principle underlying the least-squares method used in many of our statistical developments." Partial is indeed the word. Why not equate the errors to zero, and so make sure of getting the right answer every time? The proof-reading has been done with inexcusable carelessness. * It is well known that the square of the correlation ratio, being non-negative, has a positive mean value. Kelley has proposed the alternative statistic

$$\epsilon^2 = \frac{(N-1)\eta^2 - (k-1)}{N-k}$$

where N is the number in the sample and k is the number of classes. This has a zero mean value, and values of ϵ^2 from different populations are more comparable *inter se* than values of η^2. So far, so good. ϵ^2 may very well be a better descriptive statistic than η^2, and anything propounded by Professor Kelley carries great

weight. But it should be evident to a child that a test of significance of η^2 is equivalent to one of ϵ^2, to which it is related by the above simple linear equation. Our authors, however, think otherwise. On page 355 we have this: "The interpretation of η was somewhat dependent on the size of the population and the number of classes into which it was divided. Furthermore, there was available no "exact" test of the significance of η. But ϵ is entirely free from these limitations....In fact, the ϵ test of reliability gives precisely the same results as the F test of analysis of variance for a given problem." This book could not be recommended for use by any student who was not working under supervision.

Math Gazette 25:190–2 Jl '41. Frank Sandon.

* the book....is a revision of a book privately published in 1935: there are at least half-a-dozen references in it to matter that is of interest but can be found only by using the earlier book * It is a comprehensive volume, and almost everything that is likely to be required by the psychologist-statistician is here. An indication of the chapter contents may be of value. I. "A Little Calculus." This chapter is inserted "to prepare the reader who has not previously studied calculus to follow the derivations." Neither in this chapter, nor elsewhere in the book, would the criteria of rigour of an English text be satisfied, and it is not clear what mathematical knowledge the reader is supposed to have. Two pages are (later) used in obtaining Σn^2, though interpolation and point of inflection are used without definition or explanation. * III. "Measurement of Variability." This includes the proof of Sheppard's Corrections. A non-educational example here involves a *J*-curve: corrections for abruptness are not used in calculating the constants of the distribution. IV. "Rectilineal Correlation." The example given at the end of the chapter—correlation between size and *per capita* cost—would involve the spurious index correlation against which there is a warning in Chapter VII. V. "Reliability of Statistics." This refers quite often to the normal curve, which is not dealt with till Chapter X, and to "Student's" t, which is only considered properly at p. 420, as well as to fiducial limits. VI. "The Reliability of Differences." This includes Fisher's table for t. It is unfortunate that certain tables of tabulated functions are included in the text and are numbered serially in with the illustrative experimental tables: there is no index of tables so that it is difficult to hunt this one of Fisher's, for example, down to p. 173 in the absence of any specific reference. VII. "Inferring Coefficients of Correlation for Changed Conditions." This chapter includes the Spearman-Brown formula for "stepping-up" reliability, the correction for attenuation and a rather full treatment of the effect on correlation of heterogeneity and selection; no reference is made to the fact that this theory is due primarily to Karl Pearson on Natural Selection. VIII. "Partial and Multiple Correlation." In addition to the ordinary theory, the Doolittle method of computing is given fully. It would have been helpful if some guide about the number of significant figures to be used and retained had been given, especially in view of the authors' note of the effect of small differences in the raw r's. IX. "Multiple-Factor Analysis." After an outline of Spearman's Tetrad Differences, Thurstone's Central Method is dealt with. This includes the two steps regarded by Burt as fallacious—the use of the highest inter-test correlation for the communality, and the rotation to maximise zero loadings (and thus make all weightings positive and no factors bi-polar)—and involves the sign-changing wangling after removing the first loadings. X. "The Normal Probability Curve." This has been rather long delayed. The graph (Fig. 19) for the histogram should state the value of n that has been used. * XIV. "Chi-Square." Pearson's χ^2 is here considered, together with t, and an outline of Huntingdon's generalisation. There is a further reference to degrees of freedom, coming down on the side of K.P. rather than Fisher in its enumeration. Table XXXIX here is inconsistent in column f_1 with the sixth column of Table XXV of p. 306, whilst the calculations here are surely too drastically rounded. XV. "Curve Fitting." Again rather a delayed topic. In addition to the Pearsonian method of fitting by moments (the authors do not seem to realise the relationship between the several usages of the term "moments," partly possibly because of their vagueness about the difference between ordinates and areas) there is something about normal equations (here defined but used in Chapter VIII) the Logistic Curve (no reference here to Yule—only to Pearl) and the Gompertz law. XVI. "The Technique of Controlled Experimentation." Here the book comes out even more strongly than before in favour of, *e.g.* matching groups as against the Fisher technique of replication. The authors' lack of

rigour, about degrees of accuracy, in not defining what is experimentally "the same," "alike," "a few points" (*cf.* p. 448) here, we suggest, has led them astray. There is nowhere in the book any definite lead given to the size of the populations (or samples) for which the formulae are appropriate, save on p. 456 which suggests that $N = 36$ gives a "large" sample. * The book as a whole is therefore an ambitious and valuable survey of the field. There is nothing about Efficient Statistics, nothing about the Q technique of correlating persons instead of tests. But in the main everything that is commonly needed in the field with which the authors are concerned is here. Our main outstanding criticisms are on relatively minor points. We have already indicated that the mathematical outlook is insufficiently rigourous: a statement (p. 264) that the residuals are so small that they are obviously due to chance is unconvincing. The system of references is not always satisfactory. Tabulated functions appear in casual tables in the text: equations and formulae have reference numbers at either end of the line and reference to them is difficult when page and index references are not given (is, for example, the F of p. 352 Snedecor's F or formula F of higher up?): page references are not always accurate: memoir references do not always give initials (for example, Jones, p. 128; Pearson, p. 159; Soper, p. 365) nor date, whilst there is some confusion between *Phil. Trans.* and *Proc. Royal Society.* The order of presentation, though possibly convenient pedagogically, is awkward: in at least a dozen cases there is used a symbol, term, result or table that is only properly dealt with (if at all) later. Thus Σ is used on p. 12 and defined on p. 44. The authors take rather an indefensible line in suggesting (p. 358) that statistical procedures are not usually conveniently adapted from one field of study for another. Yet they claim (pp. 122, 280) on grounds of genetic theory that mental traits are normally distributed. Mental traits are unmeasurable: we can only determine them indirectly by some more or less subjective measures of certain manifestations. And it is as reasonable to claim that the traits behind the measures follow the same frequency law as the measures as it is to claim that the stature of a man, determining his bulk and thus his weight, follows the same frequency law as does his weight, or his business capacities as the income earned by these. The book is nicely got up. There are a few misprints * There are some usages that read strangely to us. We recognise "componendo" in "composition" but are not prepared for a "complex value" to mean a "complicated expression" nor "percentages" (pp. 437, 440) "fractions." And we get tired at the ninth appearance, on the last page of the text, of the idea expressed on the first page of the preface, of mathematical and statistical tools being "magic." But these are minor points, and should not present any serious difficulty to the British reader. He should find the volume of great assistance if he is working in the field the authors have surveyed so carefully.

Nature 149:151 *F* 7 '42. * The point of view of the authors is easily comprehensible, and merits sympathy. On one hand we have books such as R. A. Fisher's "Statistical Methods for Research Workers," which promulgate formulae and procedure by the voice of authority, without descending to proofs; on the other we have few text-books, but a profusion of memoirs, not only abstrusely mathematical, but often controversial. A student or researcher, initially of slender mathematical equipment and desirous of applying statistical methods to some problem of research, may well feel at a loss. This book is intended to help him, and without doubt, by the time he has read its almost five hundred pages (the last thirty are devoted to useful tables) he will know a great deal about questions of distribution, correlation, regression, the χ^2-test and the rest. Will he be able to digest his knowledge and discriminate? While fully sympathetic, one may feel dubious about the efficacy, and even the desirability, of such an approach. Envisage a continuous variate; the compound probability of even two individuals involves a double integral, and n-fold integrals with very large n are the merest commonplace. Consider again the question of partial correlation; the abstract underlying ideas are those of linear transformations and positive definite quadratic forms. Indeed not only the infinitesimal calculus, but also algebra, both matrix and combinatory, and some notion of the geometry of hyperspace are prerequisite to the study of statistics. It is better that these fundamental preliminaries should be mastered as if for their own sake. Then, when the time comes for application to mathematical statistics, one will have a background not merely for understanding and applying, but also for doubting and reserving an opinion; for high authority does

not yet speak with a single voice. A truly elementary and comprehensive book of this kind would have had to be at least twice as long again. For example, the normal function is deduced from the exceedingly special case, the symmetrical binomial; while the χ^2-distribution and many other results are only incompletely established, the reader being referred to more advanced treatments.

Plant Breeding Abstracts 11:243 Jl '41.

* There is no doubt that working carefully through this book would give the student a better understanding of statistical methods and more confidence in using them than are felt by most people who use them. Though there is a tendency for the authors to cater for psychological and sociological students, particularly in the choice of examples and in the attention devoted to correlation, all users of statistics will find the book of value, for all the fundamental procedures are covered, including the analysis of variance and the χ^2 test. The book is well written, well produced and provided with tables and an index.

Psychol B 39:677–8 O '42. Jane Loevinger.

* The first chapter gives a fairly accessible introduction to the differential and integral calculus, though it may not enable the average student to follow all of the calculus which appears later in the text. The most notable omission is a chapter on theory of probability, which is the mathematical basis of all statistical inference. The authors recommend that the student read Fisher's article on "Inverse probability," "which he will not find very difficult." The substance of Fisher's article is that knowledge of population parameters enables us to assign probabilities to statements about sample values; knowledge of sample statistics does *not* allow us to make probability statements about population values but does affect our degree of belief in hypotheses about populations. Peters and Van Voorhis assign probabilities to statements about population parameters on pages 137, 175, 186, 187, and elsewhere. For example, "A ratio of 0.7 between a difference and its standard error indicates chances of only 3.1 to 1 that the true difference lies in the same direction." (P. 184.) Use of inverse probability obscures the important question, not mentioned in this book, of how large the true difference must be in order to have a reasonable chance of being detected with a sample of a given size. The assumptions underlying statistical techniques are consistently difficult to find, and in some cases the examples involve straightforward violations of assumptions. The fundamental additive assumption of factor analysis is presented not as an assumption but as a conclusion, and no attempt is made to examine its meaning in relation to various types of psychological data. Similarly, the criteria for simple structure are presented as arbitrary rules for rotation without any psychological rationale. The reader is not informed that there are any limitations to the use of the critical ratio; all sorts of differences are divided by their standard errors and interpreted as if any such ratio were normally distributed. In the section on the significance of the difference between percentages, the percentages compared happen to be 99.48 and 97.65, too high to permit an assumption of normality even for the relatively large number of cases involved. Another misleading numerical example is the illustration of chi-square in Table XXXV. Although on page 417 we find, "The chi-square technique is not sound unless the numbers in the cells are reasonably large," on page 411 the theoretical frequency in each cell is two. The organization of topics is novel if not entirely logical or convenient. Chapters on correlation theory are interspersed with chapters on sampling error theory; and while standard errors are interpreted in terms of the normal distribution in chapters V and VI, the normal curve is not derived until chapter X. The use of Student's and Fisher's tables of t is described at length in chapter VI, "The reliability of differences," but instructions for entering the table when t is used to compare two unmatched groups are not given until chapter XII, "The analysis of variance." This book can hardly be recommended to research workers, for instructions for the use of formulas and tables are not readily accessible; nor to beginning students, for the number of sheer mistakes is larger than one expects to find in print. But persons who already have considerable background in statistics will find some of the derivations original and the sequence of topics in some cases provocative of new insight.

For additional reviews, see 2:227; for reviews of a preliminary edition, see 36:B205.

[253]

★PHIPPS, I. F.; PUGSLEY, A. T.; HOCKLEY, S. R.; AND CORNISH, E. A. **The Analysis of Cubic Lattice Designs in Varietal Trials.** Commonwealth of Australia, Council for Scientific and Industrial Research,

Bulletin No. 176. East Melbourne, Australia: the Council, 1944. Pp. 41. Paper. Out of print. *

J Am Stat Assn 41:135–7 Mr '46. Gertrude M. Cox. * This bulletin follows closely Yates' original description illustrating the recovery of inter-block information in cubic lattice designs published in 1939. The authors are correct in their statement that reprints of Yates' article are not readily available. A volume of the *Annals of Eugenics* cannot be used extensively by computers in a laboratory. Therefore, a bulletin such as this one provides a useful guide. The formulae in both articles are the same but the notation differs in minor details. To solve block components (*a*), (*b*), and (*c*) a series of separate tables 2, 3, 4 and 5 are constructed. This makes the computing instructions much easier to follow than those given by Yates. * From the standpoint of the applied statistician, the presentation in this bulletin is excellent. At each step, the mathematical discussion and formulae are followed by the corresponding numerical results from the example.

[254]

★Polya, George. **Exact Formulas in the Sequential Analysis of Attributes.** University of California Publications in Mathematics, New Series, Vol. 1, No. 5, pp. 229–39. Berkeley, Calif.: University of California Press, March 31, 1948. Pp. 229–39. Paper. $0.25. *

[255]

★Puffer, Ruth Rice. **Practical Statistics in Health and Medical Work.** Foreword by Hugo Muench. New York: McGraw-Hill Book Co., Inc., 1950. Pp. xiii, 238. $3.75. * (London: McGraw-Hill Publishing Co., Ltd.)

Am J Pub Health 40:1017 Ag '50. Elizabeth Parkhurst. This welcome addition to the small number of textbooks on public health statistics is unique in its approach to the problem of collecting and analyzing many kinds of data for the purpose of planning and evaluating the programs of a modern health department. Its emphasis is on the need for definition of objectives, for collection and analysis of data to answer specific questions, and on the role of the statistician as a member of a team of specialists working on a problem. It is not so much a book on statistical methods as on the application of these methods, based on the author's many years of experience as Director of Statistical Service in the Tennessee Department of Health. The book is particularly valuable for its discussion of prevalence and incidence of disease, and the comprehensive presentation of the methods used in "longitudinal" studies, first designed by the late Dr. Frost to describe the development of disease in observed populations over a period of time. The chapters on the handling of various types of records and the presentation of data are also excellent. The bibliographies appended to each chapter would in themselves make the book worth owning. * a book which should be equally stimulating to statisticians, health officers, and other public health workers.

J Am Med Assn 144:353 S 23 '50. The handling of statistical data in the definition of public health problems is an important subject, often neglected but well spotlighted in the discussion by Dr. Puffer in her book. The foreword well describes the purposes of the book itself and gives a good evaluation of this excellent contribution to the field of health statistics. * She gives some small attention to the general morbidity problem, with particular emphasis on the development and utilization of industrial data and the statistical phases of control programs. In discussing these points she is quite successful. There are, however, certain sections in which her statements are somewhat dogmatic and others in which they are too brief. For example, on page 70 in reference to a bar chart she makes the statement: "The addition of numbers within the grid at the top of a bar is not permissible because of possible deception of the reader." Proper use of numbers in bar charts will not necessarily be deceptive and they often can be helpful. On page 79 in discussing the estimation of annual increase of population she recommends the use of an arithmetic rather than a geometric progression, the most usually accepted form. On page 80 she makes the statement: "Ratios multiplied by 100 are percentages." This must not be interpreted as a definition, since percentages themselves are definitely ratios. In this instance either a correct definition should be given or the sentence deleted. The term "stillbirth ratio" is usually used in this country in reference to the formula given on page 84 which Dr. Puffer calls "stillbirth rate." Stillbirth rate is a term normally restricted to the ratio of stillbirths in thousands to total births rather than to live births. On page 86 she refers to a "corrected" death rate. This term might well be misleading unless a careful reader realizes that it is obtained from a standard population and is probably more properly called an adjusted or a standardized death rate. The word "corrected" is not well

chosen. Chapter 5 is entitled "Elementary Statistical Method." This name is rather strange for the material included, which is primarily a discussion of the rates and ratios used in vital statistics. Only the last section on standard errors is properly called statistical method, and this section is somewhat too brief for much help to a reader not trained in statistics. Reference should be made to the different excellent statistical textbooks available for a complete explanation of the problem here discussed. It might be well to modify the title to describe the content and to exclude the section on standard errors, which makes the chapter somewhat heterogenous. Dr. Puffer presents charts on page 104, and indeed in other instances, without any numerical scale. This is quite confusing and not consistent with the principles of charting which she states on pages 68 and 69. In view of the fact that this is a first edition and that later revisions will undoubtedly modify these points, it is well that a book of this type and of this caliber has been presented to the medical profession and to the health statistician to clarify their thinking on the problems which face them in giving advice on the allocation of funds for medical and public health research.

[256]

★REICHENBACH, HANS. **The Theory of Probability: An Inquiry Into the Logical and Mathematical Foundations of the Calculus of Probability, Second Edition.** English translation by Ernest H. Hutten and Maria Reichenbach. Berkeley, Calif.: University of California Press, 1949. Pp. xvi, 492. $12.50. * (London: Cambridge University Press, 1950. 94s.)

Nature 166:413–4 S 9 '50. Harold Jeffreys. The German edition of this book has had a considerable reputation; substantial revision has been done for the translation. * Probability is defined in terms of the Venn-Mises limiting frequency. The first problem is to show that this satisfies the axioms, and it is to the author's credit that he recognizes that this is desirable. He does it, but does not appear to see the magnitude of the price that he has to pay. It is well known that even for a random series the limit cannot be proved either mathematically or experimentally to exist; and the author does not assume its universal existence. He finds then that, to prove either of the addition and product rules, it is necessary to assume two limits of this type to exist. Thus, any development of the theory must rest on a complicated substratum of existence postulates, which are asserted for the cases considered but not as always true; hence, in any specific application it could be objected that at least one of the limits concerned may not exist and that consequently nothing relevant to that application has been proved. The author ridicules the alternative that probability is a primitive idea representing a degree of rational belief and exists as a relation between any pair of propositions. His argument against it, when stripped of rhetoric, seems to reduce to "A lot of beliefs are irrational; therefore there can be no theory of rational belief." He does, however, investigate seriously a "many-valued logic," which appears to be the same thing. The general postulate does guarantee that any hypothesis can be tested by means of the theory when relevant data arise; Prof. Reichenbach's caveats serve only to restrict the scope of scientific method without even specifying the cases where it is not applicable. The principle of inverse probability is proved subject to the restrictions made by the author—the prior probability is required to be based on previous knowledge, as in some statements in Karl Pearson's papers—but he fails to see that this would imply an infinite regress (*cf.* Bertrand Russell's "Human Knowledge"). He makes the usual onslaught of advocates of frequency theories on the "principle of indifference," the function of which was to state ignorance and give the applications a possible starting point. He even states that no modification that would meet one of his difficulties has ever been suggested—in fact, I gave one in 1931, and modifications for other cases have been suggested at various times since 1919. The book is difficult to read; for example, "theorem" and "axiom" appear to be treated as synonymous on p. 58, and there are far too many forward references. However, some of the comments are very apt. To some extent they overlap those in Bertrand Russell's "Human Knowledge," on which I comment in a forthcoming paper in *Mind*. There is abundant work to be done in probability theory, and philosophers can make and have made important contributions. However, these contributions will be better when more philosophers find time to attend to constructive developments in the rational belief theory within the past thirty years.

Sci 111:415–6 Ap 21 '50. R. v. Mises. This book is the English version of the author's *"Wahrscheinlichkeitslehre"* of 1935. Several changes—which, however, do not bear upon the

essential contents—are listed in the preface. Reichenbach's theory is an attempt to combine and to reconcile two different concepts of probability: the mathematical notion of numerical probabilities which underlies the so-called calculus of probability, and the entity of phenomena to which the terms *probable* and *improbable* of everyday language usually apply. The main characteristics of his conception are that he accepts the frequency interpretation in the calculus of probability without introducing a randomness concept and that he claims for the probability theory an over-all importance as being "the nucleus of every theory of knowledge" (p. v). The first chapters of the book are an introduction to the more or less elementary problems and methods of probability computation. Much use is made hereby of the modern notations of symbolic logic. What the reader finds here can be found in a more conventional form of notation in most mathematical texts. In fact, it is not difficult to prove that, if one writes down all natural numbers starting with 1, 2, 3, ...and continuing up to the highest 100 digit number, only 20 percent of these numbers will include more than 12 fives. But it is a long way from this arithmetical fact to the statement that in putting down one set of 100 digits at random one has an 80 percent probability of getting less than 13 fives. This gap cannot be bridged by any display of formulas of symbolic logic. It would require a clear-cut definition of what is meant by random, but the author has not given such a definition. The examples he uses to illustrate the theory are of a different type. He goes to great lengths, for instance (pp. 254–257), in dealing with the case of a Dr. B., who was suspected of murdering his wife in order to collect insurance benefits. The starting point is a statement of the insurance company that four out of five husbands who take out large amounts of life insurance for their wives do so with criminal intentions. After a lengthy calculation which takes into account several instances of possible murder the result reads: "The probability of murder, on the basis of the known facts, is therefore 84%. What makes this value even higher than the antecedent probability of 80% is the fact that the insured person died, and not of a natural death" (p. 257). Computations of this type are often used to discredit the calculus of probability in the public eye. The eighth chapter introduces a new idea under the heading "Theory of Probabilities of a Higher Level." Its main purpose is to justify the "inductive inference," *i.e.*, the rule that the frequency observed for a finite initial section of a sequence can be identified with the probability controlling the sequence (p. 329). It is not quite clear to the reviewer why the inverse probability, discussed in the preceding sections, should not belong to the probabilities of second level (*i.e.*, probabilities of a probability value). The last three chapters—9, 10, and 11—are entitled "The Problem of Application," "Probability Logic," and "Induction." In this field lies what the author apparently considers to be the main original achievement of his theory. The multivalued logic is another form of presenting the most elementary probability relations. "Quantitative truth" and "quantitative negation" can, in the last instance, be interpreted only in terms of frequencies. Reichenbach thinks that he needs this new formalism for his theory of induction. Here he discusses such questions as why Newton's law of gravitation has been accepted as a general law when it was checked only by a finite number of tests; why it was discarded in favor of Einstein's theory on the ground that it disagreed with observations in one single instance. He rejects the idea that the unification of theories serves intellectual needs—it simply increases their probability (p. 433). All kinds of scientific statements, each single argument and each comprehensive theory, has a certain assignable probability value, and "all the questions concerning induction in advanced knowledge, or *advanced induction,* are answered in the calculus of probability" (p. 432). These quotations and the following one must be given here without comment. The reader might wish to know what Reichenbach calls the rule of induction and presents in prominent print on page 446:

> *"RULE OF INDUCTION. If an initial section of* n *elements of a sequence* x_i *is given, resulting in the frequency* f_n, *and if, furthermore nothing is known about the probability of the second level for the occurrence of a certain limit* p, *we posit that the frequency* f_i $(i>n)$ *will approach a limit* p *within* $f_n \pm \delta$ *when the sequence is continued."*

No indication is given in the book about the magnitude of δ.

[257]

★RICE, WILLIAM B. **Control Charts in Factory Management.** New York: John Wiley & Sons, Inc., 1947. Pp. ix, 149. $2.50. (London: Chapman & Hall, Ltd. 20*s.*) *

Adv Mgmt 14:88–9 Je '49. Robert W. Merry.

* Chapters III and IV deal with the statistical

techniques * This material is written in the symbolism of the statistician, although the technical jargon is largely avoided. Most businessmen and others having no previous understanding of the statistical theory of a constant system of chance causes will probably wish to pass over these two chapters. The text will be largely beyond their comprehension. Those with some knowledge of the theory of probability who wish to know the derivation of the factors and formulae used will find two brief technical appendices. * Fifteen case histories of control charts in manufacturing plants constitute the material of the next chapter. * The last chapter is devoted to the problems of setting up a statistical quality control program in a company. * The principal contribution of the book lies in these last two chapters. The case histories should be of interest to businessmen seeking concrete knowledge of the type of help that can be expected from control chart analysis. The advice on instituting a quality control program together with the cautions on easy-to-make mistakes should be valuable to industrial statisticians who may wish to start such a program.

Gen Elec R 50:56 Je '47. A. V. Feigenbaum. * the statistics are clearly presented, there are several good industrial examples, and some of the basic thinking underlying modern Quality Control activities is effectively described. Perhaps the best feature of Mr. Rice's book is his discussion of how control charts may be geared into the perennial factory effort to determine and maintain the most economical costs of manufacturing its products. * [the book] can be of great benefit as a source of information for industrial personnel at large about Quality Control, and, as a result, in advancing the quality control cause * a great disservice will be done the book by its readers if they should consider it as attempting to portray the management aspects of an overall quality control program, as some of the descriptive matter on the book jacket seems to suggest. There remain several very wide gaps between the techniques presented in this book and the numerous methods used in the actual operations of Quality Control programs in modern industry; and, no doubt, Mr. Rice would be the first to agree to this statement. *Control Charts for Factory Management* is an able presentation of the statistics, philosophy and practical applications of the control chart tool of quality control, it does not pretend to be anything more than that and should not be so considered.

Ind Qual Control 4:30 Jl '47. Warren R. Purcell. * fills an important need for the busy executive who wants a picture of control chart techniques but whose schedule does not permit extensive study. Its well-proportioned perspective is valuable also to those who specialize in controlling quality. * The chapter on fraction defective charts will probably be the controversial part of the book. The impression prevails throughout that the author regards the upper control limit as the limit of the fraction defective of the entire product. To this reviewer, on the other hand, the upper control limit is the maximum fraction defective to be expected in *samples,* if the *product* fraction defective remains *substantially constant* at the value represented by the central line. The case histories are practical and realistic. Many are illustrations of the use of fraction defective charts. While Mr. Rice demonstrates in these cases the value of a logical approach to quality control problems, he does not....establish that the control limits have any value in the solutions to the problems presented, with one notable exception. The exception is the valuable observation that consistently poor operators need constant training and supervision, while good but erratic operators need occasional attention. The cases illustrating the use of charts for measurement are excellent illustrations of true control chart technique. Three of the cases are interesting illustrations of the extension of control charts to the fields of production volume, production flow, and cost study. Chapter 6 is one of the best contributions to the literature that this reviewer has seen. It is "must" reading for any one who has the responsibility of organizing a statistical quality control program. With excellent appreciation of the importance of jurisdictional jealousies and the influence of personalities, Mr. Rice points out the personal qualifications, training, and experience needed by the outside consultant, new employee, or old employee who embarks upon the project. The pitfalls and methods of avoiding them are admirably described.

J Am Stat Assn 42:482–5 S '47. Charles D. Ferris. * This book is well written and straightforward. It is quite evident that the author has had a good deal of experience in the field of quality control and in using the statistical techniques he describes. From the viewpoint of

a factory executive, it probably gives as clear an idea as any of the existing literature of the objectives of quality control and the manner in which it uses the control chart in the manufacturing process. This is particularly true of the introduction, Chapters 1 and 2, the case histories in Chapter 5, and those sections of the last chapter dealing with consulting, organization problems, and qualifications of quality control personnel. It is doubtful whether a vice president or manager of manufacturing will concern himself with the specific computations and interpretations of control charts or with the problem of reporting, publicity, and sound data and statistics. That is the job of the quality control engineer and his associates. Once the executive is aware of what can be done and provides for the organization and suitable authority, the details and results are in the hands of the quality control organization. At times the author speaks as though management were actually setting control limits and samples sizes. * The section on the usefulness of a consultant is an excellent one, and the author makes a fine point when he stresses the importance of keeping the quality control department independent of operating department responsibilities and orders. * The mechanics of construction of the $\bar{X}$ and R charts are very clearly set down. None of the theory underlying the limits is mentioned which fact will probably not interfere with the use of the techniques by factory personnel. The book is unique, however, in not containing a normal curve or explanation thereof. A schematic diagram of a distribution indicating the result of a casual system might have been helpful in this presentation. The fact that control limits are based on the independence of sample observations might have been stressed a little more explicitly. That part of the chapter dealing with p charts concerned with the analysis of a special study for assignable causes is very clear. There will be some disagreement in the section which deals with the setting of sample sizes for acceptance and rejection. The rule given on page 82 will necessitate unnecessarily large sample sizes if it refers to the process average as might be interpreted. If applied the formula $q^n = 1$ would seem more accurate and simpler than the one provided. The protection provided by the quality limit, L, on page 82 is not clearly described. I believe that when it comes to incoming inspection it is much easier and more precise to accept and reject in terms of $AOQL$ or Lot Tolerance protection. A control chart should, of course, be kept as a guide. The examples in Chapter 5 are best where they illustrate the use of control charts in finding assignable causes of variability in special studies. In the case of process control it is not necessary that incoming batches represent controlled quality in order that sampling be used as stated on page 97, and the acceptance number used here, considering the break even point, seems unduly severe. This writer would also have liked to see more emphasis on the operation of the control chart by the operator with the use of very simple charting techniques and the reestablishment of responsibility at the operator level. * One of the most instructive portions of this book, from the viewpoint of the quality control engineer, is the last chapter. The author provides some excellent advice on the problem of getting authority and proper publicity for quality control and presenting the results to every level of management. It has been the experience of this writer that observance of these sound administrative principles may well spell the difference between the success and failure of an installation. * may be read with profit both by those who wish to know what it may accomplish in the manufacturing phase and by those who would take part in carrying out the program.

J Am Stat Assn 42:485–6 S '47. N. Lloyd Johnson. In the preface to this book the author states that he has "striven to achieve both clarity and brevity." In this he has undoubtedly succeeded. Indeed it may be said, without exaggeration, that the book is written in an unusually attractive style. It is both easy and interesting to read. Such qualities are rare in statistical literature and deserve recognition when they occur. However, a book should have something important to say as well as an attractive way of saying it. It is in this respect that the present volume seems somewhat lacking. It is, therefore, to be hoped that it will be read and appreciated by those "business executives" to whom it is "particularly dedicated." So far as other classes of readers are concerned the contents of the book which are of most interest might have appeared as articles in periodical publications with greater advantage. * The fifth chapter is the high spot of the book. These fifteen case histories, discussed in a most engaging manner, provide pleasant reading and a valuable factual background. * These examples of the possibilities of statistical quality

control will probably prove more impressive to the readers for whom the book is mainly intended than will the more general arguments of the earlier chapters. In the final chapter the author has much sound advice to offer on the practical running of quality control. One dictum in particular should be ever-present in the minds of quality control propagandists. It is "quality control is not a religion." Obvious, perhaps, but the author has felt it necessary to say so, and it is a good thing that it should be pointed out. It is difficult to assess the value of Chapters 3 and 4. If the book is intended to be an advocacy of quality control for nontechnical executives, the inclusion of technical details in the construction of various types of control charts seems to be uncalled for. If, on the other hand, an introductory treatise for the embryo quality controller is intended, then the theoretical treatment is inadequate. It is also, in parts, definitely incorrect. We are, indeed, warned in the preface that "the mathematical statistician will see something to criticize from the viewpoint of exact statement." Even so, page 82 comes as a shock. Some details will be given, so that the reader may judge whether the deviation from exact statement is or is not excessive. It is desired to choose a sample "large enough so that at least 9 times out of 10 one or more defectives will be found." If $100\bar{p}$ per cent be the average percentage defective, orthodox theory gives the formula—$[\log_{10}(1-\bar{p})]^{-1}$ for the lower limit of sample size. The book gives the formula $(\sqrt{2-\bar{p}}+\sqrt{1-\bar{p}})^2/\bar{p}$. The sample sizes required by the first formula are (for $\bar{p}$ fairly small) only about 40 per cent of those required by the second. There are other instances where the deviations from exact statement have been so unnecessarily great as to confuse the ideas of the reader and to be possibly actually misleading. When one takes into consideration the fact that the best part of the book, the case histories, could with equal advantage have appeared in technical magazines, the value of the book as a whole must remain in doubt.

J Marketing 13:123–4 Jl '48. Lloyd L. Shaulis and Solomon Ethe. * a welcome contribution * the basic principles involved, with slight modifications, can be applied to marketing problems, to the setting up of sales quotas, for instance * this would involve setting up a standard of performance based on such factors as population within the sales territory, income, buying habits, *etc.* Using past sales records, reasonable limits of variation in monthly sales could be set up. Any month's performance falling outside of these limits would call for investigation. If management's sales goals are found to be too high in light of the statistical standard, the current selling techniques might have to be changed basically—more advertising, different media, or perhaps the product itself might be changed to meet consumer acceptance. Presently such applications of the theory of statistical quality control are rare. The control-chart technique....is not applicable to all problems nor does it automatically give final answers. The author cautions against its use except in skilled hands and of the necessity of sound judgment in interpreting results. The user needs not only to understand his tool and its use, but also the material to which it is applied; *e.g.,* the manufacturing or marketing processes involved. Its adoption will be limited pretty much to available qualified specialists and their ability to sell its product to operating personnel.

[258]

★Richardson, C. H. **An Introduction to Statistical Analysis, Third Edition.** New York: Harcourt, Brace and Co., 1944. Pp. xiv, 498. $4 00. *

J Am Stat Assn 40:397–9 S '45. J. H. Curtiss. The earlier editions of the book, which appeared in 1934 and 1935, enjoyed considerable popularity. The book was perhaps the best text of its kind then available. The picture in statistics has greatly changed since 1935 * this book is probably intended as a text in....elementary mathematical statistics * The contents cover what were formerly the traditional subjects for such a course, with various brief excursions into the field of elementary college algebra. Calculus is avoided, except in certain exercises and in the discussion of the Gaussian distribution as an approximation to the binomial distribution. * As a textbook in elementary mathematics, to be used for purposes of drill in formal operations, and as a technical basis for further mathematical work (but not necessarily in mathematical statistics), this book is well written and well organized. The algebraic exposition is skillfully arranged. Tabular forms and other similar devices are frequently used in clarifying derivations. The numerous exercises should give students plenty of practice in substituting in formulas and a good workout in elementary algebra and arithmetic. The book is obviously the work of a skillful and competent

teacher of college mathematics. But from the statistical point of view, the trouble with the book is that it is just about *fifteen* years out of date (the reviewer is not attempting to subtract 1935 from 1945); and in a field in which the methodology is advancing as rapidly as it is in statistics, this is a pretty serious criticism. Lip service is paid by the author to the newer concepts of statistical inference in two or three introductory passages, but when he gets down to business in the body of the text, he goes right back to the old *Handbook of Mathematical Statistics* and Rietz's *Mathematical Statistics*. Perhaps the references sound the keynote to this anachronism; Pearson's *Tables for Statisticians and Biometricians* is said to be indispensable for the advanced student, but Fisher and Yates is nowhere mentioned; and the one reference for "Chi Square" which is given in a footnote on page 416, is to the *Handbook* and to Pearson's original paper published in 1900. * a textbook in elementary statistics nowadays can hardly afford to omit *all* the following topics (as this one does): Analysis of variance, quality control, contingency tables, methods of solving the normal equations adapted to machine computation, Poisson distribution, and estimation by confidence intervals. Instead of these, we find a considerable fuss made over skewness, kurtosis (the usual error being made concerning the latter measure) the coefficient of variation, and how to interpolate for positional means. It is in the study of the relation between probability and statistics that the greatest advances have been made, and when the book skirts on such problems, the effect is quite disconcerting. The one chapter on probability appears late in the book, after probability and random sampling have repeatedly been mentioned previously. The chapter is a modest one and the treatment is mainly intuitive, but even with these limitations it seems to be going a little far in the direction of brevity to "prove" the composition and addition theorems by apparently assuming that the expected value of a random variable is exactly the value it will assume! Yet with this introduction, plus the students' imagination, it should certainly have been possible to discuss adequately a few of the simpler concepts of statistical inference, such as confidence intervals. The author accurately explains the meaning of a probable error as regards the relation between sample statistic and population parameter (except in the case of regression equation, where the concept of a population line of regression never makes its appearance and incorrect probability statements are made about the sample line), but when the idea of the confidence interval is completely set up and ready for the kill, he stays his hand. To be sure the words "confidence limits" are used in one place, but incorrectly, as signifying the probability levels of a distribution. Another consequence of the weakness of this book in probability theory is that no distinction whatever seems to be made between the conceptual bases of correlation and regression. It is therefore of course not necessary for the author to caution the student as to the basic logical difference between the variables X and Y in a regression problem. However, the author does issue various unexplained warnings from time to time, such as the following sinister statement made in connection with the standard and probable errors of the correlation coefficient: "Since the assumptions underlying these formulas are rather severe, they are to be used with care." (Just what the severe assumptions are, or how to use them with care, is left to the student's good judgment.) *

For reviews of earlier editions, see 38:B684 and 2:242.1.

[259]

★RICKER, WILLIAM E. **Methods of Estimating Vital Statistics of Fish Populations.** Indiana University Publications, Science Series No. 15. Bloomington, Ind.: Indiana University Bookstore, 1948. Pp. v, 101. Paper. $2.00. *

J Am Stat Assn 44:456–7 S '49. Charles M. Mottley. * There is a growing list of publications on the subject of the vital statistics of fish populations and a considerable proportion of the funds for fishery research is spent in this field. Dr. Ricker's work is one of the first attempts to bring together the body of modern knowledge on the subject. He has worked actively in this field himself. * Ricker devotes six of his nine chapters to the fascinating problems of deriving vital statistics from the results of marking experiments. He has included a useful "actuarial" appendix. It gives numerical values of the functions needed in this type of work, including the instantaneous mortality rate, the annual mortality rate and the annual survival rate. Although Dr. Ricker's work will be of most value to fishery "actuaries," others will find it extremely useful as a source of ideas and methods. Military scientists have made use of Volterra's treatment of the problems of com-

petition between species to develop combat models. Dr. Ricker's work may also prove to be useful in the apparently unrelated field of combat attrition. The work is undoubtedly a first edition. It is hoped that it will be enlarged. In future editions some mention should be made of the approach suggested by Dr. D. B. DeLury and this reviewer, which utilizes the data on the catch per unit of effort to derive direct estimates of the total population under certain conditions.

[260]

★Rissek, H. **Quality Control in Production: A Machine-Shop Manual on the Statistical Method of Controlling Product Quality During Manufacture.** Foreword by Frank Gill. London: Sir Isaac Pitman & Sons, Ltd., 1947. Pp. xvii, 181. 21*s*. * (New York: Pitman Publishing Corp. $4.00.)

J Am Stat Assn 44:574–5 D '49. H. A. Freeman. * an adequate set of tables, a fair index, a good bibliography * It is hard for me to say if this book is better or worse than its many competitors. Its statistical level corresponds to that now standard among quality control manuals; it must therefore be rated on its effectiveness in educating factory personnel. On this, I can only guess; my guess would be that this is a superior book, neither as facile or extended as some American manuals, but one which shows both that the author has digested his experience in industrial quality control and that he knows how to write about it. One novelty: A discussion of Tippett's dual control chart is included. In this plan, the sampling results of go and of no-go gauges are used separately, the difference between the two numbers defective being a good estimate of the dimensional average, the sum, a good estimate of dimensional variability.

[261]

★Robinson, H. F.; Rigney, J. A.; and Harvey, P. H. **Investigations in Plot Technique With Peanuts.** North Carolina State College, Agricultural Experiment Station, Technical Bulletin No. 86. Raleigh, N.C.: the Station, January 1948. Pp. 19. Paper. Gratis. *

[262]

★Robinson, Julia. **A Note on Exact Sequential Analysis.** University of California Publications in Mathematics, New Series, Vol. 1, No. 6, pp. 241–246. Berkeley, Calif.: University of California Press, 1948. Pp. i, 241–246. Paper. $0.25. *

[263]

★Roos, Charles F. **Charting the Course of Your Business.** Reprint of Section 1, Book 6, of *Reading Course in Executive Techniques*. Edited by Carl Heyel. New York: Funk & Wagnalls Co., 1948. Pp. 94. $1.00.

Mgmt R 38:224 Ap '49. Marcus Nadler. * So long as the sellers' market lasted, the principal problem confronting the American business man was that of finding the necessary sources of supply. Now, for the first time in several years, he finds himself again in the midst of a buyers' market, and he must therefore chart his company's course more carefully than has been the case since 1941. In view of these circumstances, Mr. Roos' new book is the answer to the business man's prayer. It is a timely discussion on charting a business and its setting and on the problems of scientific forecasting. It affords even the average business man, with little time at his disposal, the opportunity of setting up for himself certain series of charts and figures which he can readily follow and which can give him at least an indication of where he is going. This is certainly better than groping in the dark. It is a book which warrants reading by executives of large companies as well as by small entrepreneurs. The text is written in simple language and, with the exception of some of the mathematical formulae on pages 51–54 (which may prove somewhat complicated for the average business man), in a fashion which anybody can readily follow. Not only will the business man profit from careful examination of this study, but many economists who are professionally engaged in analyzing and charting the course of business should also derive great benefit from it.

[264]

★Rose, T. G. **Business Charts: A Clear Explanation of the Various Types of Charts Used in Business, and of the Principles Governing the Correct Presentation of Facts by Graphical Margins, Fourth Edition.** Foreword by Graham Cunningham. London: Sir Isaac Pitman & Sons, Ltd., 1949. Pp. xv, 126. 18*s*. *

J Royal Stat Soc 112:229 pt 2 '49. Too often charts and graphs are produced for business men who do not know what they want by clerks who do not know what they are doing. The standard of charting could hardly fail to benefit if managers would not only keep this book on their shelves for reference, but encourage their statistical clerks to become fully acquainted with its contents. Mr. Rose writes primarily for managers and executives, and is admirably clear as to the object of business charts and the advantages of various types for specific purposes. The directions he gives are marked by practical common sense, and even an untrained junior clerk should be able to put them into practice.

Statistical students, whether intending to enter business or not, will find this 4th edition a useful introduction to elementary graphic methods. It does not claim to deal with the presentation of advanced mathematical data.

For reviews of earlier editions, see 38:B691 and 2:250.

[265]

★RUTHERFORD, JOHN G. **Quality Control in Industry: Methods and Systems.** New York: Pitman Publishing Corp., 1948. Pp. xvii, 201. $3.50. * (London: Sir Isaac Pitman & Sons, Ltd. 20s.)

Adv Mgmt 13:181–2 D '48. Joseph M. Juran. [See 107 for joint review.]

Gen Elec R 52:57 F '49. A. V. Feigenbaum. * The book shelves and magazine racks have been filled with material on industrial statistics, at the expense of adequate coverage of other important phases of quality control. It is refreshing, therefore, when a book appears which addresses itself—at least in part—to some of these other issues. The first one third of *Quality Control in Industry* treats of such important topics as quality-control organization, economics of product quality, reports and records, and personnel training. Discussion is couched in general terms and is based upon actual industrial applications. The remaining portion of the book covers statistical methods. While the presentation of statistical theory contains little new material, the examples that it employs are practical and useful. Mr. Rutherford's book is more nearly a survey of selected quality-control topics than a detailed analysis of any of these topics. This is both its strength and its weakness. The book will be of interest to men and women new to this activity. It will not, however, be overly useful to quality-control practitioners, for whom its statistical materials may not be new nor its discussion of organization sufficiently fundamental.

Mech Eng 71:929–30 N '49. Louis C. Young. * For top management, the book should suffice for a large proportion of manufacturers of intermediate size: it would be particularly appropriate for those who supply others with parts and subassemblies and (possibly) raw materials. In the larger and more highly integrated companies, the text would serve best as a primer for quality-control foremen and their supervisors. * The average student of quality control, lacking industrial experience, would find the discussion of straight-line, staff, and functional organizations of decided value for the light it throws on the possible weaknesses of quality-control operations. *

[266]

★SCARBOROUGH, J. B. **Fundamentals of Statistics.** Boston, Mass.: Ginn and Co., 1948. Pp. vii, 145. $2.40. * (London: Ginn and Co., Ltd. 18s.)

Am Math Mo 56:274–5 Ap '49. A. T. Lonseth. * designed for a brief course in statistics at the United States Naval Academy. While this project has had to be deferred, the authors felt that their work might be useful to others. This will certainly be so. * About half of the text is descriptive (*i.e.*, non-probabilistic) statistics. * Most of this is done briefly and clearly, though the student might wonder just why certain quantities are important. The purity of the descriptive approach is somewhat adulterated in Chapter V, "Correlation." One reads (page 38): *"Simple correlation....is a mutual variation between two variables which is not accidental."* This apparent promise of stochastic developments is followed instead by straight analytic geometry—the least-squares fitting of a line to a finite set of points in the plane. The equations and formulas are properly derived; there is the proper final warning against identification of "correlation" with "casuality," but the gap between "non-accidental variation" and "least squares" remains unbridged. * Chapter VIII, "Sampling," is limited to large-sample theory. Some of the current words and phrases are to be found here, but even "parameter" and "statistic" are defined only in a footnote. * For the authors' original purpose, their selection [of topics] would seem to be a good one. For students of experimental science, the omission of small-sample theory is serious; fortunately, the authors do not leave the impression that pre-1908 methods constitute the final word. Those whose interest lies more in questions of inference than in techniques for displaying and summarizing data could wish for more probability, sooner, so that difficulties of motivation and of justification might have been put on a different level. * Format and cover are pleasing.

J Am Stat Assn 43:339–40 Je '48. Leo Aroian. * The book is remarkably brief. Simplicity and clarity are stressed throughout. * The originality in conception of the book must be highly praised. Undoubtedly it will be extensively imitated. The mathematics carries the burden of the explanations. Very few words are wasted. The authors exhibit considerable ingenuity in the development of the topics and

are at their best in descriptive statistics, excellent in their treatment of probability and sampling once their point of view is granted. They have not been afraid to drop many topics considered sacrosanct such as Sheppard's corrections. Many problems illustrate the main points of the text. A nice balance is maintained between theory and numerical computation. Yet there is a greater nod to the past than to the future. Fundamentally the reviewer disagrees with the authors' philosophy of testing hypotheses. Some intuitive explanation of the modern theories of probability as developed by von Mises and Kolmogoroff would be desirable. In many places too little explanation is given. Only two-sided tests of hypotheses are mentioned and needless to say nothing concerning Type II errors, the error of accepting a false hypothesis. * Some important topics omitted are significant figures, the range, *J*-shaped curves, the chi-square test of goodness of fit, analysis of variance, control charts, and small sampling theory. * The common error concerning α_4, the measure of kurtosis, occurs on page 33. * The final discussion on the limitations of the coefficient of correlation is good. * It is a pity that in the section on collateral reading no mention is made of the recent books by H. Cramer, H. A. Freeman, P. Hoel, A. Wald, C. E. Weatherburn, and S. S. Wilks. [See original review for minor criticisms not excerpted.]

J Royal Stat Soc 112:226 pt 2 '49. D. R. W. * The widespread use of range in connection with quality-control charts might have justified its inclusion. * An illustration containing twelve histograms of various shapes is particularly instructive. * No reference is made to the possibility of unequal variances, nor is the *t* distribution introduced. In fact, throughout the book, any detailed discussions of small sample techniques have been specifically avoided. * The main criticism of the work lies not so much with the method of presentation, which is both clear and concise, but with the choice of subject matter. For example, the omission of Chi-squared tests and contingency tables is unfortunate, and their inclusion might well have been effected at the expense of Tchebycheff's inequality, Bernoulli's theorem and the Gram-Charlier series. Despite the serious limitations imposed by the brevity of the course, more might have been accomplished in providing statistical techniques which could be widely applied to problems likely to be encountered by the technical student.

Math Gazette 33:152–3 My '49. J. Wishart. * A good deal of information is contained within its short compass, more or less of a didactic character, but it has merit for students that in addition to worked-out examples many problems are set for solution, the answers being provided * The book has been constructed on the principle that mathematical results should be proved. Since, however, the readers are not assumed to have a very high standard of mathematical ability, a great deal is omitted which might be considered proper to the subject-matter of even an elementary course on statistics. It may be doubted whether a good course can be given nowadays which does not include something of what is generally called small sample distributions, but these have been left out for the sake of brevity. A notable omission is the use of the Sheppard correction to the calculated moments of a grouped frequency distribution. A good deal of space has been given to the fitting of frequency curves, particularly the Gram-Charlier, which is only one of the ways of dealing with data that depart from normality. It is the experience of the reviewer that the statistician does not often find himself concerned with this problem, but requires to know about theories of estimation and tests of significance. In any case, when he fits a frequency curve he requires to test the "goodness" of the fit, and has a handy tool here in Pearson's χ^2 test, which unfortunately is not mentioned. So far as it goes this book should succeed in conveying to the reader something of what statistics tries to do, and part, at any rate, of the methods that have become standard. Its perusal should stimulate the reader to find out more from other sources.

Math Mag 22:216–7 Mr–Ap '49. A. M. Mood. Books in statistics written by statisticians usually turn out well while those written by non-statisticians usually turn out badly. Unfortunately practically all elementary books in statistics belong in the latter category; the present volume was written by two mathematicians at the U.S. Naval Academy. Apparently they made the mistake of letting themselves be guided by other elementary books in the field. The book is intended as a textbook for a brief course in statistics for students who have had calculus. It is clearly written and contains a wealth of exercises. Considerable material is packed into its 108 pages: frequency distribu-

tions, the first four moments, correlation, regression, binomial and normal distributions, Gram-Charlier series, and a few large sample tests of significance. Also there is an appendix on combinatorial probability, and tables of the normal distribution and its first four derivatives. The trouble with the book is in its selection of material. The main problem of statistics is uncertain inference: sampling theory, estimation theory, and tests of hypotheses. The book relegates all these fundamental problems to a brief final chapter. It chooses instead to emphasize the frequency tally, the class interval, the miscellaneous means, skewness and kurtosis, computational details, and the Gram-Charlier series. These topics are included at the expense of Student's distribution, the Chi-square distribution with all its many uses, and the most powerful technique the statistician has—the analysis of variance. The student who surveys statistics through these pages will not see it as the exciting subject it is, but merely as an insane accounting system apparently bent on reducing any number of figures to four figures. Although it now appears utterly useless to do so we are duty-bound to observe some of the ancient errors reproduced in this book. First of all there is the nonsense about skewness and kurtosis. Statisticians have been poking fun at skewness and kurtosis in their classrooms for years. They have buried skewness and kurtosis in their journals time and time again. Yet here they are again, not only hale and hearty, but of sufficient stature to be included in a severely limited selection of topics. Another thing statisticians like to exercise their sarcasm on is the band about a regression line bounded by parallel lines. This text does not deprive them of that opportunity. A favorite classroom sermon has to do with the sin of equating parameters to their estimates. The authors do just that on page 105. To me, page 105 is the saddest part of the book for here the authors commit two mathematical crimes. The second one is in leading the student to believe that an unbiased estimate of a function of a parameter may be obtained by using the same function of an unbiased estimate of the parameter. Of course every book has its little errors, and by emphasizing them a reviewer can give a bad impression of a good book. But the errors mentioned here are not of that category. Statisticians will immediately deduce that authors who can make such errors do not read the statistical journals, have not read Fisher's books, have not read the Neyman and E. S. Pearson papers, have probably not even read Karl Pearson. In short they have attempted to write a textbook in a field about which they are ill-informed.

[267]

★Schorling, Raleigh; Clark, John R.; and Lankford, Francis G., Jr. **Statistics: Collecting, Organizing, and Interpreting Data.** Yonkers, N.Y.: World Book Co., 1943. Pp. iv, 76. Paper. Out of print. *

J Am Stat Assn 40:399–403 S '45. Helen M. Walker. The publication of the first separate monograph on statistics designed for use as a high school text is a notable event * There is no doubt in my mind that ultimately some work in statistics will be taught in a large proportion of our high schools. However for two reasons I feel apprehensive concerning that development although I believe it to be inevitable. One reason is the almost complete lack of teachers who are competent both in the subject matter to be taught and in the art of teaching. * The second reason for apprehension is the fear that textbook writers—who have committed enough blunders in college texts—would write for the high school watered-down versions of poor college texts. This is exactly what has happened in a number of recent high school mathematics texts which have incorporated a chapter on statistics. The material is too often neither theoretically correct nor psychologically sound. After reading the monograph by Schorling, Clark and Lankford, I feel greatly reassured. The emphasis of the brochure is on interpretation, on obtaining and using statistical data to aid in making practical decisions, on ascertaining that data are comparable and relevant before comparisons are drawn. Relatively little emphasis is placed on formulas or computations. The data employed are richly varied and within the range of active interests of teen-age girls and boys. Pictures have been used effectively and they are pertinent, not merely something to divert attention from an otherwise dull page. The treatment of the normal curve as "a fundamental law of nature" is one of the most unfortunate features of the book. In my judgment the normal curve is an excellent topic to avoid in the ninth or tenth grade, no matter how large it may have bulked in college texts a teacher has studied. Certainly it is undesirable to create an impression that "you can be sure that if scattering data of this general kind do not come close to a normal distribution, then the sample

from which the data were obtained was not truly representative of the entire group" (p. 42). The book loses a great opportunity to help students acquire the general ideas of sampling variability and unreliability of measurement. The omission of any real attempt to develop these two concepts which are of such great practical importance is another weakness which should be corrected when the book is revised. Considerable caution is needed here to make sure that formal talk about standard errors is omitted and a genuine feeling for sampling variability is built up. It can be done, but not easily. Great resourcefulness has been shown in exploring statistical situations which are real to young people, in making them aware of the statistical nature of the world in which they live. The net effect of the text should be to create respect for statistical investigation, to develop intelligent "consumers" of statistics. Statisticians should be grateful that the first separate treatise intended for high school use is of such high quality.

[268]

★SCHROCK, EDWARD M. **Quality Control and Statistical Methods.** New York: Reinhold Publishing Corp., 1950. Pp. xi, 213. $5.00. * (London: Chapman & Hall, Ltd. 40*s*.)

[269]

★SCHUMACHER, F. X., AND CHAPMAN, R. A. **Sampling Methods in Forestry and Range Management.** Duke University, School of Forestry, Bulletin 7. Durham, N.C: the School, January 1942. Pp. 213. Cloth; paper. * For latest edition, see 270.

Ecol 24:414–5 Jl '43. Richard H. Blythe, Jr. and Joseph F. Pechanec. * should be helpful not only to the practicing forester but to anyone confronted with the problem of sampling plant or animal communities. The authors have certainly performed a good service by assembling in one place the essence of a large part of the widely scattered literature on sampling and organizing it into an exposition having logical continuity. * Probably foremost among the features that make this bulletin of particular value to the ecologist is that it deals with sampling problems especially familiar to him. * But unhappily the discussion of procedures is neither simple nor easily understood. True, the first chapter treats with the simplest basic conceptions of sampling, which an elementary reader can easily comprehend. But this brief discussion of fundamentals would not enable the reader easily to understand the more complex discussions that follow unless he already possessed a reasonable knowledge of statistics. The non-mathematical reader is further handicapped by the very frequent use of equations in developing the discussions. There is much valuable material in the bulletin that would be used by a large body of the foresters, range technicians and ecologists if it were more clearly expressed. * By and large, the decision on whether to sample systematically or randomly is not always in favor of random, as the authors of this bulletin would have the reader believe. Considering all aspects, the virtues of this bulletin more than outweigh its faults. It is a useful text on sampling for the ecologist as well as the practicing forester, more so to those with a fair knowledge of statistical techniques than to the elementary student.

J Am Soc Agron 34:957–8 O '42. J. F. P. * this bulletin....will be welcomed by those vested with the responsibility of sampling timber or range and pasture lands. * The authors, cognizant of the requirements for efficient sampling systems on timber and range lands have assembled many systems that are more directly applicable to the problems being confronted than was heretofore available. Some of the methods discussed which should find favor are (1) stratified or representative sampling; (2) simultaneous sampling of two or more populations; (3) representative sampling of diverse, but unknown, areas; and (4) regression in representative sampling. The range ecologist will be disappointed in the actual content of the bulletin, especially in view of the promise held by the title. The bulletin is replete with examples of sampling drawn from timber land management but is devoid of any examples drawn from range or pasture forage inventories or from range research. Nor is more than passing mention given to any of the specific problems of sampling ranges or pastures, the assumption being made that the problem is identical to that of sampling in timber lands. The dissimilarity of forest surveys and range or pasture forage inventories in type of characteristic being observed, character of sampling unit that it is possible to use, and ability to check ocular estimates still leaves personal ingenuity free play in adapting sampling systems suggested by the authors to specific sets of conditions. Many readers may find the authors' discussions of the different sampling systems and the reduction of the data to statistics rather difficult to master because of their distinctly mathematical flavor.

This is not serious, but it will deter from more widespread use of some systems advocated. We have pointed out what appears to be the major shortcomings from the standpoint of range or pasture inventories. To the forester interested primarily in timberland management, and to the mathematically inclined, this bulletin should be especially welcome.

J Forestry 40:663–4 Ag '42. Donald Bruce. * Schumacher and Chapman have performed a very real service in expounding methods of sampling that retain a sufficient element of randomness to permit valid estimates of sampling error and yet are distributed in such a manner as to estimate well whatever characteristic of the forest is being investigated. This is the first time that such methods have been assembled in a concise volume based almost exclusively on forestry problems. * Emphasis is given to the special treatment of small samples from limited populations, which are often ignored in elementary statistical texts. The principal subject matter of the book is divided into two parts. The first of these discusses various types of random sampling designed to determine the average of some single characteristic, such as volume per acre. * The second and final part deals with the use of regression in estimating. The methods explained are efficient in cases where the characteristic being investigated is relatively difficult or expensive to measure yet is closely related to some other characteristic which can be cheaply measured. * the use of differential calculus is infrequent and brief, but it is to be feared that many forest school graduates will find the going a little heavy in some of the chapters. This is not so much because the mathematics are involved as because they are continuous. Each line of thought is developed primarily by a series of equations accompanied by a little descriptive text. The result is admirably concise but will appear formidable to the mathematically timid. The book will be indispensable to the forest research worker who is inevitably concerned with the probable errors of his conclusions. Foresters engaged in routine measurements may not feel that they need adopt any of the procedures described but they will find the book full of stimulating ideas, which should be a part of every forester's technical knowledge.

Nature 150:196–7 Ag 15 '42. R. A. Fisher. * an excellent introduction to modern statistical methods, and its success in this respect seems to flow directly from the fact that the authors' aims are not academic, but are concerned only with a competent planning and handling of this aspect of practical forestry. The utmost care is taken to give the reader a clear grasp of the elementary concepts which all statistical work involves; but this does not mean that only unimportant ground is covered. * In respect of the factor $\left(1 - \frac{n}{N}\right)$ used in the variance of samples from finite populations, I would suggest that the student can gain a clear idea of its origin from the circumstance that sampling errors only affect his estimate of that fraction of the whole which is not included in the sample. The technical note on this point thus seems unduly heavy.

[270]

★SCHUMACHER, F. X., AND CHAPMAN, R. A. **Sampling Methods in Forestry and Range Management, Second Edition.** Duke University, School of Forestry, Bulletin 7, Revised. Durham, N.C.: the School, June 1948. Pp. 222. Cloth, $2.50; paper, $2.00. *

J Am Stat Assn 44:575–7 D '49. Walter H. Meyer. The first edition of this valuable treatise appeared in January 1942. The newly published revision attests well to the thoroughness and exactness of its predecessor, since scarcely a correction was found necessary in text, formulas, tables, or figures. One new chapter has been added, titled "Double sampling of individuals in representative sampling of groups; systematic computations." The authors must again be commended for assembling in one volume the variety of sampling techniques most appropriate to the complex fields of forestry and range management and for suggesting many methods of approach to sampling procedures in cases where earlier and current "attempts to extract sampling error are more akin to the art of the conjurer than to scientific assay." * If any criticism is to be made of this book, it must be toward the restriction indicated by the title, for surely the methods advocated will find a far broader application than in the fields of forestry and range management alone. * The forester may regret the scant attention that is given to systematic sampling, to which he has been addicted ever since the beginning of the use of sampling procedures in the estimation of wood volumes and which he probably will never discard completely. He knows that systematic sampling, especially with the double stratification that he uses (one for unit areas, the other for

forest types) gives good results and he is supported in this view by the few known investigations involving the checking of 100 per cent enumerations by various types of sampling schemes. These have shown that systematic sampling gives results of high precision, superior to random or stratified random sampling under at least several typical conditions, but a precision which cannot be proven on the basis of the data and under current lack of a suitable mechanism of analyzing systematic samples. Since the publication of the first edition of this book, several authors have investigated the case of systematic sampling, including Osborne, Yates, Madow and Madow, Finney and others, and have demonstrated its suitability under certain conditions. The [illegible] of systematic sampling in forestry are so many from the administrative and financial point of view (and this is probably true also of many other fields) that statisticians could well devote more time and effort in developing a suitable theory. Part III deals with the particularly valuable tool of regression as an aid in indirect estimation. *

For reviews of the first edition, see 269.

[271]

★SEALY, E. H. **A First Guide to Quality Control for Engineers.** Ministry of Supply. London: His Majesty's Stationery Office, 1943. Pp. 38, 7 inserts. Paper. 1s. (New York: British Information Services. $0.35.) * [The 1945 edition is a reprinting of the 1943 edition.]

J Am Stat Assn 40:403–4 S '45. W. Edwards Deming. * written, "primarily for use by engineers....as a downright working guide for the man who, having decided that quality control is worth trying, wants to experiment with it on his own shop floor. It is not the object of this book to sell quality control to anybody, or to demonstrate the advantages....Neither....to detail any of the mathematical theory which lies behind the subject...." The book accomplishes these aims with distinction and with the unmistakable masterful touch of an author who understands the underlying mathematical theory and has contributed to it, but who does not flaunt it; one who also knows his way around in engineering and shop-practice, and appreciates what is needed in the way of clarity. The book explains the author's "modified control limits," which successfully meet most of the difficulties encountered in the use of control charts in shops where toolwear gives rise to a continual drift in the dimensions being cut. * The booklet is filled with numerous illustrative examples, concisely and clearly discussed. * The book....is without doubt a distinct contribution to statistics in industry. The Ministry of Industry, Dr. Sealy, and colleagues, deserve the thanks of statisticians and industry for making it available.

[272]

SIMON, LESLIE E. **An Engineers' Manual of Statistical Methods.** New York: John Wiley & Sons, Inc., 1941. Pp. ix, 231. $3.00. (London: Chapman & Hall, Ltd. 24s.) *

J Am Stat Assn 36:574–5 D '41. Eugene L. Grant. * avowedly a book for practical men—engineers and production supervisors—who are not specialists in statistics. Although written primarily for use in instructing ordnance officers, it is an excellent working manual for anyone confronted with quality control problems. The many possible applications in defense industries make it particularly timely. * The author does a good job of stimulating the necessary reader-interest in statistical methodology by frequent critical comments on alternative methods which interrupt his explicit directions for the use of his formulas, diagrams, and nomographic charts. One might perhaps question whether this book ought to have been called an *engineers'* manual; this title may have both good and bad results. A possible good result would be to stimulate engineers to read the book; this is true even though some important engineering applications of statistical methods (for instance in hydrology and in telephone trunking) are not mentioned. However, it would be unfortunate if the title should discourage statisticians generally from reading this work. The author's evaluation of the uses and limitations of old and new statistical theory in a variety of situations, and his special contributions on such matters as sample size and the use of the range as a measure of dispersion make this useful reading for anyone concerned with the design of experiments or the interpretation of their results.

Mech Eng 64:496–7 Je '42. Andrew I. Peterson. * We are fortunate in having....[this] experienced exposition added to the still inadequate literature on engineering statistics. * Consignment and process inspection are discussed separately, but the latter could have been extended usefully by more complete illustration of the fundamental control-chart techniques. An understandable reluctance to overlap the adequate publications of the American

Society for Testing Materials and the American Standards Association may have been present, but there seems to be a loss of development for the average reader. Another suggestion would extend the sampling discussion to include situations where the sample size is an appreciable fraction of the lot size, increasing the reliability of estimates. * As a refreshing improvement upon other presentations, Mr. Simon has included a practical and competent discussion of the problem of selecting the size of sample. It can be reported from teaching experience that few questions appear more frequently, or create more confusion. The author also presents the technique of reducing sample size through tests of increasing severity, although again it would seem that additional case solutions would have provided greater clarity. * In view of the prevalence of technical problems requiring objective interpretation of the significance of differences between independent groups of observations, the author presents the more directly useful criteria for attributes and variables. Discussion is provided regarding the limitations of these applications and the use of conservative assumptions where *a priori* information is particularly lacking. The emphasis given control analysis, a prerequisite to any reasonable confidence in the interpretation of these tests, is a commendable precaution not ordinarily evident in technical research. Even more critical attention might have been desirable, space permitting, particularly as regards the errors associated with the acceptance and rejection of null hypotheses. Added usefulness would have derived from a treatment of the simpler experimental designs, whereby the errors arising from anticipated or potential assignable causes are offset or minimized. * Notable is the inclusion of the use of successive differences for estimating standard deviation freed of the effects of assignable and predominant causes. This may prove to be useful in many ways for industrial research. * Another useful technique, briefly illustrated, is the arrangement of data for the estimation of the precision of a specific operation of measurement. Because of its wide importance, more illustrations and applications could have been used, pointing out the problem of reliability and justifiable meaning to be attached to any estimate of precision from a limited set of observations. * The book is a welcome contribution to engineering statistical methods, aimed at the engineer with little background of statistical theory. However, the occasional reader may have some reservations as to his ability to grasp essential meanings in some cases, or to apply the procedures safely, without a modest, preliminary background in statistical theory. Mr. Simon's material has been particularly valuable in our work at the College of Engineering, New York University, for some hundred students annually, in undergraduate, graduate, and engineering defense training courses.

South Econ J 8:513 Ap '42. J. M. Clarkson. * The explanations given in the book are by no means complete enough to make it suitable for teaching. By means of examples, the author explains the use of several charts (furnished with the book) in forming a basis for accepting or rejecting a lot of articles from which a sample is tested. These examples are described in great detail, but no attempt is made to explain the theory underlying the reading of the charts. The usefulness of the book as a statistical manual could be increased by deleting a large portion of the expository material, and including a section on Analysis of Variance. As a guide to sampling procedure, it is probably adequate. Four appendices are attached to the book. In them some discussion of the mathematics involved in the construction of the above-mentioned charts is given, and in one of them is described a system for the control of quality in a manufacturing process, with instructions for the use of the system.

[273]

★SMART, L. EDWIN, AND ARNOLD, SAM. **Practical Rules for Graphic Presentation of Business Statistics.** Columbus, Ohio: Bureau of Business Research, College of Commerce and Administration, Ohio State University, 1947. Pp. xii, 86. $2.00. *

J Am Stat Assn 43:341–3 Je '48. Rudolf Modley. * the authors do not discuss why something should be done in a certain way. They rarely present alternative methods of presentation; they only give the rules and leave it at that. There can be little doubt that a simple book of this nature is badly needed today. The use of charts has been increasing rapidly and many businessmen need quick and simple guidance on how to draw charts. Unfortunately, "Practical Rules" cannot be recommended as filling this need. There are several reasons why it does not. (*a*) The proof of a chart is in its looks. The least we can expect from a book on graphic presentation is that the charts are well

laid out, well designed, and fit harmoniously into the book. This is not the case in the book under review. Nearly all the charts look awkward; they lack proper balance within themselves and on the page. There is poor selection of size for lettering and poor weight selection for rulings and curves. The instructions on lettering sizes (p. 6) are insufficient, instructions on grid and curve weights (p. 34) limited to "light" and "heavy." Unnecessary or incorrect rules, as for instance, "that the grid will be wider than it is long in somewhat the same proportion as 5 is to 3" (p. 7) or that pictorial symbols should be "mere outlines with little detail" (p. 48) also make it more difficult to obtain clear and forceful charts. (*b*) This leads us to the second shortcoming of the book. Instructions are usually given as if there were "generally accepted standards" of chartmaking. While there are some such standards it is obvious to all of us who deal with charts that effective presentation calls for considerable flexibility. Most of us will make trial layouts before we draw up a chart. We do so because this permits us to make adjustments in the many different elements which go into a chart. We reorganize or eliminate some elements, we emphasize others, we adjust dimensions and sizes of lettering until we are satisfied that the chart is truly effective. Only then do we begin the final draft. If the authors had tried harder to make the draftsman understand what one can "get out" of a chart by different treatments instead of giving a set of seemingly inflexible rules, a more helpful book would have resulted. (*c*) The authors state that they did not want to "give the pros and cons of various practices." (Actually they have done so occasionally displaying a preference for 100 per cent component bar charts over pie charts and absolute component bar charts.) * an objective listing of the advantages and disadvantages of certain types would be essential in a practical book for those who cannot be expected to judge all the elements which go into making a chart correct and effective. Alternative ways of presenting the same set of data would also have been helpful. * (*d*) This reviewer has spent about twenty-five years in pioneering the development of pictorial presentation of statistical data. The shortcomings of the book under review naturally become most clearly obvious to him at this point. Pictographic presentation is advantageous in a limited field. These limitations in regard to audience, accuracy, and cost should be stated if we are to give a prospective chartmaker practical help. If the chartmaker decides for pictographs he will have to follow a set of simple rules; the authors give one of these and leave out all others. Several ways are available to duplicate pictorial symbols so that charts can easily be prepared. They can be photostated, photo-offset, type-stamped, or rubber stamped. Symbol sheets are sold by some organizations. None of this is mentioned in the book. The stencil suggested in the book is not being used by any chartmaker known to this reviewer. The statement that "pictorial charts are more effective if the classification is qualitative" is not correct. There is ample literature in existence on pictorial presentation to have avoided the textual and graphic shortcomings in this section. (*e*) A short book of this type needs a bibliography. Many readers will want to know where to turn for more information. * the American Society of Mechanical Engineers....published....*Time Series Charts—A Manual of Design and Construction*....in November 1938 * The authors could have performed a real service to students and businessmen if they had tried to popularize the more important elements contained in the manual. At present this little volume, *Time-Series Charts,* is still the best guide for those who want to draw charts of the conventional type.

[274]

★SMITH, EDWARD S. **Control Charts: An Introduction to Statistical Quality Control.** New York: McGraw-Hill Book Co., Inc., 1947. Pp. xi, 161. $3.00. * (London: McGraw-Hill Publishing Co., Ltd. 15*s*.)

Chem & Eng News 26:1478 My 17 '48. Ralph H. Munch. * an introduction to the use of control charts primarily for executives, production workers, and others who should have a general understanding of them but who need not be experts in their use. It should serve this purpose well, in general. Its weak point is that there is no adequate discussion of the limitations of statistical methods. It assumes the availability of measurements of suitable accuracy and shows how to treat the data, neglecting to note that in many practical problems the error of measurement may be large compared with the variability of the material and that, in such cases, one must distinguish between the two. * A new feature of this book is the use of a table devised by Prof. Smith to eliminate necessity for calculating spread values

for control limit charts for fraction defective. Interesting and instructive exercises are provided to help the student become better acquainted with the use of control charts. *

Gen Elec R 51:57 Mr '48. A. A. Merrill. * While not exactly a popularization, it does an excellent job of simplification. In a space of just 143 pages, Professor Smith outlines the subject in a truly painless fashion. In fact, he doesn't mention "sigmas" or "standard deviations" until page 132. The type is large, the style is readable; yet it may not satisfy one who prefers to see detailed derivations of all formulas. However, it should appeal to those who are not familiar with mathematical statistics; to those who would like to gain a working knowledge, a speaking acquaintance, with the subject in a minimum length of time.

Ind Qual Control 4:28–9 Mr '48. John A. Henry. * the simplification of the spread of control limits by referring to it as $\pm Y_A$ and $\pm Z$ is in the long run an unnecessary complication of the standard nomenclature. The latter is, of course, properly introduced a bit later. Professor Smith has done a good job of showing how control limits and specification limits are related, and how to squeeze the last bit of blood out of a tight specification. However, to a beginner, it might appear that every process is in a life-and-death struggle with tolerances. While this is far from true, the emphasis on close tolerances is probably well made, for most chart applications will be made under those conditions, real or imagined. * It is possible that many production men would disagree with Professor Smith about the relative value of the averages and range charts. The maintenance man and trouble shooter frequently uses the range chart for his guide, whereas the process inspector is more concerned with the average level. * The opening chapter provides a basis for some serious thinking. From Shewhart's book to the present day, various authorities have sought to present the basic concepts and definitions in an ever-clearer fashion. If a major fault could be found in the book, it is that of oversimplification at this point. A definition of statistical control should have in it somewhere an implication of a constant system of chance causes. Eventually, if one is to grasp the significance of the control chart technique, one must face this idea and have it out. It seems better to give a definition that cannot be comprehended immediately, but is worked out as a purpose of the book rather than to give a substitute definition that does not stand up under subsequent study. * It may never be possible to write a perfect book for the busy executive on such a technical subject. Chapter 1, which is his chapter, could well have included some of the typical problems that a control chart would help to solve, when faced with a production or inspection decision. While this deficiency of economic and philosophical ideas may keep the book from being of maximum benefit to the management group, the technical portions are admirably suited to an in-plant training program.

J Am Stat Assn 43:343 Je '48. Joseph M. Juran. * There is a good discussion of the use of control charts for averages, ranges, and number or fraction of defectives. Visual aids in the form of charts or tables are well prepared. The exercises are well chosen. The claim that the book is "a test for the busy executive" is wishful thinking. In this work, and for that matter, in others, there is little evidence that the authors have truly grasped the quality problems of the industrial executive. Industry's problem has been and still is to make product to meet specifications. The statistical methods, if they are to be grasped by industry, must be presented as a means to the solution of that problem. The emphasis must, in the first instance, be *not* on (*a*) how to achieve controlled processes; the emphasis must rather be on (*b*) the fact that through a controlled process it is easier to make products to meet specifications. To a statistician, (*b*) seems only too obvious; ergo the executive should take (*b*) for granted, and thus only (*a*) remains to be learned. The precise opposite is true. The practical problem is to convince the executive of the truth of (*b*). Even after he is convinced of (*b*) he will ordinarily not be concerned with (*a*); instead he will delegate the learning of (*a*) to another. With the exception of the unrealistic first chapter Professor Smith's book can well serve as a supplemental text for undergraduate engineers.

J Am Stat Assn 43:343–6 Je '48. Mason E. Wescott. * Chapter 1 is probably the best chapter in the book from the point of view of the audience to whom the book is addressed. * One may very well take exception to parts of the definitions given, but on the whole, they are acceptable for the purposes intended. The statement that *"A production process is said to be producing goods of satisfactory quality if 99.7*

per cent of the items are satisfactory in quality" is, to this reviewer, the kind of a statement he would rather not see used with the emphasis it is made to carry here. The remaining chapters are, for the most part, well organized and clearly presented. One becomes conscious of a tendency to emphasize details rather than to paint the picture in broad outline. The latter treatment would have seemed more consistent with the objective of "selling" the subject to an audience which is not supposed to be interested in details. * (*a*) There is an irritating looseness with which the word "normal" is used. Such phrases as "normal, symmetrical distribution," "normal average," "normal and approximately symmetrical frequency distribution," "normal process" occur repeatedly without the benefit of any consistently adhered to definition; in fact, without any "definition" at all! Unless the reader has unusual insight or sophistication, he may very well end up with the happy delusion that everything will be just dandy if only it can be described as "normal." The word is simply overworked in the last four chapters without reserving to it the distinction it rightfully possesses in statistics. (*b*) It is the opinion of this reviewer that on pages 48–52, and elsewhere in subsequent discussions, Professor Smith overplays his hand in the matter of testing control against product specifications. In the first place, the practice of putting "danger limits" (three-sigma limits for individuals) on a chart for averages is questionable, particularly if the chart is to be kept at the machine. Exhibiting the to-be-expected spread for *individuals* on a chart for *averages* simply invites trouble, because the operator finds it hard to understand why he must keep the points within the narrower band set by control limits for averages when the "danger limits" are way out beyond this band. In the second place, the discussion manages to convey the impression (although the contrary is explicitly stated on page 52) that there will frequently be hair-splitting closeness between a "danger limit" and a blueprint specification which has to be resolved before a controlled process can be adjudged in satisfactory control. The criterion described is not in error: it simply overemphasizes a relatively unimportant point. Time might better have been spent in showing how to estimate the per cent of production likely to be out of tolerance when control is not satisfactory, and in discussing more fully the problem of balancing the cost of sorting and/or rework against that of making process or specification changes that will yield control safely within acceptable blueprint tolerances once the optimum capabilities of the process have been determined. (*c*) The discussion in Chapter 4 uses the word "lot" where the word "sample" would ordinarily be preferable. The beginner reading this chapter must surely experience a sense of confusion when, after digesting 21 pages in which he has had the word "lot" drilled into him at every stage, he suddenly discovers on page 106 that a *box* full of beads is a "lot," but a *paddle* full of beads is a "sample," and that now it is the *sample* that is to be inspected 100 per cent rather than the *lot* as he has previously been led to expect! Evidently the author intended this chapter to deal with attribute inspection for process control rather than for acceptance sampling, although, of course, the two are not mutually exclusive. But if inspection for process control is intended, it would seem more consistent and realistic to characterize a "day's production" (which the author says must be inspected 100 per cent!) as a "sample" from the cause system represented by the production stream than it is to describe these items as a "lot." Furthermore, it would be entirely possible for the beginner to get the impression from this chapter that 100 per cent inspection (in the ordinary sense) is required to keep a fraction defective chart. Many plants exercise very satisfactory process control through the maintenance of fraction defective charts based on samples that are a very long way from being what the average man has in mind when he finds himself reading about 100 per cent inspection of a *lot*. It is the *sample* that is inspected 100 per cent, and it would be wiser to say so, rather than to use language that can be so easily misinterpreted. Table II appears to be potentially useful in simplifying the calculations required for control limits on p and np charts. Its use is amply illustrated in Chapter 4. The typography is good; tables, charts, and diagrams are well done and legible. The book is easy on the eyes. Except for a few missing punctuation marks, only two errors were found * *Control Charts* could prove useful as a text for a short training course at an elementary level. As a textbook for untutored home-study or as a "quickie" for the casual reader who wants to see the forest but not the trees, it is the opinion of this reviewer that the book is likely to prove disappointing.

[275]

★SMITH, G. MILTON. **A Simplified Guide to Statistics for Psychology and Education, Revised Edition.** New York: Rinehart & Co., Inc., 1946. Pp. xiv, 109. Paper. $1.25. *

J Am Stat Assn 42:195–6 Mr '47. Edmund Churchill. This book was primarily designed for use as a supplementary text for psychology and education courses for which formal training in statistics is not prerequisite. It is perhaps difficult to write a really good book for this purpose, but the fact that Professor Smith's book consists largely of a retelling of an old and oft-told story—the material added since the first edition was not particularly new when that edition was published—justifies our expecting a clear, sound, well-organized book. We have, instead, a book containing more than its share of errors of fact and interpretation and which, in addition, suffers from the lack of an index, from the lack of references both to source materials and to more complete elementary discussions of the material treated here, from the author's failure to handle his illustrative data in the best fashion possible, and from a rather insipid set of exercises. It should suffice to mention some of the book's weak points. The whole question of the acceptance of false hypotheses is largely ignored. An apparent confusion in the author's mind on this subject leads to a fallacious argument as to the interpretation of small values of chi-square (p. 89) and to dubious statements elsewhere. The null hypotheses that two samples come from populations with equal means and that they come from the same population are considered equivalent (p. 57). A group of individuals is judged to be homogeneous simply because it is not obviously heterogeneous (p. 12). The extremely dangerous suggestion is made that one can assume experimental and control groups to be similar with respect to many non-experimental factors if only they contain 50 or 100 individuals (p. 7). True, Smith says this only about "noncontrollable" factors, but the examples he uses are noncontrollable only if one insists on samples so large that proper matching becomes all but impossible. It is argued that small samples may yield misleading results (p. 6) as though this were not also true of samples of any size. The effects of "moderate amounts of skewness" are discussed (p. 16), but no guide is given anywhere as to what constitutes a moderate amount of skewness. The procedure for testing the significance of a product-moment correlation coefficient (p. 76) is faulty, and the formula for the standard error of a rank correlation coefficient (p. 74) is wrong. This book is free from some of the errors which frequently appear in psychology-education statistics texts; nevertheless, the book is of decidedly limited usefulness.

J Am Stat Assn 42:196–8 Mr '47. H. M. Johnson. * [The purpose of this book] is largely to enable the reader to pass courses based on textbooks that are already inexact and in many respects false and misleading. In so far as it succeeds it tends to strengthen and perpetuate the superstitions which the original authors proclaimed. Its merit in this respect is otherwise a detriment to the student. Let us, however, consider some of these superstitions. The first one is that the Gaussian law describes "the normal, *or most common* distribution of *measures* ....when the data are derived *from a large and unselected sample* (*i.e.,* chosen at random, or by chance)." (The last italics are his, the others mine.) Height and weight he mentions as instances. Although a normal distribution may fit an actual distribution of some human traits throughout a limited range of experience, nevertheless, it is quite probable that because of intrinsic characteristics, the trait cannot possibly be normally distributed. Let us recall a few characteristics of a truly normal distribution: (*a*) The X-series must be continuous. (*b*) The distribution is symmetrical about the mean. (*c*) It is symmetrical about the mode. (*d*) Its range is unlimited. (*e*) The probability of a measurement falling between any pair of X-values is described within the imprecision of sampling by the Gaussian equation. (Of course this condition implies all the others.) Let us admit that according to theory, *if* certain conditions are approximated, a distribution of *sampling-means,* of *standard deviations,* of *differences between two means* can be described and predicted on the assumption that the function in question is normally distributed. But in respect to the *original measurements* this is not generally true. Heights of men are not in fact normally distributed—nor can they be—because they cannot satisfy condition (*d*). Weights of men cannot be normally distributed because they fail conditions (*c*) and (*d*). The number n of accidents accruing to N operators in a specified number of years, miles, or operations cannot be normally distributed because it fails con-

dition (*a*). So does the number of successes in N throws of n dice. The distribution of intelligence quotients fails conditions (*a*) and (*d*). Is it possible that the ages of human beings at death *could* be normally distributed? Is it credible that in a culture such as ours, the ages of the bridegrooms on their wedding-days could be normally distributed? Of course they aren't. There are some traits, such as eye-dominance (which is measured by the number of times in so many chances that the subject uses his right eye for sighting), the distribution of which is U-shaped, thus failing condition (*c*), and necessarily failing conditions (*a*) and (*d*). Choice-reaction times, as I have found, fall into multimodal distributions even when as many as 900 reactions are made with a given hand; as one of my students found, this characteristic does not smooth out when N becomes 2500. There is a superstition, supported in this book, that if a sample population is large enough and if the measurement of the trait in question was properly made, then the distribution will approximate more and more closely to normality the larger N becomes. An example occurs in the discussion of "Grading on the Curve." It seems to me that the student should be made to understand that for any trait there may be *some* ideal form of distribution that is most appropriate to fit the data; that the most appropriate form can be derived from the several moments of the distribution and by the interrelations between the constant κ and the two β-constants. I would not include this among the problems to be solved in the first course, but the student should be made aware of its existence, and he should be told that it can be solved without very much labor. He should be reminded also that the normal distribution is only one among many competitors; and he should be impressed that whatever the most appropriate type may be, as one progressively enlarges the sample while holding to the original mode of sampling, the empirical results will fit the most appropriate type more and more closely, and the less appropriate types more and more loosely. And one very inappropriate type may be the normal distribution. Indeed, it may be questioned whether this guide-book, as well as the books to which it is a guide, may not be placing far more emphasis on significances of differences between means, *etc.*, than the subject matter justifies. A distribution is not adequately described merely by its mean coupled with its standard deviation unless we have proof that it is normal. Of course, an expert, given these two constants, could reconstruct the best fitting normal distribution in perhaps an hour, only is he likely to do it? Why not present the gross measures in a cumulative frequency table or graph, and obtain the quintile, decile, or centile scores directly? If two distributions are to be compared, present them side by side and use Pearson's test for homogeneity. My own students learn to do this in the first half of their first semester, and some educational experts rate me not very high as a teacher. Chapter 6 deals with index-numerology. If the student is convinced by it, he believes firmly that an individual's standard scores or z-scores in two or more different traits can be added, compared, averaged, to yield a meaningful result. He may not instantly notice that each of them is a pure or abstract number, denoting exactly nothing, and that a set of such numbers however treated denotes exactly nothing—unless and until a meaning is imposed on it by correlation. It takes a good while to unteach a student who has been brought up in this superstition. Principles of classification and of sampling receive scanty attention in this book. So does the discussion of *matching* individuals in two selected samples according to one or more traits. In fact it is not even suggested that if n traits are considered then two individuals are not really matched unless they are matched with respect to all n traits simultaneously. Of course this makes for 2^n ultimate classes, even if one merely dichotomizes according to each trait. Still, if we have 80 traits with 10 possible values of each, the number of ultimate classes is 10^{80}. But, since the traits are intercorrelated, most classes will be empty, and enough of them will contain enough members to enable us to work on them. To summarize: although the book has merit as a guide, it nevertheless guides the reader toward acceptance of some vicious doctrines and beliefs.

J Ed Psychol 38:314–5 My '47. Chester W. Harris. * One of the tables....added is an original one that makes it possible to estimate readily the standard error of a biserial r. * The attempt to give students a "short-cut" to statistics often results in setting up a number of precepts that the student is to memorize or to refer to at appropriate times. * The concept of "sparing the student" and of "making devices plausible" suggests the tone of the volume. This point of view leads to a number of statements

in the text that are likely to be misleading to students. The exercises at the end of Chapter 7, for example, ask the student seven questions that cannot be answered. If the student does, faithfully, work out the percentage of the cases falling above and below certain points in these distributions of achievement test scores that are represented only by means and standard deviations, he is likely to come out with a reinforced idea of the magic of the normal curve. It should not be too much to ask that students in elementary statistics be given some understanding that a normal distribution is a special case and that markedly skewed distributions of test scores and of grades are often desirable. The chapter on grading on the curve, however, reinforces the idea that grades should be normally distributed; and one or two remarks at other points in the volume emphasize this. Finally, the concept of teaching that is implicit in this volume leaves much to be desired. On page 10, for example, the author says regarding an instructor who is "supposed" to have given an intelligence test to his new class: "He wants to get a rough idea as to whether he will be teaching just another average class, whether he will have to struggle to get his ideas across, or whether he will have to be on his guard against an excessively bright group of students who will be constantly catching him up on careless slips. He also wants to get a rough notion as to whether the class is of fairly uniform ability or whether there will be a large and annoying difference between the worst and the best students, with the result that what he says may pass over the heads of some but may bore the brighter members of the class." It is hoped that students who expect to teach will not take from this volume the impression that individual differences are annoying, and that addressing remarks to classes constitutes teaching.

Psychol B 45:181 Mr '48. David A. Grant. * Smith's book has a number of good points; *e.g.*, experimental orientation, natural introduction to some topics by means of examples, and exercises. But these good points are, unfortunately, out-weighed by a plethora of meaningless statements, pointless statements, and outright errors. To give a few examples: to state that "age to nearest birthday" scores are "mathematically more precise" than "age to last birthday" scores (p. 9) seems meaningless if not incorrect. It seems pointless to remark that "There is no simple explanation of these last two percentages; they are derived by integrating the normal curve between certain limits. But this need not concern us here" (p. 33). Also if any instructor is enlightened by the "Note for instructors" on p. 54, he is in desperate need of a decent elementary course in statistics. Errors, though seldom egregious, are numerous. The *PE* should not be "used interchangeably with *Q*" (p. 33). The rank-difference coefficient, rho, is not "best suited to studies involving a small number of cases" (p. 73). Although usually *very accurate* on the interpretation of confidence intervals, Smith slips up on the asymmetry of the interval for true percentages other than 50 (p. 62) and makes another type of error with respect to the confidence interval for chi-square (p. 89). On p. 80, we learn that a high validity coefficient indicates validity only if accompanied by high reliability coefficients. And so it goes. There is probably a need for a short "Guide to Statistics," but the reviewer feels that the quality of this book is not high enough for it to merit extensive use.

Q R Biol 22:248 S '47. A. Chapanis. * As a text this has limited usefulness. It is probably too lengthy "to supplement the material in general and laboratory courses" and too short and sketchy for a course in elementary statistics. The weighting given the various topics leaves one with the impression that the author prepared it for some particular course he happened to be teaching. Chi-square, for example, receives much more space than does the product-moment correlation, although the latter is unquestionably the more important technique for the student's needs. The product-moment correlation is treated in such cursory fashion, in fact, that the student will only learn how to compute it for ungrouped data. The meaning and interpretation of a correlation coefficient and the concept of a regression equation are merely mentioned in passing. The author's style is clear and the text is readable. It is unfortunate that the contents are not better balanced.

For reviews of the first edition, see 38:B697 and 2:271.

[276]

★SMITH, JAMES G., AND DUNCAN, ACHESON J. **Elementary Statistics and Applications: Fundamentals of the Theory of Statistics, [Vol. I].** New York: McGraw-Hill Book Co., Inc., 1944. Pp. x, 720. $5.00. * (London: McGraw-Hill Publishing Co., Ltd. 40*s.*)

Am Math Mo 52:448–9 O '45. J. L. Vanderslice. * Calculus is used sparingly. * The book is of considerable dimensions, the introduction alone occupying 157 pages. * A valuable chapter on sources goes as far back as the Domesday Book and is particularly complete as regards U. S. government publications of a statistical nature. * Higher moments receive an unusually complete and lucid treatment. Change of class interval, arrangement of work sheets, and short cuts in computation are discussed in great detail and in a thoroughly practical way. * Noteworthy [in Part 3] is an excellent critique of the Laplace and von Mises concepts of probability, leading to an acceptance of the "intuitive-axiomatic" approach in the form exposed by J. Neyman. * A laudable point....is the carrying of a single set of data through various aspects of a statistical analysis. * A chapter on sampling, statistical inference, and confidence limits includes a tabulation of the standard errors of the more important sampling statistics. Diagrams and clear explanations take the place of rigorous derivation. There are 176 pages devoted to multivariate analysis, starting with simple regression and correlation and running the gamut of multiple and partial correlation into a discussion of the normal frequency surface. No pains are spared to clarify this rather confusing field. For example, detailed work sheets and diagrams and a precise attention to notation lead one through a two and a three variate analysis up to a final tour de force in four variates. * The description of normal frequency surface includes excellent perspective figures and a detailed evaluation of the undetermined coefficients in terms of the fundamental parameters. * Notable [in Part 5] is a paragraph on adjustment of indexes to bench marks with presentation of a method used by the Bureau of Labor Statistics. * For use in higher order trends orthogonal polynomials are given a very practical discussion. * A final relatively short division deals descriptively with forecasts, a subject which the authors judiciously term an art rather than a science. * Very few misprints or misstatements were noted, none of them serious. There are no exercises. The book is neither written by mathematicians nor designed primarily for mathematicians so one must overlook a certain lack of mathematical elegance sometimes apparent. The book's most striking positive characteristics are its heroic comprehensiveness in content and references, its clear elementary exposition, and its richly detailed illustrative material drawn from real life.

Child Develop Abstracts 19:191–2 O-D '45. * more than adequate addition to an evergrowing list of textbooks on elementary statistical methods * A very good chapter on the art of forecasting with statistics * Although the illustrations are drawn from a variety of subjects, the slant of the book is toward the economic field. It is plainly designed for classroom use, for an instructor is needed to help the student overcome such defects as this first edition contains. Among these is an unhesitating use of algebra and calculus, although a number of pages are unnecessarily spent on the elements of permutations and combinations. One wishes that some of the introductory pages had been devoted to the use of significant figures and the elements of numerical computation, and that greater stress had been laid on when and how to apply the various statistical methods described.

J Am Stat Assn 40:138–9 Mr '45. Edward E. Lewis. Considered as an exposition of the chief statistical methods, this volume has much to recommend it. The coverage of topics is adequate, details of calculation are given in full with attention to the organization of worksheets, and well selected charts illustrate the text. Many minor features will appeal to the careful teacher. Bivariate charts (*e.g.*, morbidity rates as related to age) are presented for what they are, and not as oddly-shaped frequency distributions. The term, guessed mean, is abandoned. The logic of the Doolittle method is made clear. While one may have certain objections to the discussion of methodology (for example, just what mathematical background is assumed?), such defects are for the most part matters that may be remedied, if necessary, in the classroom. The book, however, should be judged on a different level. With the admirable purpose of showing the student that the subject concerns real and important matters (not "just numbers") the authors have included a considerable amount of interesting historical material. With this good start in the direction of "realism," one wishes that they had followed through with more discussion of concrete issues in the main body of the text. While actual data are used, there is little in the way of comparative analysis. * The introduction of more "interpretations" throughout the discussion of methodology would have driven home the point

of the historical material and made the book a greater innovation than it is. * the nature (and limitations) of statistical inference should certainly be emphasized in showing the student "what statistics is about." This section of the discussion (in Part III) treats (*a*) the elements of the probability calculus, (*b*) the normal curve in its "binomial" aspect, and (*c*) certain types of inference, handled on the whole in a very sketchy fashion. * one wonders whether this introduction to the subject will give him a clear view of the nature of inference, or any idea of its fundamental role in scientific work. The defects of the book are largely those of not doing full justice to the sound ideas apparently held by the authors. Certainly, in its present form, it is worthy of careful consideration by prospective users.

J Pol Econ 54:279 Je '46. John H. Smith and Frances A. Marans. * compares favorably with other good texts in statistics and contains some features which are not usually found in general texts. Topics which are given special attention include the three important concepts of probability, derivation of the normal equations, orthogonal polynomial trends, normal bivariate surface, and linear regression functions for all choices of dependent variables. Since the scope of the book is so broad, it is not surprising that some parts of it should need improvement. For example, a number of misleading statements in the treatment of graphical presentation are probably due to the common failure to distinguish correctly between amount of change and rate of change, between distance and slope and between rate of change and relative rate of change. Another type of shortcoming can be found in the section on measures of skewness, where too many technical devices are presented with inadequate indication of the purposes which each might serve. While the authors have presented the mathematical parts of the subject with commendable clarity and thoroughness, they have presented with even greater effectiveness the introductory and nontechnical material of Part I. The opening chapter on the place of statistics in the arts and sciences is enlivened by notes on the development of statistical methods and bits of excusable optimism concerning their contribution in these fields. Charts, tables, schedules, instructions, and definitions are accompanied by sensible, lucid discussion of sources, collection, and presentation of data.

For additional reviews, see 278; for reviews of Volume II, see 277.

[277]

★SMITH, JAMES G., AND DUNCAN, ACHESON J. **Sampling Statistics and Applications: Fundamentals of the Theory of Statistics, [Vol. II].** New York: McGraw-Hill Book Co., Inc, 1945. Pp. xii, 498. $4.25. * (London: McGraw-Hill Publishing Co., Ltd., 1946. 34*s*.)

Accounting R 21:112–3 Ja '46. James E. Dugan. * not written for those who desire a non-technical exposition of the subject, but for the serious student of statistics. To follow the argument of the book, a background of mathematics is highly desirable, though probably not absolutely necessary. * This book seems to have covered the field of sampling theory thoroughly. * The authors....discuss the interesting and frequently occurring problem of the sampling fluctuations of percentages where there are more than two possible outcomes, *e.g.* not only "yes" and "no" answers but also "undecided" answers. This analysis should be of interest to those who are interested in the reliability of public opinion polls. As a textbook to fire the enthusiasm of the student for the application of statistics to real life problems this book cannot compare to some of the more specialized works which tell how these tools were applied in the analysis of the yields of corn, the size of litters of pigs and similar practical problems. However, as a reference for the mathematical derivation and the mathematical characteristics of the tools of sampling it should serve a useful purpose.

Am J Sociol 51:573–4 My '46. Morris H. Hansen. This book....contains a good presentation of the distribution of various statistics in samples and of the methods of drawing inferences from samples, but does not, as its title might imply to some, contain an adequate presentation of the theory and practice of sampling from finite economic and social populations. * The discussions of theory are accompanied throughout by many numerical illustrations. The most important of the sampling distributions are derived; the physical and geometrical interpretations that accompany these mathematical derivations should be most helpful for students not too facile in the use of the mathematics involved. Some of the discussions of sampling distributions of statistics are presented with especial clarity, as, for example, the presentation of the limiting distribution of

the binomial in chapters iii and iv and of the joint sampling fluctuations of the mean and standard deviation in chapter xiv. On the other hand, there are several specific points where further clarity of presentation is needed, as, for example, in some of the discussion in chapter viii on the testing of hypotheses. In spite of the general excellence of the book, the authors' treatment of the fundamental notions of sampling as applied to finite populations is confusing, if not faulty. Actually, only a very small part of the book is devoted to this subject, with apparently no attempt on the part of the authors to deal adequately with it. However, from the title and some of the material presented, readers might be entitled to assume that this aspect of modern sampling theory and practice is covered. In particular, this is true of parts of chapter viii, entitled "A Preview of Sampling Theory," when considered in conjunction with the material presented in the other chapters. There is no reference, however, to the principles that must be considered in such aspects of sample survey design as the definition of sampling units, subsampling, optimum allocation of sampling to strata, double sampling, estimation problems and criteria of good estimates where the distribution is unknown, cost functions, the use of varying probabilities in sample selection, and various other devices that have proved highly effective in maximizing reliability of returns and minimizing costs in sampling from finite economic and social populations. There is a discussion in chapter viii of some of the methods that are used to obtain random samples, both from finite and infinite populations. While this has a number of excellent features, it is confusing at some points. For example, the statement is made that "random sampling is the only method so far devised that permits logical inferences about a given population," where the authors define random sampling to be a method such that all possible samples are drawn with equal frequency. This restriction is, as a matter of fact, much too strong; inferences about a given population can be made from a sample if it is known what the probabilities of the inclusion of any sampling unit are, even if these probabilities are not equal. Again, in a discussion of what the authors have referred to as "ordinal selection" it is stated that if a reporter of a college newspaper visits every tenth room in a dormitory, and if each dormitory is so arranged that each entry has ten rooms, it might happen that he would visit only a first floor room in each entry. The authors conclude that the preferred location of the rooms visited might give a definite bias to the sample obtained. Thus they fail to distinguish between the concepts of bias and variance; for (as is frequently the case in practice) if a random starting-point is used and every tenth room is visited thereafter, the sample will be unbiased, although it is true that there are other means of sampling in such a situation that are more efficient, *i.e.*, that will yield a smaller sampling variance. The discussion of natural selection and its assumed equivalence to random selection seems to dismiss lightly many of the more serious problems of drawing inferences from samples. An error which is likely to mislead many readers is contained in the following quotation: "An organization investigating public opinion, for example, may send an agent to a given locality where the first dozen people he meets, of the sort whose opinion is desired, may be taken as a random sample of the given class of people." To call such a selection "random" is certainly to pervert the meaning of the word. The discussion of purposive selection in the chapter, on the other hand, and its relation to random selection is well done, though brief. The volume is relatively free of typographic errors, and those that occur should not trouble the careful reader. For the most part the book can be read by persons not familiar with mathematics beyond college algebra, although facility in algebra and in mathematical reasoning is necessary. On the whole, it can be commended as a straightforward and useful presentation of what is conventionally regarded as modern statistical theory, with numerous illustrations that add to the clarity of presentation.

Am Math Mo 52:576–7 D '45. J. L. Vanderslice. * A 22-page introduction sets forth briefly those definitions and basic concepts of the first volume which are essential to the present one. Thus it can be read independently of the first, particularly by advanced students or research workers. * an excellent discussion of the Gram-Charlier type A series, cumulants and all, presented according to the same pedagogical pattern. Noteworthy is a short lucid comparison of the assumptions underlying these two approaches. * The distinction between the cases of known and estimated population variance is brought out with some unusual diagrams. * The final division of the book opens with the multi-

nomial distributions leading up to a clever and admittedly non-rigorous derivation of χ^2. * Quite novel is the joint study of mean and standard deviation * Just about every question that can be raised in connection with pairs of samples is discussed: difference between percentages, means, variances, correlation coefficients, and regression statistics. * plenty of real-life examples are worked through to illustrate procedures. The chapter on analysis of variance is particularly instructive. Without developing highly specialized techniques the various fundamental procedures are presented through successive analyses of a set of student grades into more and more component variances. A short meaty concluding chapter, rich in references, introduces the reader to the difficulties of the problem of non-normality. * The lack of exercises would seem to limit its use in the classroom. A number of irritating misprints and misstatements indicate some careless proofreading. * The authors are economists, not professional mathematicians, and have bravely set about writing a book which was to be rational, comprehensive, even scholarly, yet be completely understandable to a reader having meagre acquaintance with the calculus. In pursuit of this last aim they sometimes become repetitious, sometimes confuse with excessive particulars, but more often they succeed in giving the reader a better working knowledge of the material than would a more concise and sophisticated presentation. Many of the artifices used to circumvent relatively difficult mathematics cannot help but clarify the subject, even to the initiated, by opening up new viewpoints. Some of these seem of general pedagogical importance. The book should help destroy the vacuum between purely descriptive texts on advanced statistical methods and formal treatises on the advanced mathematical theory.

Child Develop Abstracts 20:55–6 F–Ap '46. Recent years have witnessed a flood of elementary statistics texts and a number of rather advanced mathematical treatments. There have been lacking the in-between books that will bridge the gap between the two; the text under review will fill part of the need rather adequately. * Simple language and simple illustrations are employed for the most part, a thing the authors were wise to do even though the book is intended for second year students in statistics. Defects of the book lie mainly in the too-brief treatment accorded such subjects as the analysis of variance and problems of non-normality. While the authors introduce modern statistical theory—maximum likelihood estimates, errors of the first and second kind, unbiased estimates, likelihood ratios, *etc.*—and show thereby a familiarity with the contributions of Hotelling, Fisher, Neyman, and others, they devote an unproportionate amount of space to such statistical tools of another day as the Pearsonian and Gram-Charlier systems of frequency curves. Omitted altogether are quality control and methods of determining the size of sample one ought to take. Nevertheless, the authors are to be complimented for a job well done. Teachers of intermediate statistics will find the book a great help.

J Marketing 10:429–30 Ap '46. * The Gram-Charlier system is well described, but the Pearsonian system receives rather inadequate treatment. * Adequacy of treatment, and the level of mathematical preparation required, vary greatly throughout the book. Certainly the reader who does not come equipped with elementary calculus and a knowledge of gamma and beta functions will find himself at a disadvantage.

Q R Biol 21:216–7 Je '46. Margaret Merrell. * This book pulls together a great deal of material which is scattered through the literature and presents it in a clear and convenient way. It is much more comprehensive on the subject of sampling than the majority of statistical text-books available, and on the whole the selection of topics is good. It would seem likely to prove to be a very useful book for both teaching and reference. With regard to the section on frequency distributions, it seems regrettable that the method of transformation of the variable is not included, since it is one of the most useful and simple methods available. It is not mentioned in this section, although reference is made to it in the last chapter of the book under "Indirect Attacks on the Problem of Non-Normality." Here it is stated that in certain cases the logarithmic transformation of the normal curve may readily solve the problem of non-normality. This approach is not developed, however. In the earlier section on frequency curves, a distribution of weights of Princeton freshmen is fitted by both the Gram-Charlier curve and the Pearson Type VI curve with rather unsuccessful results, so that it is concluded: "Apparently, owing to the sharp peak in the center, the given data cannot be well

fitted by a smooth curve" (p. 152). This sort of statement is always dangerous, and in the present case, the logarithmic transformation of the normal curve gives an excellent fit, and is a simpler curve, as to number of constants, than either of those used. In a number of places in the book, percentages are used as if they were proportions or probabilities, and on p. 190 this leads to an erroneous formula for β_2 in the point binomial, since the formula as quoted is correct if p_1 and p_2 are probabilities, but not if they are percentages, as stated. There is no bibliography, but there are frequent footnote references to original papers. These are not, however, as numerous as one would like. Student, for example, does not appear in the author index, which seems a rather serious omission in a book written under this title. A bibliography at the end of each chapter would be a distinct addition. More than [illegible] the points of disagreement with the presentation which have been mentioned are the many features of the book which recommend it. These include the statement of assumptions, the inclusion of derivations where possible, and the directing of attention to abbreviations and omissions in the mathematical argument where necessary. It is emphasized that problems of sampling are more than testing hypotheses but pertain also to getting observations and to making estimates from them. The book should be very useful to students who are finding out what sampling is all about, as well as to more advanced students who will undoubtedly appreciate having so much of the material brought together in one place.

Sci 103:462 Ap 12 '46. Raymond Franzen. * a very well-presented combination of advanced statistical method and both elementary and advanced sampling theory. It is intended for advanced students and research workers and is gauged at a level which makes a thorough knowledge of elementary statistics a prerequisite to its enjoyment and comprehension. However, granted a thorough training in the elements of statistics, basic concepts and definitions in advanced theory are clearly presented. Symbols are well defined, and the scope of mathematical treatment is chosen in a manner which makes the volume very valuable as a text and as a reference book. * Parts II and III deal with important sampling considerations not usually found in statistical texts. The advantages and necessities of random sampling are discussed, and a very careful treatment of the practical difficulties encountered in the use of random sampling is included. *

For additional reviews, see 278; for reviews of Volume I, see 276.

[278]

★SMITH, JAMES G., AND DUNCAN, ACHESON J. **Fundamentals of the Theory of Statistics, Vols. I and II.** New York: McGraw-Hill Book Co., 1944, 1945. Pp. x, 720; xii, 498. $5.00; $4.25. * (London: McGraw-Hill Publishing Co., Ltd., 1944, 1946. 40s.; 34s.)

Am Econ R 35:969–73 D '45. Charles A. Bliss. * First a few comments on Volume I. The point of departure is variation, first "static variation," then "dynamic variation," *i.e.*, time series. On this note the authors build their analysis. As they claim, considerable care was taken to make sure that the logical exposition does not set too rapid a pace. The more difficult topics are delayed in their treatment even when logical arrangement might suggest their being handled earlier, yet all done with sufficient skill that the parts are smoothly blended into a clean and consistent progression. The book abounds with useful footnote cross references to specific pages, and if the decision to use a pedagogical rather than a logical outline is the reason for this happy practice, the by-product was of unforeseen value. The book has a forbidding appearance, for considerable experience in mathematics would seem to be a prerequisite to its classroom use. Actually, the authors avoid complete mathematical demonstration of all points and frequently beg a question as being beyond the scope of the text, and probably wisely so. Whether the book is feasible as a general text will be revealed by classroom experience; in this reviewer's opinion there is no reason for students expecting to concentrate in statistical work to find it prohibitively difficult. Correlation is developed from Pearson's product moment approach in a section characteristically entitled "Study of Bivariates and Multivariates." As a teaching device it may be questioned whether this method is as efficient as the variance approach, although it is well presented here and leads smoothly into the general discussion. The analysis of time series section is notable for its discussion of rational and for its strong section on fitting of trends, which includes a welcome chapter on orthogonal polynomials. Treatment of seasonal variation is less thorough despite the wide use of the technique. In this section, as well as throughout the book, there are interesting notes on the historical

background of the techniques under discussion. The second volume is a welcome statement, in what is for the most part nontechnical form, of the theory of frequency curves and random sampling. Its focus is on the theory, and that theory is built up step by step with considerable skill. While there is little that is new in the book, it is valuable to have its systematic presentation of material hitherto found in rather scattered form. That the book is designed as a teaching vehicle is evident in the pains that have been spent upon orderly development of ideas. Use is made of the technique of setting up a mathematical model and subsequently relating the model to actual experience situations. The mathematics burden is somewhat heavier in this second volume than in the first and the practice is followed of inserting mathematical appendices to chapters where they seem to be desirable. Extensive appendix material is included covering basic needs. * It will be disappointing to the general student that the authors give relatively little attention to the technique of the analysis variance. Though this approach is covered, ramifications are not developed, nor are there many practical illustrations of its use. This relatively slight treatment of analysis of variance and the meager mention of the problem of design of experiment give something of a clue to the character of the book under review. It is not a practitioner's book in the sense, for example, that Snedecor's book is. Illustrative examples for the most part are the familiar problems of age or grades of college students, or the more or less classic problem of the life of electric light bulbs. The approach is theoretical and attention is paid to the systematic development of the theory rather than to the exploration of solutions to practical research problems. Yet it must not be thought that Smith and Duncan have failed to provide an excellent book. They have without question given us a usable textbook for the orderly development of the theory of sampling. The student who goes through a course using this text will have firm grounding and much of the background necessary for the understanding of current sampling procedures, at least so far as they rest on random sampling; but for modifications of these procedures or for the practical background of research work, the student must expect to look elsewhere. To return to the thought expressed in the opening paragraphs, training in statistics must be focused in the light of purpose. If this reviewer is correct in believing that the basic curricular purpose behind most elementary statistics instruction today is not a desire to develop a knowledge of statistical methodology but to develop skills in the imaginative use of figures, then no textbook is satisfactory which concentrates solely on the ramifications of technique. But where the intent is to provide instruction for the purpose of training a man in research procedures based on statistical techniques, an entirely different type of textbook is called for. In such a program of instruction the Smith and Duncan book might well find a place.

J Am Stat Assn 40:534–6 D '45. W. Edwards Deming. * A large amount of ground is well covered in both volumes * The first book can undoubtedly hold its head up among all elementary books; the second among all books on sampling. * does not attempt to go into modern sampling techniques * Both books give an excellent approach to the elementary ideas of sampling from a stable universe, but they leave untouched the whole class of problems wherein one deals with instability and requires a different approach, leading him into tests for randomness, the Shewhart methods of attaining randomness, and the important distinction between finite and infinite sampling. In the study of causes (infinite sampling), even a complete count must be interpreted as a sample. In spite of a long and excellent introduction to statistical matters, the student is not told what is going to be expected of him if he plans to be a statistician. The point of view in both books is rather for the economist or other scientist who wishes to improve his ability by learning something about statistics. This is an important aim, but falls short of inspiring people to become statisticians, or to explain where the statistician belongs in relation to other professions. * There are long chapters on the Gram-Charlier series and the Pearson curves, but it is not clear where their importance lies in sampling. * One aspect of sampling that seems to be neglected in all texts is the matter of choice of sampling unit. The books contain formulas, and these formulas contain constants belonging to the universe, but nothing is said about choosing and manipulating the sampling units so as to give values to these constants that will produce small sampling errors. * The authors' treatment of judgment or purposive selection is admirable, especially where they say (p. 185), "Samples of this kind depend largely on the judgment of those making

them and are worth just about as much." Sampling for public opinion is mentioned on p. 330 without an explanation of how the data are usually collected; and the calculations that are made on the poll for Roosevelt and Willkie leave the unsuspecting reader with the impression that randomness and the binomial series are applicable. The problem is fraught with difficulties that are not mathematical, and hardly a more misleading example could have been picked out. The notation will disturb many people—two different sets of type for sample and universe, much like scalars and vectors in plain and bold face type. It is a bit unusual in print, but may become unobjectionable with use. In the classroom, however, problems will arise, although a wavy line under a symbol is satisfactory to indicate bold-face type. The books definitely bear the pleasing imprint of scholarly study. Books like these are not produced in a hurry. *

J Am Stat Assn 41:259–62 Je '46. John Wishart. * The first book is arranged on more or less orthodox "nonmathematical" lines * A very great deal of groundwork is covered, and the book is particularly full on the questions of the gathering and presentation of statistics. The reader coming fresh to the subject will learn a great deal of what statistics is about, although it is quite clear that in these days this will not be enough, and he will therefore be required to go on to the subject matter of the second book. This is implicitly recognized by the numerous forward references to the second book. This raises the question of whether it is intellectually satisfactory to leave so many questions unresolved until a more advanced stage in tuition is reached. To some extent the books fall between the two stools of providing self-contained texts for an elementary and a more advanced set of readers. * It might have been better to have planned the whole as one standard text, while indicating at the same time what sections could be omitted on a first reading, or by those who were prepared to take on trust the derivations of mathematcial formulae, being content if they knew the basic principles on which tests were based, and how they worked. * such a method would have avoided a good deal of the repetition that has gone into the second book with the commendable object of making it self-contained. The second book does not appear on a first reading to be nearly as good in construction as the first. True, it contains a great deal of sound argument, not usual in the ordinary text, on the inferences that can legitimately be made concerning the population parameters from a knowledge of the sample statistics, and it is clear that the authors have studied this question and the work of Pearson and Neyman very thoroughly. But the book is somewhat uneven as a whole, conveying the impression that questions which have specially interested the authors, and which have doubtless been in consequence worked out in great detail in the laboratory, are reproduced in full, while in others the treatment is somewhat sketchy. Since there is little in the modern theory which is not dealt with, it is surprising to find such a small author index, and to note the absence of a number of eminent names, surely the easiest way of finding what has been left out of the book. It must have surprised the authors to read in W. Edwards Deming's review that "the second is not a textbook in mathematical statistics." The present reviewer thought on examining it that it was intended to be such a text; the present criticism rather refers to the uneven "weights" attached to the different aspects of the subject. It is doubtful whether a long explanation of the distributions of samples of two by means of an arithmetical model is needed when the full composite distribution of mean and variance is later derived; on the other hand it is somewhat startling to find in chapter 12 that mathematical methods are laid aside and Fisher's distribution of r merely quoted. Somehow one feels that a text should be either the one thing or the other. *Either* these distributions should be quoted, explained and illustrated, giving the same treatment to all, *or* they should all be derived as well. Another example is the goodness of fit distribution. The impression is left on the reviewer's mind that the authors are not yet sufficiently at home in the synthesis, and therefore exposition, of the formidable amount of mathematical theory that goes to make up the present-day theory of statistics. There is no reason, however, why with a good deal of revision in a subsequent edition the book should not prove useful for the class of student for whom it is intended. The opportunity could then be taken to correct a fairly large number of minor errors of one sort or another that have no doubt already been spotted. A few of the more important may be set down here. On pages 125–26 the .95 point has been read from table 8 instead of the .98 point; page 142 (foot-

note) suggests that 11 degrees of freedom, and not 8, have been taken; table 24 has not been calculated very accurately, and there is at least one major error (.2033 for $p_1 = .105$ should be .2136), also the mean should be p_1 in the footnote to the table; the formula in the heading of table 41 is wrong, while it is doubtful whether table 42 should be used for N as low as 11 except as a rough test—Neyman and Pearson suggested it for N greater than 50. On pages 410–11 the authors are evidently referring to a different table from table 9, since in the latter the values for $n_1 = 9$ appear, which makes interpolation rather pointless, and incidentally shows up the weakness of the interpolation method advocated. One wonders why Fisher's harmonic method on z, half the natural logarithm of F, cannot be used. The authors have incidentally used the .01 values throughout instead of the .05 values in this illustration. Lastly a word about analysis of variance. The authors began promisingly in the first book by illustrating analysis of variance in the simple problems in terms of population parameters. It was therefore somewhat disappointing to find the method dealt with very sketchily in the second book, and treated as a somewhat limited tool for special tests. It is not known why they refer to "a so-called 'analysis of variance.'" The name is well established and is used by the authors themselves in both books. The process *is* analysis of variance, and so there need be no doubt about the name employed.

J Royal Stat Soc 109:503–4 pt 4 '46. S. V(ajda). * The two final parts in vol. I....are a "Study of Dynamic Variability," including index numbers and time series, and a very chatty Part VI on "Forecasting." They are strange intruders in an otherwise systematic exposition. Stress is laid throughout on modern developments, and it is welcome to find the theory of testing, of confidence intervals and of point estimation treated as different aspects of the same subject—namely, statistical inference. It is perhaps just as well in a textbook not to mention partisan conflicts (the term "fiducial" does not appear), but one may doubt the wisdom of omitting any references whatsoever to inverse probability and Bayes's problem. Some readers will find the authors too anxious to reach quickly the normal distribution, which according to them has "its greatest usefulness in the theory of random sampling" (I, 307), and it is surprising to find Tchebychef's and similar inequalities hidden away in the very last chapter, on the problem of non-normality. Mathematical developments are, as a rule, put at the end of chapters, and one must sympathize with the authors' difficulty of separating fundamentals from details. * Does....[the book] encourage independent thought, or is the stress laid rather on giving answers to examination questions? The somewhat dogmatic treatment suggests the latter: "There are five kinds of charts" (I, 101), "The simplest type of functional relationship is expressed by a polynomial" (I, 256), "The coefficient of risk, as it is called" —meaning the level of significance—"is commonly, but not necessarily, set at 0.05." Why? Then again on p. 11 of vol. II we learn that R. A. Fisher has suggested the use of certain k-statistics "because of their theoretical advantage," but the reader can hardly guess what kind of advantage this may be. Incidentally, the text suggests that only four k-statistics exist. (The same applies to p. 243, but the formula given there for k_4 differs from that on p. 11 and is incorrect.) In a book for students statements which are misleading cannot be excused by saying that they are correct as far as they go. Anyone not familiar with the subject will take a passage on I, 316 to mean that the well-known relation between the standard deviation of the population and that of the sampling distribution of the mean only holds because the latter tends to be normal. The statement on II, 242, that the sampling distribution of the median from a normal population is itself normal, is, of course, wrong. The reviewer is unable to attach any meaning to the assertion that the normal bivariate surface of correlated variates is "narrower" than that of uncorrelated ones (I, 492), and on the same page the double integral of $dP(x_1x_2)$ should certainly not be denoted by $\iint P(x_1x_2)dx_1dx_2$. The main merit of the books consists in their dealing with modern theory. But here again something could be gained by more attention to logical principles. On II, 163 a clear and convincing description is given of the notions of errors of the first and second kind (surprisingly enough, without mentioning either J. Neyman or E. S. Pearson, who are only introduced as the originators of the likelihood ratio test), but it is at least misleading to state (II, 162) that "the possibility that ....may be due to chance....may be determined by probability theory," without adding "assuming the null hypothesis to be correct" or some words

to this effect. On p. 163 the hypothesis "not more than 10 per cent. substandard" is confused with "10 per cent. substandard," and it is incorrect to describe the limits of the confidence belt as "boundary lines for which it can be stated that the chances are, say, 95 out of 100 that this boundary includes the true population" (II, 174). An analogous mistake occurs on p. 179 in connection with an example. On p. 183 we are told that maximum likelihood estimates are sufficient, without any warning that sufficient estimates may not always exist, and without an appropriate explanation what sufficiency means. The footnote on p. 198 should contain a hint that the power of a test is a function of alternative values of a parameter, or that most powerful tests cannot always be devised. There is, moreover, no need to introduce (II, 202 n.) unbiased confidence intervals after the previous introduction of unbiased critical regions. On the other hand, unbiased estimates are not mentioned (unless the reviewer has overlooked them), possibly because only maximum likelihood estimates are considered. * a few misprints ....[of] minor importance * The reference on p. 291 of vol. II should be to equation (2), not (3) of Chapter X, and this is an unfortunate mistake, because it adds to the difficulty of students to understand the relation between the frequency distributions of σ and σ^2 respectively. * the graphs and diagrams....are quite admirably selected and printed. Much thought has gone into their construction, and if it were for nothing else, the perusal of the books must be recommended for their sake. The reader who already knows something of the subject will find them stimulating, and teachers will be convinced that geometry can be used for teaching statistics without climbing up to the nth dimension. The tables are well chosen, and the clarity of type is above criticism. American publishers are fortunate indeed in being able to produce such books "in full compliance with their governments regulations."

For additional reviews, see 276–7.

[279]

★SNEDECOR, GEORGE W. **Statistical Methods: Applied to Experiments in Agriculture and Biology, Fourth Edition.** Ames, Iowa: Collegiate Press, Inc., 1946. Pp. xvi, 485. $5.00. *

J Agric 53:518 F '47. H. P. * The text is generously illustrated with examples from agriculture and biology, and there are many useful exercises for the student to work out for himself. The final chapter on Design and Analysis of Samplings (not in the first edition) contains advice which should be valuable to research workers in any statistical field. A wisely chosen bibliography also forms a useful guide to those more mathematically-minded readers who will be stimulated by the excellent discussions in the text to delve deeper into the mathematical derivations of the many formulas used and thus to appreciate more fully their theoretical grounds and limitations. It is only to be regretted that the author did not see fit to include more references to those books, such as Keynes' *Treatise on Probability,* which discuss thoroughly the problem, fundamental to all statistical theory, of the logic of uncertain influence.

Ann Math Stat 19:124–6 Mr '48. Frederick Mosteller. * a non-mathematical treatment of modern experimental statistics. Few non-mathematical books are available that treat such topics as confidence limits, use of transformations, and analysis of variance and covariance in the detail presented by Snedecor. The examples are largely, but not entirely, drawn from agriculture and animal husbandry. The exercises for students are extensive and thought-provoking. Unlike most non-mathematical texts the book under review does not spend pages and pages on methods of recording frequencies and methods of computing countless moments which are seldom used in the later developments of the text. There is no long exasperating discussion of kurtosis and skewness; and there is no parade of qualitative Greek names for categorizing frequency distributions. The reviewer has used this book for teaching a second course in statistics to social science majors with reasonable success. The main disadvantage was the biological nature of most of the examples, but until some author writes a comparable book using social science examples, the reviewer will continue to use Snedecor's material for a large part of the course. * The practice of using random sampling numbers....to help explain theory has long been employed by teachers of statistics, but few authors have taken as much advantage of this technique as has Snedecor. * The author uses the adjectives "confidence" and "fiducial" more or less interchangeably, but it is the reviewer's opinion that it is the Neyman concept rather than the Fisherian that predominates. It should be remarked that this is one of the few texts that give the students the idea that in linear regression we do not predict y with the

same accuracy for every x even when linearity and homoscedasticity hold (v). The main emphasis....is on the analysis of variance. The author succeeds extremely well in showing the student how to carry out the analysis even at rather complex levels. On some other points he was not quite so successful. For example, the reviewer feels that the meaning of "interaction" was never gotten across, and that for the student the higher order interactions are still just things to be computed. Furthermore in attempting to make sure that the student understands how to do the computation the author often does not encourage the student to take any overall view of the data before blindly starting to compute. In addition, reasons for doing the experiment are sometimes vague and the conclusions are often couched only in the jargon of analysis of variance. Therefore, the student seldom gets an opportunity to find out what kinds of recommendations might reasonably be made as the result of an experiment. Perhaps the worst example is on pages 275–280. Here the experiment deals with yield of wheat in 48 pots, with two series of soil treatments, humus and chemical. Anyone glancing over the results of the experiment will be startled to find that every yield from pots with "no humus treatment" (12 observations) is greater than any yield with "humus treatment" (36 observations). The reader will be further startled to find that all the evidence tends to support the notion that "no chemical treatment" is at least as fruitful as any of the chemical treatments tried. However, Snedecor says "The striking feature of this experiment is the discrepance among the subclasses. The chemicals applied to one humus treatment produced yields out of accord with those from other humus treatments." Snedecor then pushes on to a more subtle analysis. The reviewer feels that here as elsewhere in the book the author occasionally forgets that the extended analysis looks rather ridiculous unless the practicality of applying the technique is discussed. The example considered here is one in which the point could profitably be made that everyone can see from a visual examination of the data what the results of the experiment show. The analysis backs up the student's common sense appraisal of the situation and gives him more confidence in and understanding of the method when it is applied in more delicate situations. It seems to the reviewer that too many times the application of the analysis of variance obfuscates the main point of the experiment. In the haste to get to the computations and the comparisons of interactions and errors the author frequently neglects to impress the student with the fundamental differences between means and their ultimate interpretation. However, the author does bring out clearly the notion of the various estimates of variance, a subject frequently neglected. In the next to last chapter the binomial and Poisson distributions are discussed. In this connection the inverse sine and the square root transformations are treated briefly, as is the logarithmic transformation. It is surprising that no indication is given of the theoretical variances when the inverse sine and square root transformations are used. The theoretical discussion of the transformation is limited to the remark that these transformations tend to make the variance independent of the means, but there is no indication of the further advantages. This is surprising because in a much earlier chapter the use of Fisher's transformation for correlation coefficients was treated quite adequately. It seems to the reviewer that in a later edition the use of transformation might well be moved forward in the book, and that the theoretical and practical implications might be treated more thoroughly. As in most other texts the final chapter "Design and Analysis of Samplings" needs very considerable expansion. * at the present time one would be hard put to find a better statistics text written at this level.

Child Develop Abstracts 20:110–11 Je–Ag '46. * probably the best American text written expressly for experimenters in agriculture and biology, and many further editions are certain to come. The treatment is nonmathematical, insofar as this is possible, and the style is friendly and personal—which may prove a snare for the indolent reader. The user is warned to be diligent; he must work out the numerous problems which dot the text if he hopes to gain mastery of its subject matter. Comparison with the third edition shows an improved printing and binding job, although the type is smaller. A "random" comparison of a number of sections proves that very considerable rewriting has been done between the third and fourth editions, although in general the same order of subject matter has been preserved. * Chapter 5 is a handy one on short cuts and approximations, with special attention to the standard deviation. Regression, correlation, and the analysis of variance and covariance next receive fairly

full treatment. (The reviewer found additional pleasure in these chapters in the fact that so much of what was contained represented original contributions by the author and his colleagues at Iowa State College.) * Notions are frequently introduced long before they are expounded upon, but the reader is better prepared for their exposition when this is reached in some later chapter. *

J Am Med Assn 130:906 Mr 30 '46. * contains a great deal of valuable information * largely rewritten. It is not simple reading for any one who is not thoroughly familiar with mathematics and the science of statistics.

J Am Soc Agron 38:568–70 Je '46. F. Z. Hartzell. This well-known work has been rather thoroughly revised and much new material has been added. * the present volume is apt to prove somewhat more difficult than the earlier editions for the student who has had little experience with statistical methods. He is liable to become lost in the mass of information. The author has tried to meet this by listing a "short course" on statistics at the beginning of the volume. The binding and typography have been changed, but the attractive style of the author has not suffered. The additional subjects considered tend to make the present edition a more complete manual. Professor Snedecor has done an excellent job of revision and the publishers have produced an attractive and well-bound book.

J Am Stat Assn 41:262–5 Je '46. D. J. Finney. * the great dilemma for the author of a book on applied statistics: he must avoid mathematical proofs, yet to convince his readers he must justify his procedure logically rather than dogmatically. Professor Snedecor has overcome the difficulty very successfully by careful choice of numerical examples and by empirical construction of the probability distributions required in elementary statistical tests. The nonmathematical student should gain in understanding of the tests very considerably by repeating his sampling experiments. Since its first publication in 1937, this book has been one of the few to combine successfully a sound theoretical basis with an exposition sufficiently clear and detailed for those without statistical experience. The rewritten and greatly improved fourth edition contains 60 pages more than the third and has a slightly smaller but better type; it is a valuable text for the experimentalist in any branch of biology, whether he be a novice or experienced in statistics, and no criticism of detail should be considered as disparaging to the whole. * Snedecor's insistence on the importance of problems of estimation is a valuable corrective to the absurdity of regarding tests of significance as the sole function of statistical analysis. The presentation of the logic of the fiducial argument, however, seems open to criticism in some places, since it may suggest to the reader that a probability of the population parameter lying between certain limits is being determined. In fact, the probability is that of obtaining a sample equally or more extreme from a population whose parameter is specified. Perhaps the reviewer attaches undue importance to the distinction between these two forms of statement, but he is convinced that the student who learns to appreciate this point will be saved from many future illogical arguments. * In chapter 4, tests of difference between two samples are described. The approximate methods proposed for use when the two samples have unequal variances are likely to be sufficiently good for most occasions in which this difficulty arises, but Fisher and Yates' tables, which make the Fisher-Behrens test so easy to apply despite its logical subtleties, might well have been mentioned. The short chapter on computing methods contains many useful hints for the novice and rightly emphasizes the value of common sense appreciation of data in guarding against gross arithmetical errors. Linear regression is introduced with a very clear explanation of the meaning of the different components of the total sum of squares, though the vague statement that the standard deviation from the regression line is "an average of the vertical distances from the line" might well be amended. * The author fails to make clear that the tests of significance of departure from zero for the linear regression coefficient and the correlation coefficient are identical, and suggests a distinction between the validity of the two; the test of the correlation coefficient is not biased by selection or restriction of values for one variable, providing that the population regression is linear and the frequency distribution within arrays of the other variable is normal. * In chapter 9, the author returns to the analysis of enumeration data and gives a good account of the use of the χ^2 test for contingency tables. In particular, he describes the procedure for $2 \times 2 \times 2$ tables, a method not usually found in textbooks. * Some elementary classes of experimental design are described, though the account

of these could with advantage be extended so as to indicate the possibilities of incomplete block and lattice arrangements. Indeed, the reviewer would like to see chapter 11 made still longer in order to give a more comprehensive account of analysis of variance in relation to experimental design. The statement that "one missing item can be supplied with the aid of a formula" should be given more precise phrasing as it tends to perpetuate the belief that loss of a few plots or animals matters little, since the statistician can always find out what the results would have been! The excellent account of modifications required for disproportionate subclass numbers has been much extended from the previous edition. Covariance analysis is well illustrated by typical examples in chapter 12. In his account of multiple regression, Professor Snedecor pays more attention to correlation coefficients than is usual; the calculation of the inverse matrix directly from sums of squares and products is generally preferable to similar calculations from correlation coefficients. The subsequent account (chap. 14) of curvilinear regression begins with useful suggestions on how to decide the best form of function, and continues with illustrations of the fitting of polynomial regressions. Since published tables of orthogonal polynomial values are sufficient for most practical needs, their use might have been described rather than Fisher's original more complex procedure for fitting orthogonal polynomials to equally spaced observations; the latter method is now only required for observations of unequal weight, a complication beyond the scope of this book. The account of individual degrees of freedom (chap. 15) is a useful introduction to the analysis of factorial experiments but scarcely does justice to the power of factorial design as an instrument of research; there is no mention of the possibility of reducing the errors of the more important treatment contrasts by confounding those of lesser interest. It is surprising to find a suggestion that Fisher and his associates have met with difficulty in maintaining the thesis that for each degree of freedom an appropriate sum of squares can be segregated! * The final chapter summarizes the main principles of the planning and analysis of sample surveys and is an excellent introduction to a most important branch of applied statistics which is being increasingly used to-day in many fields of investigation. This chapter will be difficult reading for those making their first acquaintance with statistical methods, and possibly in subsequent editions Professor Snedecor might consider its amplification. The book contains all the usual tables now customary in textbooks of statistics for biologists, together with several less commonly found, of which the table of confidence intervals for the binomial distribution and the short table of range in normal samples are likely to be the most useful. The reviewer has noticed [several]....misprints, most of which are trivial * [see original review for 22 corrections not excerpted.]

J Am Stat Assn 41:265–6 Je '46. W. J. Youden. * The discussion of the term "unbiased" might have made clear that it is used not only with respect to a sample but also to a statistic which is used to estimate a parameter of the population. * Great care is taken in the early chapters to keep before the reader just what he is attempting to do. * Throughout the book, the illustrative examples as well as the exercises are chosen from research data with citations to original sources. This feature greatly enhances the use of the book by research workers who must dig out the methods without benefit of classroom instruction. * there is a lengthy and excellent presentation of the analysis of variance and covariance * It is especially encouraging to find how much attention is given to the vicissitudes of actual data. Such difficulties as unequal numbers of items in the groups compared, missing values from otherwise well-planned experimental data, unequal variances in the groups of data under comparison, and transformations of data to bring them into a normal distribution arise continually in actual data and are often ignored in elementary texts. * Snedecor's book has already earned the gratitude of many research workers and the new edition, with its inclusion of recent developments in statistics, should get a cordial reception.

J Royal Stat Soc 109:505–6 pt 4 '46. J. W(ishart). * the book has been very much improved. It will startle the reader accustomed to the orthodox treatment of the subject as addressed to students of economics and commerce to find the χ^2 test in Chapter 1, fiducial inference in Chapter 2, and the t-distribution in Chapter 3, while, on the other hand, the binomial and Poisson distributions are relegated to Chapter 16, and are left out of the short course of reading in the elements of statistical method suggested by the author. But the

deliberately conceived plan is to use all that is known of the logic of statistical inference from the beginning, and in even the simplest classes of observational data. Mathematical proofs are necessarily absent from a book conceived as this one is, but the plan followed is logical. * It will be clear from what has been said that there is much in the book which can be studied with profit by any worker in statistics. Having said this, it remains to be added that students of agriculture and biology have to go much further into details of experimental design and analysis of variance applications than workers in other branches of the subject. That is done in this book. * Apart from the special emphasis given to the biological applications there is little of the content of the modern methodological textbook on statistics that does not find a place; the economist will look in vain for a discussion on index numbers or time-series, but he will profit by study of the chapter on sampling.

Sci 103:407–8 Mr 29 '46. F. M. Wadley. * There has been considerable minor rearrangement, and new emphasis has been placed on sampling, fiducial limits, estimation, and components of variance. The format is somewhat more attractive than in previous editions. The book begins with several new sections on sampling of attributes, considerably more imposing than the former very elementary opening. A table of fiducial limits for binomial material is introduced (its theory being left to Chap. 16). There is also a new and useful table of random numbers. Some of the ideas brought out in the former Chapter 1 are then developed. Other chapters show less difference from former editions, but in all there are changes. Graphic tests of significance are omitted from Chapters 2 and 4, and mathematical tests are treated more exhaustively. Fundamentals of regression and correlation are more fully discussed, and the Z-transformation is introduced. Chapter 9, on chi-square, contains some material originally in Chapter 1, as well as some new material. The chapters on analysis of variance contain material on basic assumptions, components, and disproportionate frequencies, not in older editions. Later chapters have fewer changes, but there is more attention to Gauss multipliers and more detail in discussion of single degrees of freedom, while the section on errors of "betas" is omitted. An obvious error in Example 14.7 is retained. Some familiar problems and sections are omitted and some new ones introduced. * The informal language with its personal pronouns, adding to readability; the effort to develop logic "painlessly"; the presentation of tables in a form to appeal to experimenters more than to mathematicians; the strong practical emphasis and wealth of practical problems are all there. Analysis of variance is strongly emphasized, and other techniques are related to it. The close relation of the author's laboratory to experimental work in various fields is well reflected. Difficult questions are handled in an apparently easy manner, reversing the practice in some texts. The changes superimposed on the former development have made logical outlining a little difficult. The text is definitely more valuable as a reference than earlier editions and seems more difficult to adapt to teaching. In studying and using the text, the scientific worker will feel anew the influence of the modest and unselfish work of the author and his associates, which has already contributed so much to progress.

For reviews of earlier editions, see 38:B700 and 2:276–8.

[280]

★Statistical Research Group, Columbia University. **Sequential Analysis of Statistical Data: Applications.** Prepared for the Applied Mathematics Panel, National Defense Research Committee, Office of Scientific Research and Development. SRG Report 255, Revised; AMP Report 30.2R, Revised. New York: Columbia University Press, September 1945. Pp. vii, 17; iv, 80; v, 57; iii, 25; iii, 18; iii, 39; ii, 41 (7 booklets in a ring binder). $6.25. (London: Oxford University Press, 1946. 50*s*.) * In 1946, a 36-page supplement to Section 2 and an additional 47-page supplement to Section 7 was published. $1.50; 12*s*.

Ann Math Stat 18:142–4 Mr '47. John W. Tukey. * A copy should be accessible to every teacher of statistics and to every statistician in industry or experimental work who can propose new techniques of testing. * There are two situations, each more frequent in war than in peace, where it is clearly desirable to reduce the *average* number of items tested to a minimum: (I) Where essentially all lots are accepted and the test is destructive so that the items tested are the main loss of production, or (II) Where the cost of testing an item is large in comparison with the cost of production. Subject to a practically unimportant allowance for the finite size of the lots, and to an allowance of unknown importance for the quality of lots presented, the methods of sequential analysis minimize this average number among all methods so far considered. When situation (I) or

(II) holds without modifying complications, then, the best known method is sequential analysis, the natural descendant of double sampling. Otherwise, the situation is far from clear, and much judgement is involved in setting up a practically efficient scheme. The reader will get no help on this problem of judgement, nor in the problem of setting risks from the book under review—he will get every needed help with the mathematical problem of setting up a sequential plan to meet chosen risks, including complete tables of all necessary functions, including natural logarithms. There is no reason to suppose that sequential analysis is the last word in testing procedures for the general problem of efficient testing, but what should be the next step ahead is not a step for the mathematical statistician. What is needed now is a careful analysis, by the operational research techniques so useful during the war, of a half-dozen industrial testing situations to determine what properties of the testing procedure are involved in cost and to what extent. Do we want the minimum average sample size, the minimum average square of the sample size—or what? With this there should go a corresponding operational study of the advantages of different *OC* curves, including those of what now seems to be a peculiar shape. Given these studies, we could put the problem in mathematical statistics to the mathematical statistician which he would then solve. But with the present lack of operational research groups in industry, it is probable that we will proceed in an unnatural way, and that the mathematical statistician will take the next step forward. For reasons of mathematical simplicity it is not unlikely that the sample plan with the minimum average squared sample size will come next. * It may be of interest to notice a few minor points for the record. On page 1.01 it is indicated that 100% inspection is 100% effective—this seems far from industrial experience. Another badly needed set of operational studies would be on the influence of the sampling plan on inspector's inspection. On page 2.27, the footnote suggests that when a tabular procedure is used instead of a graphic one, that more decimal places should be kept—the logic of this is not clear. On page 4.14 it is stated that "similarly, if all patches had tested 400 minutes, the experiment would have terminated at 9.4...." Clearly no such experiment can terminate after a fractional number of tests. On page A.09 it is stated that "Finally it should be mentioned that truncation of any kind ought generally to be avoided." This seems to the reviewer to be a rash statement, for when not only average sample size but all other properties entering into the practical efficiency of a sampling plan are considered, this decision will almost certainly be reversed. The relatively small number of these detailed points is an evidence of careful and competent workmanship. A footnote to the Appendix (B) on some principles of sequential analysis states: "Any mathematician who may stray into this Appendix should be assured that the validity of the conclusions in no case depends upon the type of reasoning presented here; indeed, even for intuitive or heuristic arguments mathematicians may prefer those given in SRG 75." This warning and caveat seems unduly strong—the appendix is recommended to all mathematically minded newcomers to sequential analysis. The same appendix warns the reader in a few places that the theory set forth does not allow for the fact that samples come in units. If the reader tries to apply the theory to cases far from normal inspection practice, for example with risks of 0.25 and average sample sizes of 12, he will then find out that this does occasionally make a difference. In conventional circumstances the approximation will not bother him.

Gen Elec R 49:64 Jl '46. G. K. Carter. * The treatment throughout is highly practical; the procedures are clearly and simply stated and are illustrated by specific examples. At the same time, there is a continual emphasis of the logical basis and implications of the acceptance specifications.

Ind & Eng Chem, Anal Ed 19:697 S '47. J. H. Davidson. * Sequential analysis may be employed to determine whether the quality of product differs from a standard in a quantitative test. * This type of criterion is the usual situation in chemical analysis, but there the sequential plan loses much of its allure. Chemical tests are usually rather involved and time-consuming compared to mechanical measurements. Hence, it is most often advantageous to run a set number of analyses simultaneously at the possible expense of taking an excessive number of samples, rather than to be undecided about the number of tests necessary until after an unpredictable number of results are known. This drawback may be partially overcome by grouping results, but even this is unsatisfactory in the majority of process control operations.

Whenever quality testing involves the number of defects per unit of production, sequential analysis presents a most efficient solution. In this case, as shown in the seventh booklet, the mathematical model is the Poisson distribution instead of the usual normal distribution. Therefore, care must be exercised that the average number of defects per article is small compared with the number possible. Although sequential analysis is indeed a tremendous boon to the problem of inspection testing, it in no way supplants the more established control chart technique which gives a running record of production as well as indications of quality change. There will continue to be many instances where the more familiar types of single or double sampling plans will continue to be preferred, particularly in chemical analytical tests. However, the field for which sequential analysis is uniquely best fitted, that in which tests are relatively simple, is vast and relatively uncovered by any kind of statistical plan. The pamphlets in the set are clearly written and easily readable by persons with no statistical training. The procedures are amply illustrated with step-by-step examples and numerous tables are included to aid calculations. The form of compilation makes it easy to divide the notebook, so that pamphlets may be used separately on the job and also provides for addition of more pamphlets should they be published. The disadvantages of such a format, however, are undue repetition from one pamphlet to another and the end result of a bulky unhandy reference volume. Numerous literature references are given for those interested in the more fundamental mathematical basis of the plans. This work may be considered a "must" for all those contemplating the introduction of sequential analysis into their sampling inspection problems.

J Am Stat Assn 41:137–8 Mr '46. Henry Scheffé. * The descriptions of the properties of sequential tests are clear, and the instructions for their use are detailed; little background in the way of statistics or mathematics is demanded of the reader. The clarity is improved by the omission of some of the qualifications that a mathematician might be impelled to add; for example, the advantages of sequential testing are well summarized for non-mathematical readers in the following statement: "Thus, conspicuously good lots are quickly accepted, conspicuously bad lots are quickly rejected, and extensive inspection is needed chiefly by lots of doubtful quality—which is as it should be." * An extra section consisting of appendices treats among other matters the device of truncating the previously described sequential tests. This device, which is of great practical importance, consists of choosing beforehand an upper bound for the sample size, and whenever this size is reached without actions (1) or (2) having been taken in the usual way, one or the other is then taken, depending on the observations accumulated. The organization and format are unusual. While the reviewer likes to see experiments in organizing and binding statistical material, he regrets finding this one somewhat unfortunate. The seven sections are separately bound in pamphlet form, stapled, not stitched, and they come in a ring binder, the whole arrangement being rather flimsy. When the pamphlets are used in the binder the book is hard to close unless a suitable process of shaking down is first used. * An effort has been made to make each of sections 2 to 6 practically self-contained, resulting in a large amount of repetition.

J Am Stat Assn 41:138–40 Mr '46. B. L. Welch. This book is a revision and extension of work which was issued earlier as an O.S.R.D. report with restricted circulation. Its publication and general circulation to a wider public at this moment is welcome. In conjunction with the more theoretical papers on the same subject, which have now appeared in various statistical journals, it makes available a very clear account of a type of statistical procedure which has been strongly advocated in several quarters. It should be noted, however, that although sub-titled "Applications," the present book is only rightly so-called in the sense that it makes clear how to operate certain sampling procedures and how to analyse the observations resulting therefrom, assuming all along that these procedures are the ones most appropriate to the questions at issue. Except, perhaps, by implication, it scarcely touches the problem of indicating in practice the types of job for which the methods suggested are genuinely preferable to others which might be used. The term "Sequential Analysis" has on occasion been applied to cover the analysis of data arising in all situations where sample sizes are not fixed in advance, but where the decision to stop sampling depends on the outcome of observations as they are made. It is not with such a wide meaning, however, that the

term is used in the present book. * The claim that is made for this procedure as against a procedure that uses a sample number fixed in advance, is that it can satisfy the conditions laid down (*i.e.*, give practically the same operating characteristic) with an appreciably smaller *average* sample size. More precisely it can be shown that, if the true mean m is in the vicinity either of m_1 or m_2, then the average amount of sampling will be appreciably less than if a fixed sample scheme were being used. However, if m is about half-way between m_1 and m_2, no such reduction in sample size will be obtained. Results of this nature are interesting, but inconclusive if no attempt is made to relate them to the values of m likely to occur in a given practical case, and it is at this point that the present book proves somewhat disappointing. A basic criticism which has been made of Wald's work is that frequently m will lie about half-way between m_1 and m_2 and that therefore appreciable average reductions in sampling size will not happen. Further, that even when m is either in the vicinity of m_1 or m_2 (so that the material sampled is in some sense abnormal) we may not be concerned so much with accepting or rejecting it, as with estimating its properties. For such purposes the smaller sample sizes then arising from the sequential method may be a positive disadvantage. Whatever substance there may be in such criticism must depend of course on circumstances and further discussion in abstract terms is probably not very profitable. In a book dealing with the "applications" of a statistical method, we might, however, have expected that more space would have been devoted to anticipating possible objections of this nature even if, in the opinion of the authors, such objections are not of great importance. * For library purposes a further edition of the book bound up in the usual manner would possibly be more convenient.

J Am Stat Assn 41:405–6 S '46. [For critical comments not excerpted, see J. Wolfowitz's reply to the above review by B. L. Welch.]

J Appl Phys 17:312 Ap '46. D. K. Wright, Jr. * should prove of considerable value to those concerned with analysis of statistical data in experimentation or acceptance sampling.

J Bus 19:194–5 Jl '46. William A. Spurr. * an outstanding contribution to the fields of sampling inspection and experimentation * The chief advantage of sequential inspection is that it results in less inspection—a saving which will frequently exceed 50 per cent. * The chief limitations of sequential analysis are practical rather than theoretical. In some plant organizations, particularly where many kinds of items are produced, it may be inefficient for the inspector to alternate between inspection and analysis to determine when to terminate the sample. Second, if the cost of obtaining the specimens is greater than the cost of inspection itself, it will probably be more economical to secure just one large sample and proceed by standard methods. Third, the method is less efficient if the available sample is quite small. The value of this procedure must be determined for each plant by specific cost analysis. Theoretical limitations arise when (1) either the total lot or the sample is of very limited size, (2) the distribution of errors is badly skewed. The publisher makes the excessive claims that this device is a "secret weapon," and a "completely new method"...."effecting an *average* reduction of about fifty percent in the amount of data needed" (italics mine), none of which is claimed by the authors. Certain sequential methods have been in use since 1929, when H. F. Dodge and H. G. Romig published a two-step method of sampling inspection in the *Bell System Technical Journal.* Other sequential procedures have been proposed by Walter Bartky, of the University of Chicago, and G. A. Barnard, of the British Ministry of Supply. It should be noted that Bartky proposed a sequential method for standard versus defective pieces by minimizing both sampling costs and the cost of defective inspection at a Cowles Commission Conference in 1940. * Both the theory and its applications offer fertile fields for future research, particularly in operating cost analysis and in the determination of proper tolerances.

J Royal Stat Soc 109:505 pt 4 '46. F. J. A(nscombe). * Abraham Wald's sequential analysis is the most important new idea in statistical theory of the last half-dozen years or so. Others before Wald had considered sequential tests, but he was the first to find a fertile principle by which to construct such tests. * For statisticians in general, perhaps the most important effect of Wald's researches is that we have been taught to think freely of sequential procedures, and it is likely that in the near future many new sequential methods will be developed, not all on the principle of the likelihood ratio. * These five sections are independent of each other, so that the reader may turn to

whichever interests him. There is therefore a good deal of repetition of description and even of tables. * That such an account of sequential sampling methods should have been produced so soon after the development of the theory indicates a creditable spirit of enterprise on the part of the Columbia Research Group. One can, indeed, find a few faults here and there. Thus there is a confident statement that "truncation of any kind ought generally to be avoided," which is presumably based only on ignorance of the effect of truncation. And Wald's elegant theorem concerning the minimum sample sizes incurred in sequential tests is stated without the necessary conditions, and becomes thereby untrue. In any case, I believe no such theorem has ever been proved regarding the test given here for double dichotomies. These inaccuracies, however, are not likely seriously to mislead anyone who becomes interested in the subject. The main facts of sequential analysis are presented clearly, and the book will do more than instruct the practical man in methods. It will prove a helpful introduction to the theoretical literature in *Annals of Mathematical Statistics* and in the Supplement to this *Journal.*

Nature 157:642 My 18 '46. M. G. Kendall. * These reports are in the main for the practical man. As such they are very good. The exposition is clear, there is an abundance of well-chosen examples and diagrams, and the whole work bears evidence of having been through a process of examination and criticism by men who were actually carrying out the methods in practice. One could have wished for a lower price, seeing that the reports are duplicated copies of typescript, and for larger type in some of the tables, but the text is not difficult to read. The publication of this work will be welcomed by statisticians and engineers.

Sci 103:490–2 Ap 19 '46. James G. Smith. * These studies make fascinating reading for those who have not been permitted, because of wartime secrecy, to follow the new developments in sequential analysis that occurred during the War. A beguiling and stimulating procedure has been devised that would seem to guarantee exciting vistas as one contemplates possible applications of great practical importance, such applications already having been extensively made by the various branches of the armed forces. The same procedure, modified to suit the problem, can be applied to reduce the cost of sampling analysis in connection with experimental work, presumably both in agriculture and in industry; and it can be applied to a series of multiple samples as well as to a sequence of observations. While considerable mathematical patience is required to comprehend rigorous demonstration of the procedure, the intuitive explanation can be grasped by anyone trained in the fundamentals of the modern theory of sampling. * Criticism is rampant on the question of acceptance sampling, but for the most part it deals with the validity of the tests, the relationship of the test to expected performance, the randomness of the samples, *etc.* However fine a method of analysis may be, it will remain impractical unless the data analyzed are suitable and in conformance with the assumptions involved in the method. Nevertheless, that criticism cannot detract from the importance of the contribution made by those who have developed the method of sequential analysis. The method is neatly and ingeniously contrived, and it is surprisingly simple in application as far as the primary requirements of any particular problem are concerned.

[281]

★STOCKTON, JOHN R. **An Introduction to Business Statistics, Second Edition.** Boston, Mass.: D. C. Heath & Co., 1947. Pp. ix, 478. $4.00. *

For reviews of the first edition, see 2:281.

[282]

★STONE, CHARLES A., AND GEORGES, JOEL S. **Work Units in Educational Statistics: A Text and Workbook.** New York: Harper & Brothers, 1942. Pp. v, 154. Paper. Out of print. *

[283]

★STUBBINGS, G. W. **Engineering Statistics: Basic Ideas on the Subject as It Is Applied in Production Control and Standardisation.** Mechanical World Monographs, No. 38. Manchester, England: Emmott & Co. Ltd., 1947. Pp. 24. Paper. 2*s.* *

[284]

★SUMNER, W. L. **Statistics in School.** Oxford, England: Basil Blackwell & Mott Ltd., 1948. Pp. vii, 183. * For latest edition, see 285.

J Am Stat Assn 44:327–9 Je '49. F. G. Cornell. * The author....is reasonably successful in some of his attempts "to make it as simple as possible." Included are some topics needed and usually not found in educational statistics such as an introduction to analysis of variance and factorial analysis. With these, however, there are questions of the value of the limited depth of treatment to which the author restricts himself evidently to avoid complexity. To what extent can a "simplified" text compromise with

the criterion of adequacy of content coverage, for instance, by including factorial analysis but limiting its discussion to tetrad differences? In his presentation of partial correlation, the author covers only the three-variable problem without multiple regression, error of estimate, and other concepts useful in understanding the subject. The chapter on correlation and regression is typical of what is likely to result from confining the subject of educational statistics to 183 pages. In that chapter there appear technical errors of omission or commission which would lead an immature student to incomplete or incorrect information. * Certain important omissions prevent this book from being a significant addition to the field. Not included is a modern approach to sampling. A careful distinction is not made between large sample and small sample method, "statistic" and "parameter." Notions of sampling distribution are introduced through the medium of the "probable error" anachronism. Chi square is presented with the limited emphasis of "goodness of fit" and contingency. The book throughout would be improved if there was greater use made of applications to educational problems and if examples were not excluded more or less to the rather sterile subject of school marks. The writing is heavily oriented in the direction of marking, to which relatively little concern has been given in education in this country in recent years. A broader orientation of a book on school statistics seems essential if it is to contribute significantly to the study of modern educational problems.

Times Ed Sup 1764:114 F 19 '49. The statistical analysis of test and examination marks is rapidly becoming a specialist subject. Much information about it is widely scattered in educational and psychological journals or is deeply buried in forbidding text-books of mathematical statistics. Mr. Sumner has done a useful service in summarizing in this volume all known methods of analysing educational data. * Useful as this book will be for reference there is a danger that its tempting list of formulae may encourage uncritical application of statistical method by enthusiastic amateurs. It might perhaps have been wiser to have stressed the need for great discretion in the interpretation of results and to have indicated more clearly the limitations of the statistical methods described. Although the mathematics have been simplified remarkably well there is no escape from the fact that statistics is a mathematical subject. The book may, therefore, discourage most non-scientific or non-mathematical readers who only glance through it. This is unfortunate, since it is important that all interested in education should understand how statistics can be applied to educational problems.

[285]

★SUMNER, W. L. **Statistics in School, Revised Edition.** London: Basil Blackwell & Mott Ltd., 1950. Pp. ix, 225. 10*s.* 6*d.* *

For reviews of the first edition, see 284.

[286]

★SUR, A. K. **Statistics: How to Handle Them: A Practical Handbook for Students and Businessmen With a Special Chapter on Business Forecasting.** Bombay, India: D. B. Taraporevala Sons & Co., Ltd., 1945. Pp. ix, 121. Rs 3/15/-. *

[287]

★TETLEY, H. **Actuarial Statistics: Vol. I, Statistics and Graduation.** Harry Freeman, coordinating editor. Published for the Institute of Actuaries and the Faculty of Actuaries. London and New York: Cambridge University Press, 1946. Pp. xi, 285. 21*s.*; $4.25. *

Economica 14:239–41 Ag '47. E. Grebenik. * Tetley's book is of particular importance, as actuaries have recently begun to take a greater interest in general statistics and members of that profession are filling many important statistical posts. Statistics is likely to assume greater prominence in the actuary's professional training, and Mr. Tetley's book will therefore serve as an introduction to the subject for an important part of the statistical profession. It is all the more unfortunate that the book is disappointing as a general introduction. Mr. Tetley disarms a certain amount of criticism by admitting that the professional statistician will find the book somewhat unbalanced. Of 285 pages, only 114 are devoted to statistics proper, the rest being given to graduation. Although graduation is more important for the actuary than for the general statistician, one cannot help feeling that the emphasis is a little misplaced. But even the treatment of the statistical part is not altogether satisfactory. There are four chapters dealing respectively with continuous and discontinuous variables, the binomial and normal distribution, correlation and sampling. The last subject is dealt with in 34 pages! No mention is made of partial and multiple correlation, though these techniques have been used in social and regional analyses of mortality and in the construction of life tables by abridged methods, subjects in which the actuarial profession should

surely take an interest. There is only the briefest reference to non-linear regression, and no mention of the correlation ratio. As regards sampling, the author himself states that "Chapter 4 [on sampling] is probably the most important, because it is not until he understands the way in which sample results can be used that a student grasps the idea of statistical inference, which underlies all scientific methods." These sentiments are unexceptionable, but it would be impossible to do justice to the subject in the short space allotted to it. The student who comes fresh to sampling is always a little puzzled as to how it is possible to reason from the sample to the population, and Mr. Tetley's explanation is not altogether convincing. And in talking about sampling distributions, a good deal of the modern work on the subject is ignored. * The only tests of significance described are those for the difference between two averages, and between two proportions, and, in each case, the formula for large samples is given without qualification. The approximate formula only is given for the standard error of the standard deviation, and that of the coefficient of correlation is given as $\frac{1 - r^2}{\sqrt{n}}$ with the implication that the sampling distribution is normal. It is possible that actuaries will not have much opportunity of dealing with small sampling techniques in the course of their work, though these may be useful in mortality studies, but it is surely undesirable to ignore, even in a first text, all the developments that have taken place during the last twenty years. It should also be mentioned that in the discussion of moments, the conventional notation is dispensed with, for no good reason. Graduation, on the other hand, is treated exhaustively with many examples. These chapters, however, will be mainly of interest to the professional actuary, as the practice of graduation has not been adopted to any large extent outside the profession.

J Am Stat Assn 42:335–7 Je '47. Eugene Lukacs. * The book....is written for a group of readers interested in certain highly specialized applications. This consideration inevitably influenced the choice of the subject matter. Consequently a statistician may find that a great many topics which he considers to be of paramount importance are excluded. This is true for most of the methods of mathematical statistics which have been developed during the last forty years. The most important exception is the chi-square test of goodness of fit which is discussed to some extent. These omissions are justified by the purpose of the book and the fact that the actuary has—at least at present—little opportunity to apply modern statistical methods. * the book will stimulate the reader and will arouse his interest in the mathematical methods of statistics. * Chapter 2 deals with the binomial and the normal distributions. Two proofs are given for the convergence of the binomial to the normal distribution (De Moivre's theorem). The first proof is made under the assumption that $p = q = \frac{1}{2}$; the second proof supposes $(q - p)/npq$ to be small. Instead of standardizing the variable of the binomial distribution, the variance npq is fixed during the passage to the limit. This conflicts with the assumption underlying De Moivre's theorem that the probabilities are constant. The proof itself is open to serious objections. Besides, it is not even mentioned that the theorem is of general validity. In this reviewer's opinion it is not quite satisfactory to prove the theorem only under restrictive conditions. It might have been preferable merely to state the theorem without a proof. Another possibility would have been to mention the central limit theorem and to present the convergence of the binomial to the normal distribution as a special case. * Chapter 4 deals with sampling and introduces the reader to some of the more modern ideas. This chapter should provide an incentive to the thoughtful reader to continue his statistical studies. A clear distinction is made between a population parameter and the corresponding statistics derived from a sample. Nevertheless, the notation used does not avoid ambiguity as occasionally the same letter is used for both. * the author remarks that comparatively little is known about sampling distributions and that it is assumed in most instances that sampling distributions follow the normal curve. It is regrettable that the existence of the extensive theory of sampling from a normal population is not mentioned. Moreover it is certainly not generally true that the normal law holds for any statistic calculated from the sample. Instead of this sweeping statement, a reference to the asymptotic properties of sampling distributions would have been helpful. It is known that the distribution of any sample characteristic based on moments is asymptotically normal, provided certain conditions are satisfied. This theorem would have justified the author's assumption that the sampling distribu-

tions discussed in the text are normal. * Chapter 8 discusses graduation by summation * It is regrettable that this analysis is not extended to the study of the curves reproduced by a summation formula. This more general approach would include graduation based on linear compounding. At the same time a deeper understanding of the nature of mechanical graduation could be gained. Chapter 9 discusses graduation by mathematical formulae such as Makeham's law. A concise and clear description of the usual methods is given. Again it would have been valuable to show that Makeham's law is preserved by certain graduation formulae. * Chapter 10 gives a brief and lucid discussion of osculatory interpolation. Throughout the text the reader will find many interesting examples. * Each chapter is followed by a brief bibliography which should be helpful to the reader desiring to penetrate deeper into the subject.

J Inst Actuaries Students' Soc 6:152–4 Ja '47. * It is obvious that Tetley has had considerable teaching experience and that he is adept at explaining to the student clearly and succinctly the essence of his subject. But the book is not a text-book in the sense that it can be used as a work of reference or a source of inspiration for research. Whilst the examination syllabus is covered faithfully, no allowance has been made for any developments in the subject which have occurred in recent years. The statistical theory goes no further than Elderton's and Hardy's books which have been available now for some 40 years. Except for the few references to Vaughan's brilliant papers on Summation Formulae we are left with the impression that no contributions have been made to Graduation Theory since early this century. Linear compounding formulae are only given a passing mention whilst difference equation methods and the Jenkins type of osculatory interpolation formula are not discussed. The methods to be used in graduating "select" tables are hardly considered and no space is given to the problem of the determination of the correct "weights" to use in graduating mortality data. That these omissions are part of a deliberate policy on the part of the author is seen from his careful review in *J.I.A.* of Henderson's 1938 text-book on Graduation published by the Actuarial Society of America and intended to assist students of that Society in their examinations: that book includes a detailed discussion of some of the methods neglected in the present work. We must conclude that either Tetley received instructions to limit himself strictly to the present syllabus and to training students to answer questions similar to those that have been asked in past years, or that he interpreted his mandate in this sense. Although this may be useful for the student who is cramming to pass his examinations, we cannot but be sorry that the potential research student and members of the profession generally cannot find in this new text-book a summary of all that is known to-day on Graduation and on statistical theory likely to be of use to the actuary. It would seem that a pretty problem has thus been posed: Is the absorption of new methods into the technical equipment of the average actuary to be effected by brilliant text-books summarizing for the first time all known contributions to theory, or must the examiners, by asking unforeseen questions, stimulate the tutors to supplement existing text-books written on conservative lines? We must conclude, then, that the new text-book on *Actuarial Statistics* can only appeal to the student preparing himself for Part III of the present examination syllabus. As we have mentioned, Tetley's didactic style is excellent and students should have little difficulty in following his explanations. However, we feel bound to point out that the new book contains a considerable number of theoretical misstatements and, what is worse, epistemological errors. There is no need to labour these defects here since the Tuition Service will doubtless remedy them in its Lessons, and a new text-book will probably be called for in connexion with the revised examination syllabus.

Trans Actuarial Soc Am 48:374–5 O '47. Mortimer Spiegelman. * The student using this text alone will gain the traditional, but not the modern, view of the elements of statistical theory and practice and only a limited knowledge of graduation. * The text requires clarification at several points and is also in need of correction in the statements of theory in a few instances. This situation, together with the development along traditional lines that modern writers are discarding, is rather unfortunate in a text for students since, on this continent at least, statistical sampling procedures are becoming of increasing importance in actuarial work. Papers concerned with sampling for mortality investigations have appeared in the *Transactions,* and sampling has already been used in reserve valuation. Statistical techniques have

been developed for the control of clerical errors and they have also been used for the selection and appraisal of agents. In addition, occasional problems may arise where sampling can effect economies; for these, statistical tests are required to gauge the reliability of the results. Investigation along these lines calls for some statistical maturity. A reading of the same number of pages of Hoel's *Introduction to Mathematical Statistics* as is devoted to statistics in the present volume will not only give the student a better insight into the elements of modern statistical thought but will also equip him for more advanced readings. * There is a singular lack of balance in the treatment of graduation. About one-third of the pages on the subject are taken by the chapter on summation formulas which "owe their importance to the ease with which they can be applied, but with modern mechanical aids this is not now as important as formerly." Oddly enough, the author then refers to the more general formulas of the linear compound type, of which summation formulas are a special class, but does not discuss this phase of graduation further, nor are references given. Entirely omitted are the difference-equation method and the modified osculatory interpolation. In fewer pages than are contained in the section on graduation in the present text, Morton Miller's *"Elements of Graduation"* introduces the actuarial student to the fundamentals of the subject in its several phases (excluding Beers's recent developments) and also prepares him for further study. Where the author is on familiar ground, his explanations are clear and are illustrated by excellent examples using insurance data. The problems at the end of each chapter are also commendable.

[288]

★THOMPSON, CATHERINE M. **Tables of Percentage Points of the Incomplete Beta-Function and of the χ^2 Distribution.** "Prefatory Note" by E. S. Pearson; "A Description of the Calculation and of Methods of Interpolation" and "A Table of Lagrangian Coefficients for Harmonic Interpolation" by L. J. Comrie and H. O. Hartley. Reprinted from *Biometrika*, Vol. 32, Part 2, October 1941. London: Biometrika Office, University College, [1941]. Pp. 151–91. Paper. 4*s*. *

[289]

★THOMPSON, CATHERINE M., AND MERRINGTON, MAXINE. **Tables for Testing the Homogeneity of a Set of Estimated Variances.** "Prefatory Note" by E. S. Pearson and H. O. Hartley. Reprinted from *Biometrika*, Vol. 33, Part 4, June 1946. London: Biometrika Office, University College, 1946. Pp. 296–304. Paper. 2*s*. *

J Am Stat Assn 42:341–2 Je '47. G. A. Baker. * The general idea of the use of the tables is to apply the test of homogeneity; and if the probability of nonhomogeneity is less than 5 or 1 per cent, then the sample variances are treated as though they were estimates of a common variance. This procedure leads to a bias in the results of the subsequent statistical analysis, as has been pointed out by T. A. Bancroft (1944), since errors of the second kind in the sense of Neyman and Pearson may be often made; that is, the variances which are being estimated may differ somewhat widely and still the test indicate homogeneity at the 5 or 1 per cent level. The effect and magnitude of this bias has not been fully investigated. Also, the effects of possible non-normality of underlying frequency distributions have not been discussed. The application of these tables will be much better than a uniform uncritical assumption of homogeneity of variances and should greatly improve current statistical practice.

[290]

★THOMSON, GODFREY H. **The Factorial Analysis of Human Ability, Second Edition.** London: University of London Press, Ltd., 1946. Pp. xvi, 386. * (Boston, Mass.: Houghton Mifflin Co., 1947.) For latest edition, see 292.

Eug R 38:191–3 Ja '47. Cyril Burt. * a standard exposition of the mathematical techniques of factor-analysis. The fact that the first edition was exhausted so rapidly is a testimony to the increasing interest now being taken in the application of novel statistical procedures to the problems of the mind. * Thomson's chief object has been to include a fuller and more up-to-date account of Professor Thurstone's recent contributions to the subject. Comparatively little is said about recent work in this country. But this after all has been concerned not so much with the discussion of methods as with the attainment of results. Moreover, summaries of British investigations, and of concrete conclusions so far reached, are already accessible; whereas Thurstone's contributions are for the most part to be found chiefly in American periodicals, which are highly technical and as yet not easily obtainable even in academic libraries. Pending a new book by Thurstone himself, some such account as Thomson gives us is urgently needed, and the exposition is marked by all his lucidity and comprehensive grasp. It might, I think, be fairly claimed that modern factor-psychology is a natural develop-

ment of Galton's early teaching. "Galton's idea of general intelligence," as Professor Pintner has pointed out, "has not only had a great influence on psychological thought, but is very like the psychological conception at the present time." Rejecting the current view of discrete levels or types (imbeciles, dullards, normals and defectives), he proposed to treat "natural ability" as a continuously varying factor, entering into and determining a wide range of intellectual activities, and capable of indirect measurement. But in addition he also assumed the existence of a number of more specialized abilities, manifested only in limited groups of activities—group-factors, as they would now be called. To him, too, we owe the notion of constructing psychological tests to assess these various abilities and of estimating the value and nature of the tests themselves by statistical calculation. Above all, the fundamental tool of the factorist—the coefficient of correlation, as a device for measuring the degree of joint variation produced by a common factor—was Galton's special contribution. The reader of this review, a little bewildered perhaps by subsequent controversies between the different schools of "correlational psychology," will want more particularly to know how far current factor-analysis bears out the underlying assumptions made by Galton, and in what direction Professor Thomson's own investigations appear to be tending. The earliest theories advanced by the psychological factorist sought first of all to simplify the double hypothesis, which eugenic writers (amongst others) took over from Galton. Need we assume the existence *both* of a general factor *and* of a multiplicity of group factors? In a summary of the earliest efforts to apply correlation methods to the results of psychological tests (*Eugenics Review*, 1912, pp. 1–33) I myself assumed that a number of inheritable mental factors were bound to be postulated, special as well as general. In a later contribution on "The Heredity of Abilities," Spearman argued that "the future of research into the inheritance of ability must centre on the theory of two factors"—a far simpler assumption. And in the present volume Thomson opens his discussion by an examination of this attractive theory, since that sets out the factorial hypothesis in its simplest possible form. Spearman's theory maintained the supremacy of a single central factor (g), and denied, or at any rate doubted, the need for a number of "basic faculties" as well. Thomson, on the other hand, showed that correlation tables, like those adduced by Spearman, could be explained by group factors only, without invoking any general factor. Twenty years later, when Thurstone entered the field, he too seemed highly sceptical about the need for anything besides group factors. "So far," he wrote, "we have not found the general factor of Spearman." Admittedly the preliminary analysis, which he makes with the aid of the simple formula used by many workers in this country, does yield a statistical factor, which is "general" in Spearman's sense. But by "rotating" the results so obtained, Thurstone is able to explain the empirical correlations in terms of a "simple structure" of group factors only. And if, as he proposes in his later work, we are willing to accept structures that consist, not necessarily of "orthogonal" (or uncorrelated) factors, but also of "oblique" (or correlated) factors, then we can, it would appear, always dispense with a general factor. And thus, as Professor Thomson puts it, "Spearman's g" seems to have been "apparently abolished." However, as he goes on to observe, the critics are now apt to complain that "when obliquity is permitted, simple structure is all too easily reached to prove anything." But more recently still Thurstone has suggested that, just as we factorized the correlated tests, so we may go on to factorize the correlated factors. This yields what he terms "second-order factors"; and we then discover "a hidden general factor causing the obliquity." Thus, in Thomson's words, "we see here a distinct step towards a reconciliation between the two analyses" of the conflicting schools. The onlooker will be tempted to add that the old method of analysing a correlation table into a single general factor and a number of group factors gave much the same result at a single step. And so we seem at length to be returning to the broad hypothesis, assumed by Galton and favoured all along by most educational psychologists, that the constitution of the mind includes *both* a general ability *and* a number of more specialized aptitudes. The eugenist will naturally inquire how far it is safe to identify the abstract factors of the statistical psychologist with the inheritable factors that interest the genetic psychologist. Here Thomson quite rightly warns us to go carefully. "What the factorist calls the verbal factor, for example, is something very different from what the world recognizes as verbal

ability." And in his earlier writings he appeared to regard the general factor, not as in any sense identifiable with an inheritable quality of the mind or central nervous system, but rather as a statistical artefact: he was "not personally a believer in the existence of a faculty called general ability." But in the present volume he seems ready to accept the idea of such a factor, provided it is interpreted as "an index of the span of the whole mind," or, as he has very acutely expressed it elsewhere, as "a sort of *volume* of the mind which does not give any indication of its *shape*." Moreover, in a sentence added in the new edition, he admits that the divergence between the two interpretations is not so wide as formerly appeared. We can therefore discern a progressive convergence of views as time goes on, which is certainly encouraging for those who recall the old disputes and controversies. Let me repeat, however, that Professor Thomson's main task is not to give a picture of the constitution or structure of the human mind, but rather to describe and evaluate the mathematical tools devised for analyzing that structure. And this he has done with admirable clearness and completeness.

J Am Stat Assn 42:199–200 Mr '47. John W. Tukey. This book should be read by everyone interested in factor analysis, whether he is an active user or a mere bystander. To read the body of the book and to understand it, a minimum of mathematics is needed—yet the reader will learn something of all the major questions which have been debated by the factor analysts. As an example of the difficulties of interpretation which can and do arise in applying the quantitative method, it is of interest to all statisticians. * Thomson considers only the application of factor analysis to mental testing....yet his comments are so well-chosen and searching that they are required reading for anyone interested in any application of factor analysis or in any study of the mind. * the author [used wisdom] in discussing many of the problems which do not involve sampling before bringing in its added complications. All important principles of factor analysis are discussed, but not all computational procedures. * In his third part, Thomson shows clearly how selection of the persons influences the nature of the factors found for a given battery, and points out that this makes the conventional standardization of test scores—namely, mean zero and unit variance for the particular sample used—exceedingly suspect. It is the practice of most analysts to analyze correlations, which amounts to using this standardization. (The best that has been said about standardization is that it is better than using raw scores.) Going this far, Thomson fails to take the next step, that of stating as a basic problem in this field—*How should the test results be expressed for such an analysis?* A new principle is badly needed, and it seems to the reviewer that, when the principle is found, it will not make the mean score for each particular test and sample zero—there will be valuable information to be gained by analyzing sample means as well as the variation within samples. If this takes place, then the lack of symmetry in the interchange of persons and tests, on which Thomson comments acutely, will tend to disappear. In his discussion of simple structure and multiple factor theories in general Thomson hints at the possibility that the experimenter may have something to do with the appearance of factors. There is nothing immoral in such an occurrence, and the whole subject deserves more study. If the experimenter is a good psychologist, in an objective sense, and if he places 17 tests in his battery which he thinks measure a "verbal factor," then he must be right, to some extent, and a suitable technique must find a "verbal factor." This influence of the experimenter is even more important in connection with Thurstone's idea of simple structure. The psychologist develops a system of ideas about tests in a certain field—which tests are simple, what are the "pure" abilities, *etc.*,—composes a battery, gives it to a sample, finds a simple structure. The sample has confirmed, quantitatively, the *consistency of the psychologist's system of ideas* and this is all. Mathematically, it is easy to construct a new system of ideas, shall we say for a Martian psychologist, which will also lead to simple structure. *The decision between these two systems cannot rest on whether or not they lead to simple structure*—it must be based on such qualitative considerations as consistency with psychological thought as a whole. The factor analysis has tested the psychologist rather than the population. In his chapter The Sampling of Bonds, Thomson states that "the physical body has an obvious structure which guides our measurements. The mind has, comparatively speaking, no organs. We can, and do, measure it almost from anywhere to anywhere." Taking the book as a whole, it is fairly conclusively shown that this

point of view cannot be proven or upset by factor analysis, hence, if it is to be upset, this must be done on more directly psychological or genetic evidence. The reviewer dares to conjecture that it will be upset.

J Am Stat Assn 42:342–4 Je '47. Helen M. Walker. * Almost all of the first edition of this book has been retained. The first fifteen chapters (240 pp.) have received such revision as could be accomplished without affecting pagination, and two subsequent chapters "Limits to the Extent of Factors" and "The Sampling of Bonds" and the mathematical appendix are practically unchanged. Some new material has been inserted at the ends of some of these chapters, minor numerical corrections have been made in certain examples, N has been replaced by $N - 1$ in the denominator of several formulas, and references to Addenda at the end of the book have been inserted. The section on Simple Structure has been completely rewritten and greatly amplified. There are new chapters on Oblique Factors, Second-Order Factors, the Maximum Likelihood Method of Estimating Factor Loadings (written by D. N. Lawley), and a searching final chapter entitled "Some Fundamental Questions." Presumably the economies of postwar publishing dictated this manner of revision which at times produces a rather disjointed effect. For example, a four-line paragraph was inserted stating that the use of the standard error of r should be discontinued unless the sample is large and r small and referring to an Addendum where the use of Fisher's z-transformation is explained. Yet throughout the book the earlier treatment making use of the formula $(1 - r^2)/\sqrt{N - 1}$ for the standard error of r has been retained, without even the suggestion that this r is the population and not the sample value. Other illustrations could be adduced of an improved technique which is carefully presented in one of the new sections of the book but which has not replaced a less satisfactory technique in the sections carried over from the first edition. Therefore the reader should be warned that the book must be read in its entirety and in particular the Addenda must not be overlooked. * The book....contains no practice material, no exercises, no lists of questions or other stigmata of the textbook. There is far less emphasis on matrix algebra and economical routines for computation than is found in most of the books and articles about factor analysis published in the United States and far more emphasis on underlying philosophy, meanings, and interpretation. If any one imagines that mastery of matrix algebra and n-dimensional geometry will be sufficient equipment for making basic contributions to factor analysis, he should with a humble mind read and ponder Section V, "The Interpretation of Factors," in particular the chapters on "Definition of g," "The Sampling of Bonds," and "Some Fundamental Questions." American readers may be surprised that the strong emphasis on Spearman's Two-Factor theory, present in the first edition, has been retained. American writers tend to treat the Two-Factor theory as an interesting and important stage in the historical development of Factor Analysis about which a well-educated factorist cannot afford to be completely uninformed. Thomson like most English writers accords it a more prominent role * Several topics are treated here which have not yet found their way into textbooks printed in America. Part IV presents an admirable brief exposition of the somewhat controversial idea of correlations between persons, a topic upon which much has been printed in England but almost nothing in America. The material presented in Lawley's chapter on "The Maximum Likelihood Method of Estimating Factor Loadings," otherwise available only in English periodicals, is of great importance particularly because it offers the most satisfactory solution thus far furnished to the vexing problem of significance tests as to "when to stop factoring." Mention of certain points which appear to the reviewer as flaws must be made in passing. On page 9 a possible solution of a set of five linear equations with six unknowns is presented as though it were a necessary solution. The concept of mathematical expectation is no more difficult than many other concepts presented here, and its use in such discussions as that of the sampling distribution of tetrad-differences on page 47, together with a statement of the assumptions as to independence of samples, would make the treatment theoretically better. Variates with zero mean and unit variance are called "standardized" and the comment is made that about two-thirds of them lie between plus and minus one. Variates with zero mean and variance equal to the number of cases are called "normalized." This is likely to make the untutored reader assume normality of distribution where such is not necessary. The geometric picture presented in Chapter IV is highly

confusing and it is regrettable that it was not completely rewritten in line with the suggestion acknowledged in the Addenda. If a reader is not already familiar with the space in which orthogonal axes represent individuals and a single point represents the scores of all individuals on a single test, so that the cosine of the angle between two test vectors represents the coefficient of correlation between those tests, the reviewer does not see how he could gain clear understanding from this chapter. If he is already familiar with this idea, he will be puzzled to be told that individuals are represented by points along the test vectors until he learns from the Addendum that individual axes have been projected on the test vectors. No serious student can afford to remain unfamiliar with this book. If he is exclusively interested in algebraic manipulation or even in mathematical theory, it will irritate him in a highly therapeutic manner and give him new points of view. If he is primarily interested in the psychological interpretations to be made from factor theory and puzzled by the controversies in this area, he will be grateful for the penetrating analyses found here. *

For reviews of the first edition, see 2:288.

[291]

★THOMSON, GODFREY. **The Factorial Analysis of Human Ability, Third Edition.** London: University of London Press Ltd., 1948. Pp. xvi, 392. * For latest edition, see 292.

A.M.A. 44:94 F '49. The appearance of the third edition of this book is a further justification of the estimate we made of its importance in our review published in February, 1939. Not very many changes have been made, but three sections have been inserted on the identity of oblique factors after uni-variate selection, on multi-variate selection and simple structure, and on parallel proportional profiles. There are also other minor alterations.

Brit J Ed Psychol 19:65 F '49. The fact that this standard work has now reached the third edition, is a testimony both to the high standard of the treatment of a difficult subject, and to the increasing interest in statistics as applied to psychology. * now, more than ever, an essential textbook for the statistical psychologist.

J Ed (London) 81:232 Ap '49. C. M. Fleming. * a welcome third edition of Professor Thomson's *Factorial Analysis of Human Ability.* This offers his reaction to Thurstone's recent work, and reiterates that wisely balanced discussion of the implications of such analyses which provides the best corrective to the loose use of technical terminology in current references to the divisibility of pupils into distinct types. His findings are in line with other recent emphasis on the functioning of the mind as a whole and they make no undue claims for the possibility of prediction in terms of the symbols *g, v, k, s,* or *F.*

Math Gazette 32:315 D '48. J. Wishart. * Within the limits of printing difficulties in the way of wholesale revision, a good deal of trouble has been taken to improve the presentation, both in bringing the subject-matter up-to-date and in using more refined statistical methods. The readability is not impaired, and the racy style and undoubted authority of the author make this a book to be commended to those who wish to master a subject which is becoming of increasing importance in the fields of psychology and education. The mathematician will find much to interest him in the exposition of this particular example of a mathematical statistical problem.

Scottish Ed J 31:757 D 24 '48. The first edition....was welcomed in *The Scottish Educational Journal*....as a praiseworthy attempt to make an intricate subject intelligible to the non-statistical reader. The fact that in spite of the war years a third edition has been called for may be taken as proof of the success attending the author's efforts.

For reviews of earlier editions, see 290 and 2:288.

[292]

★THOMSON, GODFREY. **The Factorial Analysis of Human Ability, Fourth Edition.** London: University of London Press Ltd., 1950. Pp. xvi, 394. 20*s.* * (Boston, Mass.: Houghton Mifflin Co. $5.50.)

For reviews of earlier editions, see 290–1 and 2:288.

[293]

★THURSTONE, L. L. **Multiple-Factor Analysis: A Development and Expansion of *The Vectors of Mind.*** Chicago, Ill.: University of Chicago Press, 1947. Pp. xix, 535. $7.50. (London: Cambridge University Press. 42*s.* *)

Am J Psychol 61:129–31 Ja '48. Robert J. Wherry. While the more discursive style, the frequent rewriting, and the addition of much new material make the new book much more than a mere revision, the theoretical framework laid down twelve years ago is still intact. The

present *mathematical introduction* (pp. 1–50) adds material from two former appendices and a new section on the computation of an inverse. The reader must master this section if he is to understand what follows. Both old and new readers will appreciate and profit by the convenient new summaries of terminology and concepts which appear at the ends of Chapters II and IV. The most important new contribution for the advanced student, from this reviewer's point of view, is the discussion of the multiple-group method of factoring (170–175). The student will profit from reading earlier sections on the grouping method (111–116) and on the group centroid method (157–161) before undertaking the final complete method, in case he does not care to read directly through the text. This procedure, which eliminates the successive residual tables, will tremendously reduce the work required when several factors are present. It makes the mechanics of factor analysis almost easy. A similar method for securing principal axes rather than centroids, derived by Ledyard Tucker, still gets factors one at a time but does eliminate the residual tables. This method "looks promising, but it had not yet been tried extensively" (497). The second most important contribution for the advanced student is the discussion of the effects of selection (440–472). An understanding of this section, which tells how selection of subjects and selection of tests affect factorial outcome, will be invaluable in planning and interpreting factor studies. This section is heavily weighted with the ideas of Godfrey Thomson. Incidentally, the discussion of the Heywood case, where the communality appears to be greater than unity, again following Thomson (289–290), will prove interesting. The remaining contribution, beyond a clearer presentation of basic concepts, is a great elaboration on the use and interpretation of oblique axes. Several new rotation techniques (Chapters X, XI, and XII), an extended discussion on oblique structure (Chapter XV), and a new chapter (XVIII) on second-order factors constitute the bulk of this elaboration, whose usefulness the reviewer doubts. The reviewer parts company with Thurstone with respect to the use of correlated factors. Despite the fairly brilliant plea for non-orthogonal factors (139 *ff.*), as just indicated, this reviewer still believes in orthogonal factors. It is true that "height and weight are two useful measures of body size, even though they are correlated;" but, to the reviewer, height is a primary factor while weight is a complex consisting of height × width × depth × specific gravity. Again, if one selects only subjects of the same specific gravity, height and weight will be even more strongly correlated than before, but that doesn't make weight a primary factor. Thurstone seems to see this briefly when he says (footnote, 458), "Our interpretation is that the primary factors represent the same basic processes in different conditions of selection and that it is the correlations between these parameters that are altered rather than the fundamental meaning of the parameters themselves." This reviewer would rather hold that true primaries (height, specific gravity, *etc.*) must be orthogonal even though complex traits (weight, volume, *etc.*) must be plotted in the hyperplanes rather than on intersections of those planes. The reviewer recognizes that his own belief in orthogonality is, as Thurstone claims, based upon "ignorance of the nature of the underlying structure of mental traits," but is convinced that Thurstone's belief in correlated primaries is based upon that same "ignorance." It is the fear that this ignorance might set up psychological "primaries" of such "complexes" as the psychological counterparts of weight, volume, and the like, in place of insisting on the discovery of true [illegible] primaries, which will be the psychological counterparts of specific gravity and height, which causes him to make this plea for orthogonality. This point is stressed because Thurstone says that "In the methods that we have developed, each author is still free to impose orthogonality on the factors if he so chooses or if the nature of his problem is such that this restriction is indicated" (140). Granting this freedom, it still follows that, if one adheres to orthogonal factors, most of the more complicated portions of the text (the material on oblique axes listed above) become useless and meaningless. This reviewer looks upon these sections as dangerous, and he advises skepticism. In all other respects we agree heartily with Thurstone. In his plea for communalities, in his stand for interpretation only after meaningful rotation, and in his emphasis upon the important rôle of the psychologist as both planner and interpreter, are to be found the strength of his system. This new work explains these basic principles more clearly than did the earlier. All workers in this field will gain much from the book. The text is clearly

written, amply illustrated and well indexed. References are almost exclusively to work at the Chicago laboratory, but this delimitation is an asset. The volume is a valuable and much needed revision and extension of *The Vectors of Mind.*

Am Math Mo 54:613–5 D '47. J. W. Tukey. This book will be of direct interest to teachers of linear algebra, since it is a thorough and comprehensive account of the best-known approaches to the leading application of real matrix theory. * Plane figures and photographs of three-dimensional models do more than in any other book known to the reviewer to stimulate the reader's geometrical intuition. It should be of great value as supplementary reading for courses dealing with vectors and matrices, and with its consideration of practical and well-tested computational methods, it might well serve as one of the texts. It can be recommended for independent reading. Any mathematician interested in the methodology of quantitative science, in the application of mathematics to science, or in the basic problems of educational measurement, will find time spent in reading the carefully reasoned discussions and pondering over the ideas developed to be time well spent. The author makes his points carefully, and with painstaking thoroughness. The reader with these interests will do well to combine the reading of Thurstone's book with that of Godfrey H. Thomson's second edition of *The Factorial Analysis of Human Ability.* Between them there is a great store of careful and wise thought about the nature of scientific method and wise application of mathematics in science. This is the philosophy of scientific method in general, and not that of psychology alone. Regarding *Multiple Factor Analysis* as a second edition of *The Vectors of Mind,* one finds, in addition to the expected features of greater coherence, greater scope and inclusion of modern advances in theory and practice, two important improvements: (i) a greatly improved and seasoned philosophy underlying the method, (ii) an exceedingly careful and thorough exposition. * It is only fair to notice, that, although the explanations are well and carefully done, many readers will find the language and presentation a little dull. * One recurrent mathematical error mars the high polish of this work, even although it is a minor scratch. On pages 93, 183, 343 and possibly elsewhere, the author states that a set of vectors, each of which lies within 90° of each other "must be contained within a cone of 45° generating angle." The author's figure on page 184 shows clearly that this is already false in three dimensions for three vectors near the coordinate axes. The three references above were easily gathered from the magnificent index, extending over 18 pages, which is the best the reviewer has seen for many a day. Like the careful presentation, the careful index sets a mark toward which other authors should strive.

Brit J Ed Psychol 17:163–9 N '47. Cyril Burt. During the last ten years no book by an American psychologist has been so frequently studied and quoted in this country as Thurstone's *Vectors of Mind;* and I venture to predict that his new volume on factorial methods will arouse an even wider interest. It has been announced as a "development and expansion" of the earlier textbook. It is, however, much more than a revised edition. * a large amount of new material, much of which has hitherto been accessible only in isolated articles, has now been brought together for the first time. * Of the newer additions, the most important are the section on geometrical and spherical models, the instructive discussion of configurations and factor patterns, two chapters on simple structure and oblique structure, respectively, and the description of second order factors and the effects of selection. The book thus presents a complete and systematic statement of Thurstone's views on factor-analysis up to date, and will be indispensable to every advanced student who is specializing in the subject. Thurstone's discussions should be of particular interest to English educationists at the present juncture. The practical problem now confronting them happens to be essentially a problem in mental factors. In the innumerable committees and conferences that have been called to discuss the allocation of children under the new Education Act, the first question to be asked is nearly always this: Can pupils at the age of eleven be divided into three main groups on the basis of three main "primary abilities," or can we only arrange them in a single linear sequence, based on what is loosely called "general intelligence"? And educational [illegible] are now joining in the debate. In favour of the latter view Spearman's "general factor theory" is commonly quoted; in favour of the former, the authority most frequently cited is Prof. Thurstone himself. Thurstone, as is well known, has published

a set of *Tests of Primary Mental Abilities* suitable for children aged eleven and upwards; and has stated that "we have not been able to find in these data any general factor that is distinct from the primary factors." However, in his recent pronouncements he has emphasized an important qualification. The various "primary abilities" that make up what he calls a "simple structure" are themselves correlated; and underlying them he now discerns a "general factor of the second order." Accordingly, much of his new volume, as he tells us on the first page, is concerned to explain more precisely his conception of a "simple structure," and to expound in fuller detail his latest views on "second order factors." As originally defined, a unique simple structure seemed by its very conditions to preclude a general factor altogether. But, just as we factorized our correlated tests to obtain factors of the first order, so we can factorize our correlated factors to obtain factors of the second order. And among these a general factor may permissibly appear. This further step, he believes, may enable us to "reconcile three theories of intelligence—Spearman's theory of a general intellective factor, Godfrey Thomson's sampling theory, and our own theory of correlated multiple factors." How far has this reconciliation proceeded? To begin with, educationists in this country will naturally turn with special interest to Thurstone's account of what he calls "the type of factor-analysis current among British psychologists." But here, I fancy, his criticisms may suggest that the actual gap between his views and those held in this country is far wider than is actually the case. His chief complaint is that British psychologists have treated group factors as mere "disturbers" of the single factor hypothesis, and as of no psychological interest in or for themselves. Thus, in his preface (p. viii) he starts out by affirming that, "when multiple factor analysis was introduced in 1931....papers being published were mainly concerned with the existence of Spearman's central intellective factors,....and group factors were regarded as the 'disturbers' of the general factor." The phrase is echoed in his section on "general and group factor" (p. 188); and, when he comes to discuss "the special case of unit rank," he opens the chapter by observing that "this case is of historical interest, because it was the case to which students of factorial theory devoted almost their entire attention for a quarter of a century" (p. 259). A little later (p. 273)† he again remarks that all other factors besides the general factor were considered to be merely "disturbers" of the tetrad equation, and avoided by eliminating similar tests; "thus," he adds, "if two number-tests were in a battery, their correlation would introduce a number factor, and the tetrad equations would not be satisfied; instead of adding more number-tests in order to investigate number ability, the preferred procedure was to keep only *one* of the number tests, eliminating the others." "This type of factorial analysis," we are told, "is still current among British psychologists. Most of them have not yet adopted the multiple factor methods." And much the same picture is presented yet again in the last chapter but one (p. 473). Now the account here depicted may be true enough of the procedure adopted by Spearman (who alone, I fancy, has used the term "disturbers") and by his own immediate followers. But it by no means applies to "British factorial analysis" as a whole. Indeed, Spearman's own attacks on rival theories, particularly those which were in their essential nature developments of the "Galton-Pearson school" (as he termed it), and his repeated criticisms of those who advocated group factors, should suffice to indicate that there were many factorists in this country, long before 1931, who had voiced much the same objections as Thurstone himself now brings forward. The last chapter but one in the book is devoted to that form of multiple factorization known as the "principal axes solution." This procedure receives his warmest approval. Indeed, he declares that, "when the principal axes solution becomes available with less computational labour, it will no doubt be preferred by all students of this subject." He introduces his account of it by again pointing out that, before the publication of his first papers, factor analysis had been engrossed with the problem of a "single general factor," and speaks as though the "extension of the factor problem to any number of dimensions" was not made until a comparatively late stage. This impression has become increasingly common among educational writers, not only in America, but also in this country; and those whose memory goes back to the lively discussions on

† My name is given against this page in the index; so it would appear that Thurstone associates my views with this description. He is right in supposing that I regard group factors as "secondary" to the general factor, if by that he means that, as a rule, I find the contribution of the general factor to the variance to be much larger. But this does not imply that I regard the other factors as mere "disturbers."

factorial work during the first decade or so of this century will agree that it urgently calls for correction. As it happens, the very first suggestion ever put forward for factorizing a correlation table was based on a multifactor principle, and consisted precisely in the "principal axes solution." Galton, it may be remembered, had suggested that the most economical description of a given batch of individuals would be secured if we selected for measurement those traits which had the lowest possible correlations with each other. Pearson went further. He pointed out that, by *combining* the observed measurements in appropriate ways, we could secure a set of hypothetical traits whose intercorrelations were all *exactly* zero, and so push Galton's principle to its logical conclusion. In that case, the "ideal index characters," as Pearson termed them, would be weighted averages, calculated by equations which he expressed in the form

$$X_1 = l_{11}x_1 + l_{12}x_2 + \cdots l_{1n}x_n,$$
$$X_2 = l_{21}x_1 + l_{22}x_2 + \cdots l_{2n}x_n, \ldots \text{ etc.}$$

where X_1, X_2, *etc.*, denote the "ideal index characters," x_1, x_2, *etc.*, the observed measurements, l_{11}, l_{12}, *etc.*, are "numerical multipliers" (or "weights") giving the "directions" of the new "dimensions" (or axes). There is, of course, an indefinite number of ways in which (as Pearson put it) "n correlated variables can be expressed in terms of n uncorrelated variables." Pearson, basing his proposals on his own theory of multiple correlation, claimed that the best values (*i.e.*, the closest fit) would be given by taking "the principal axes of the correlation ellipsoid."† Now this procedure, put forward more than forty-five years ago, is absolutely identical‡ with that so warmly praised by Thurstone towards the close of his book. Thurstone reminds us that before he adopted what he calls the "centroid" method, this was the solution which he himself first thought of using in his earliest papers on multiple factor analysis; and he adds that the solution itself was "suggested to the writer in 1931 by Professor Walter Bartky, of the Department of Astronomy in the University of Chicago." Here, as a matter of fact, American experience has followed much the same course, and for much the same reasons, as British factor analysis. With us, too, the method of principal axes, or "weighted summation" as I have called it, came first; and was later replaced by the method of "simple summation," which is identical with what Thurstone calls the "centroid procedure." And the reasons were much the same. First, the original method was far too laborious to be applied in actual practice; and secondly it was easy to show that, even with a correlation table based on 3,000 cases (like that to which Pearson was referring), only three or four of the common factors which Pearson proposed to extract would, at the most, be statistically significant. Spearman's first paper, to which Thurstone so often refers, followed Pearson's suggestion by about three years; and went to the opposite extreme of simplification. Pearson proposed to extract the maximum number of factors; Spearman the absolute minimum. Instead of reducing n observed variables to n hypothetical factors, he maintained that, at any rate in the sphere of mental testing, such variables could always be expressed in terms of a single general factor only, because (so he contended) the remaining factors could be shown to be "vanishingly minute." In point of time, therefore, the "theory of a single general factor" appeared as a simplified substitute for a multiple factor theory. The multiple factor theory was not a later innovation, reached by "extending" the single factor theory; it was a natural corollary to Pearson's theory of multiple regression. To suppose, as Thurstone does, that British factorists regularly eliminated all group factors by dropping every test but one from any ascertained "group" is quite erroneous. Take Thurstone's own instance, that of the "factor for number." As early as 1917 (in *Distribution and Relations of Educational Abilities,* where the centroid formula was first printed), we encountered, together with several other group factors such as Thurstone has since described, a factor for number

† *Biometrika,* I (1901), p. 209. Pearson's proposal related to *physical* characteristics. There he showed that, besides the effects of the general factor (as we should now call it) accounting for Darwin's "general correlation of growth," we had to recognize augmented correlations due to the specific "correlation of like parts." Spearman's argument amounted to a denial of this supplementary source of correlation in *mental* traits. Needless to say, Pearson strongly dissented.

‡ This is still more obvious on turning to the paper in which, some years later, J. McMahon endeavoured to work out this and related problems more systematically by adopting, at Pearson's suggestion, "the trigonometry of higher dimensional space" (*Biometrika,* XI, esp. pp. 194 *et seq.*). Thus, the "fundamental factor theorem," to which Thurstone says he was led, was given in McMahon's equation 75 (p. 195); and the "diagonal method" which Thurstone describes as "perhaps the simplest of the factoring methods," was also described by him (p. 194). But the most explicit formulation of the "fundamental factor theorem" was that given by J. Maxwell Garnett (formerly lecturer in Pearson's department): *cf. Proc. Roy. Soc.,* XCVI, 1919, equation 16, p. 96. His multidimensional diagram is, I think, the first example of the geometrical method of representing correlated tests and factors of which Thurstone has made so much use; and his various papers were the first to give a detailed and rigorous proof for the essential formulae of multiple factor-analysis.

or arithmetic. Instead of "keeping only one of the number tests" and dropping the other, we deliberately went on to "add more number tests to the battery." In reporting the results (obtained by several school teachers working quite independently), I claimed that, so far from "disturbing" our theory, the presence of these additional factors fully bore out the hypothesis which I had formulated some years before,† and which, as it seemed to me, merely put into explicit form the prevailing view of most experienced teachers and educationists, namely, that educational performances are the result of *both* a general factor of intelligence *and* a set of specialized abilities. And I argued that, since more than one common factor was plainly involved, the problem required to be "attacked by the statistical method of multiple correlation." What was the prevailing opinion in this country at the period to which Thurstone refers may be easily ascertained by referring to the Report of the Board of Education on *Psychological Tests of Educable Capacities* published in 1924. The Board's Consultative Committee collected answers from leading British educationists and psychologists on two main issues, namely, the status of the general factor and the status of special or group factors, respectively. A few still doubted the proof of Spearman's *g;* but nearly every one of the replies stressed the practical importance of group factors. It was, for example, urged that they should be taken into account in both vocational and educational guidance—*e.g.,* in selecting older pupils for special types of education, for the "literary" or the "mathematical" sides of secondary schools, and for trade schools or technical institutes. A year or two later, when I revised and published my own memorandum to the Board (*The Measurement of Mental Capacities*, 1926) it was possible to claim as many as twelve different cognitive factors. This list, it may be added, includes practically all the "primary abilities" since independently discovered by Thurstone. Finally, I should have thought that the constant reference to group-factors in our discussions of the backward child and his various educational disabilities would have made it quite clear that we were far from underrating the existence of such factors. On this main issue, therefore, I think it may safely be contended that the differences between Thurstone and British factor-analysis are far smaller than he believes. Indeed, the very fact that, independently and (as he supposed) in opposition to older views, he himself has arrived at a list of factors so closely analogous to ours is a welcome testimony to the value and trustworthiness of the factorial procedure. The chief difference between Thurstone and myself‡ has been that I have always insisted on the presence of a general factor *in addition* to the group factors or "primary abilities." But even this difference, as we have seen, now promises to vanish with the admission of a general factor of the second order. The older scheme, which brackets "general and group factors" among factors of the *first* order, is made the subject of a brief section in Thurstone's admirable chapter on "alternative factor patterns." His chief objection is that, with such a pattern, "there is some uncertainty in the interpretation of the factors." He suggests that "a new factor experiment should then be made in which it is predicted that the first factor should be absent"; for, with a wider variety of tests, the general factor will probably turn out to be a group factor after all. With that again I fully agree, though Spearman would not. As early as 1914, I argued that the general factor common to all "cognitive" abilities might, for all we knew, extend to non-cognitive traits also, and that it was, therefore, logically desirable to include assessments of emotional and conative characteristics, so as to show, beyond all question, that the factor had zero saturations for all besides cognitive traits. Actual experiment then revealed that there were two "general factors"—one common to cognitive and the other to emotional processes. Thus, the so-called "general" cognitive factor, it was declared, is

† *Child Study*, IV (1911), p. 95, and other papers This was called a three-factor hypothesis, since it included three kinds of capacity (those applicable in all directions, in several directions, and in one direction alone).

‡ A word or two may be expected from me in answer to some of Thurstone's more specific criticisms. In the main I should accept the views he himself advances, though his form of statement appears to attribute to me opinions that I do not actually hold In his preface he states that "Burt....does not accept the necessity for rotating the reference frame for purposes of interpretation; neither does he accept the use of oblique axes....The configurational interpretations are evidently distasteful to Burt, for he does not have a single diagram in his text." I do not regard rotation as *invariably* "necessary," because the "group factor methods" that I have used often yield the same results in a single step. But I do not reject it; on the contrary, I have described several methods of effecting such rotations by arithmetical calculation: it is rather the graphical methods of rotation that I am tempted to deprecate, at least for accurate research. I certainly prefer orthogonal to oblique reference-axes, but again I should not reject the latter, where the conditions seem to demand it Diagrams of configurations I consider helpful; and have frequently used stereographic, globular, and gnomonic projections for class illustrations. Indeed, I fancy the first attempt to depict the configuration presented by a set of correlated traits were the circular trigonometrical diagrams which I myself published in 1915 and 1917. However, in the war-time publications to which Thurstone refers, diagrams had to be reduced to a minimum.

after all "merely the group factor of widest extent." But this is very different from the suggestion that with every battery of tests we should insist, so far as we can, on getting a "simple structure," whether the tests have been planned to exclude a general factor or not. Some of the apparent divergences between British and American views have doubtless arisen from the fact, that in the early days, most British work was carried out on children and most American work on adults. In the United States, from Wissler's historic study of general and special abilities in 1901 to Thurstone's well known monograph on *Primary Mental Abilities,* the more outstanding contributions have been based on data obtained by testing students. Even when school children are tested, they are chosen by grades, not by complete age-groups. Critics in this country have, therefore, argued that the low correlations thus obtained, and the lack of evidence for a general factor consequent on such low correlations, might spring largely from the fact that students or pupils in a single grade form a selected and relatively homogeneous group. In such cases British psychologists would seek to correct for such selection, if they could not otherwise avoid it. With this object in view Thurstone now adds a valuable chapter dealing with the effects produced by such selection in the observed correlations. The essential formulae are those of Karl Pearson, though Pearson's work is unmentioned. Thurstone's own discussion, however, as well as his ingenious diagrammatic illustrations, is at once original and suggestive. An important conclusion is eventually deduced, namely, that "a simple structure is invariant under widely different selective conditions." Godfrey Thomson, whose contributions to the subject are fully acknowledged by Thurstone, has taken, as Thurstone points out, a more "pessimistic" view, and argued that the effects of selection "make it very doubtful indeed whether any factors have absolute meaning."† In this country most of the early work on factor analysis was undertaken by teachers and others working in elementary schools. Under these conditions it is far easier to test complete age-groups; and the problem of selection thus hardly arises. Moreover, since children of that age (as Thurstone acknowledges) tend to be far less specialized in their abilities and interests than older children or adults, it is not surprising that British psychologists have found the general factor to be far more conspicuous. Thurstone, in administering his tests for primary abilities, has decided to work downwards in successive inquiries. He began with students; and proposes to take groups of children at successively younger ages. He definitely anticipates that there is likely to be more evidence for a general factor with the youngest groups. Here, as on many other points, Thurstone now appears to be approaching much closer to what (in his own phraseology) I may venture to call the "British school." For example, he believes it desirable to consider the logic of factor-analysis; and this leads him to views very similar to those advanced over here. Thus, whereas he previously seemed to regard factor-analysis as essentially a device for "discovering faculties," he now describes its aim as the discovery of "categories," *i.e.,* of classificatory principles. And he no longer writes as though factor-analysis was limited to the study of abilities; but emphasizes that it is applicable to temperamental, physical, even environmental data, and, in fact, to the problems of almost any complex science. It does not necessarily follow that on these or other matters Thurstone has altered his fundamental opinions; but he has certainly rendered them more explicit. On one point, however, he has unquestionably reversed his former belief; previously he held that, if the general intellective factor were established, it would probably prove to be a mere "maturation factor." A similar view was put forward by Kelley; and has occasionally been expressed by educationists in this country. No doubt, they were correct in surmising that the large general factor found by Spearman with his early tests was due mainly to the fact that the children he tested differed widely in age. But in later researches it was found that, though maturation tends to enlarge the range of individual variation in tests of almost every type, nevertheless, as children got older, their increasing maturation actually reduces the relative importance of the general factor, and magnifies that of the group factors. On the other hand, analysis of data from unselected samples of adults shows that the general factor never wholly disappears; it still remains the largest contributor to individual

† In the latest edition of his own book, however, Thomson has observed that "Thurstone's new work on oblique factors entitles him to hope that invariance of factorial structure may be shown to persist." Neither writer has dealt with the effect of selection on a factorial structure consisting of both general and group factors; but here, I think, it is possible to show that such selection as obtains in actual practice does not seriously affect the factors obtained, though of course it modifies their saturations.

variance, even when maturity is complete. Thurstone now appears to accept this contention. "Factorial results at different age levels," he says, "have recently shown that such a hypothesis (the maturation hypothesis) is probably wrong." He does not, however, go on to specify which of the two remaining alternatives he now considers to be right, *viz.* (*a*) that the general factor is after all a factor for general intellectual ability, or (*b*) that there is really no general factor to be explained. Elsewhere he states that the orthogonal reference-frame (consisting of one general, *G*, and several group factors, *a, b, c...*) "is preferred by some students rather than the frame *G, A, B, C,* which is oblique" (where *G* is a "second order" factor and *A, B, C* are "primary" factors); and his tone implies that he does not reject the former mode of analysis, though he personally prefers to work with correlated "primaries." In this and in many other ways it would seem that factorists of opposite schools are now at last approaching a common ground of general agreement. And, whether we accept Prof. Thurstone's own hypotheses or not, there can be no question that they are stated and developed in a way that is at once logical and suggestive. At times, owing to the complexity of the issues, the mathematical arguments become of necessity involved. Yet they are unfolded, stage by stage, with admirable lucidity; and the simplified examples, the numerous diagrams, and the photographic models should make both the procedure and the results clear and comprehensible even to those who possess little or no mathematics. Every educational psychologist who wishes to understand the techniques by which his science is being built up will have to sit down to study Prof. Thurstone's pages; and, it may be added, he will find the task far less formidable and far more absorbing than he expected.

Can J Psychol 2:137–9 S '48. Chester E. Kellogg. "A Correction for Thurstone's Multiple Factor Analysis." [See article for detailed corrections, too numerous to reproduce here, of clerical errors made on pages 453–7.]

Cath Ed R 45:506–7 O '47. Paul Hanly Furfey. * begins with a 50-page "Mathematical Introduction" devoted principally to the theory of matrices. This will serve as a useful review for anyone who has some familiarity with the subject, but one who approaches matrix theory for the first time may find it somewhat too brief. After the introduction, twenty-one chapters develop the theory of multiple-factor analysis systematically. The writing is clear and accurate, but remains on the abstract level. The author's purpose is to develop his system as a mathematical theory rather than to illustrate its practical application to the problem of psychology, education, and other disciplines. He accomplishes this purpose very successfully. * It seems safe to say that Thurstone's method is mathematically sound. The reservations which the reviewer feels are based on quite other grounds. It is a fundamental postulate of factor analysis that aspects of human behavior may be represented by points on a one-dimensional continuum and that these measurements in turn can be represented as linear functions of more elementary traits. One may question whether this somewhat atomistic viewpoint is the best one for explaining human behavior. Again, since factor analysis uses correlation coefficients for its basic data, one may raise the question how meaningful these coefficients are. They are useful in the study of many elementary problems; but are they a solid enough base for the elaborate structure of factor analysis? It is doubtful whether the rather rigorous conditions for the meaningful interpretation of correlations are very often fulfilled in practical work. In a word, it is questionable whether the general method of mathematical analysis, so brilliantly successful in the physical sciences, is the ideal method for explaining human behavior. The questions raised in the last paragraph can best be solved by experience. To the present reviewer the results accomplished in the seventeen years since Thurstone first proposed his method seem disappointingly small. It has called forth a fascinating literature of mathematical discussion; but it is hard to see that it has given any fundamentally new insights into the way that human beings behave.

J Abn & Social Psychol 43:244–5 Ap '48. Quinn McNemar. * The centroid method is again presented as the most feasible for arriving at a set of arbitrary reference axes. Reflection of tests (sign changing) is accomplished by an improved procedure, and a new scheme of checking the computation of residuals is used. The reviewer is unable to see that the latter is an improvement over the simpler adding of column residuals to zero. The principle of simple structure is retained, with convincing arguments therefor. This, of course, necessitates rotation of axes, and accordingly several methods are

presented for accomplishing this arduous task: plotting on a sphere, two-dimensional diagrams in succession, and three-dimensional sections involving extended vectors. All this is preceded by an excellent, clearly written, well-illustrated presentation of the simpler geometric aspects of factor analysis. As in the original, several schemes for estimating communalities are discussed—the highest value in a column is still a satisfactory estimate. The special case of Spearman (unit rank for the correlation matrix) and the closely related topic of second-order factors are treated in separate chapters. Any devotee of Spearman can still claim that the first centroid or the principal axis represents a general factor (g maybe), and Thurstone admits that a second-order factor may be considered as a general factor. But the problem of interpreting any general factor is not as easy as assigning meaning to an axis which has been determined on the basis of simple structure. Regarding whether factorial description is invariant, it is argued that a test's loadings on the primary abilities will not, under proper and specified conditions, change when the test is moved from battery to battery; that simple structure, if it exists in a domain, will emerge in any experimental group unless drastically selected; and that invariance of factor loading *size* is not to be expected as one passes from group to group. This volume will not be easy reading for those unversed in matrix algebra and space geometry. It does not pretend to be a systematic treatise of all factorial methods, but is rather an exposition of those methods which Thurstone has devised. From time to time he replies to his critics, and frequently one finds non-mathematical passages of unusual clarity. An 18-page index greatly enhances the use of the volume as a reference. One finds in this book a curious paradox: a complaint, in the preface, that mathematical statisticians have not in general accepted factor analysis, then a frequently expressed disdain for the statistical aspects of factor analysis. When one finds the statement that "the identification of a factor or parameter does not presuppose the experimental population to be in any sense representative of any sort of hypothetical general population" (p. 324), and the idea that a "sample of freaks" will be just as revealing as a carefully randomized sample (p. xii), is it any wonder that the mathematical statistician regards Thurstone's type of factor analysis as outside his domain of interest? The foundations of factor analysis are just as shaky as the correlation coefficients with which an analysis begins, and until such time as information is known concerning the effect of sampling fluctuations it will not, in the reviewer's opinion, be possible rigorously to check hypotheses via the factor technique. Psychologists who are skeptical of factorial methods are apt to remain so unless some other method is used to verify the resulting constructs. Incidentally, the cynic might take one sentence from Thurstone's text—"The correlation coefficient is a symbol of complete ignorance" (p. 107)—and raise the question as to how one can, with n variables, begin with $n(n-1)/2$ symbols of ignorance and arrive at enlightenment.

J Am Stat Assn 42:651–6 D '47. Louis Guttman. * Thurstone's work already has had a tremendous influence in the field of psychological measurement. The trail he has blazed is being followed by many, and the present book will make it even easier to follow. If a student is given a table of the intercorrelations between a set of variables, he now has a clear and relatively simple guide to follow for a series of numerical computations. However, it seems that some of the basic methodological problems which existed a dozen years ago still remain. There are still polemics concerning rotation of axes and the naming of the common factors. There is also the problem of the relationship of factor analysis to the prediction of outside variables, which involves the unique factors as well as the common factors. There is no problem of rotation for Spearman's theory; the rotational question arises when two or more common factors are found. There is no algebraically unique solution for reproducing correlation coefficients from two or more common factors. The problem of external prediction does affect the single-factor pattern as well as the multiple-factor. It is intended in the remainder of this review to emphasize these problems and to present alternative suggestions which may indicate that progress to a solution may lie in other directions from these common factor approaches. * It is this reviewer's belief that the hypothesis of multiple-factors in the case where Spearman's is rejected may often not be the best alternative. Instead of proceeding to multiple-factor analysis, one might investigate other possible *single* factor patterns. * In these single-factor theories, problems of rotation and the like do not arise because there is an algebraically unique solution

for each. To state the factor problem in terms of specifications on what kinds of partial correlations should vanish also has the advantage of immediately generalizing into non-metric approaches. Thurstone prophesies, in his preface, that non-metric theories will come in the future. There are already in existence two non-metric approaches to factor analysis * In any theory of factor analysis, the notion of a universe of tests or observed variables must be paramount. Any n tests used in a study are but a sample of a universe (and also are not ordinarily obtained by a random sampling process). It has been shown that the number of tests must be indefinitely large in order to estimate perfectly the individual scores on the common factors and on the unique factors. Thurstone suggests that in practice one would not want to use the multiple regression on all the tests in the battery, but rather try to devise some new tests which will measure the common factors more directly. While this may sometimes be possible, unfortunately the implications of a universe of tests seem to have been overlooked when Thurstone goes on to introduce the concept of *second-order* factors. His multiple-factors are in general intercorrelated. Thurstone therefore suggests that the $r \times r$ matrix of these common factor intercorrelations be factored in turn, to yield second-order factors. From the theorem just referred to, however, in order to obtain individual scores on such second-order factors, it is necessary in general to have an infinitely large number of first-order common factors. But the number of first-order factors is supposed to be small, in fact, very small. Hence, introducing second-order factors would seem to vitiate the basic idea of parsimony that underlies Thurstone's approach. The communality of a test expresses but part of its variance, namely that associated with the common factors. From this arises another serious difficulty, with respect to prediction of external variables. In general, the common factors of a battery will not predict as well as the original tests themselves. If an external variable is related to any of the unique factors, then using only the common factors throws away predictive efficiency. It becomes a real question, then, as to wherein the parsimony of factor analysis lies when it comes to external predictions. * *Multiple-Factor Analysis,* then, does not lead into new realms, but broadens the footsteps of its predecessor. It will be a more easily taught book, and hence should be even more useful in introducing the student to Thurstone's approach. It would be unfortunate, however, if certain algebraic routines became a substitute for thinking. It would be a setback for psychology—or any other discipline—if students were so drilled that, on being confronted with a table of correlations, they would automatically "multiple factor" it. While this is certainly not Thurstone's intention, many of his followers—as do followers of any leader—seem to deviate from the intended path and become enmeshed in arithmetic to the exclusion of basic thinking. Thurstone has contributed perhaps more than anyone else to the opening of the eyes of psychologists and other social scientists to the world of multivariate analysis. It is a subtle world, and perhaps not tractable to any single approach for examining its structure in different situations. [See original review for alternative methods of factor analysis suggested by the reviewer.]

J Am Stat Assn 42:656–8 D '47. D. N. Lawley. * One of the many ingenious illustrations of the author's methods is his application of them to data which we are subsequently told have been obtained from measurements of such things as cylinders or boxes. * The argument is frequently illustrated with numerical examples, and high praise is due for the lucidity and clarity with which the sometimes highly complicated computations are explained. Though here and there references are made to sampling errors and problems of significance testing, the author has avoided any discussion of these topics. From a statistical point of view this is a pity. He says "a fair appraisal of the situation would probably acknowledge....that, while statistical theory has made important advances in the last two decades, it has not advanced far enough to be immediately useful for factor analysis as a scientific method without still further advancement." This statement is perhaps a little unfair. Under certain conditions a method is now available for testing how many common factors can be regarded as significant; though the method cannot of course tell us anything regarding the nature of the factors obtained, it does indicate how many dimensions are worth including in the common factor space. The point is important since in many investigations in the past more factors have been extracted than are warranted by the size of the data. The result has been that psychological interpretations have been forced upon factors which are entirely spurious and repre-

sent nothing but sampling error. Since it appears that in general the [illegible] errors of estimated factor loadings are rather large, one is led to wonder whether in dealing with experimental data it may not be a matter of some difficulty to detect simple structure even when it does in fact exist. Two variables are (p. 63) defined to be statistically independent when the correlation between them is zero. This definition is however at variance with the proper meaning of statistical independence, which is by no means identical with or a necessary consequence of zero correlation. In spite of these criticisms the book should certainly be read by all those who are interested in the subject of factor analysis. Even though they may consider some sections of it to be controversial, they are sure to find the arguments put forward stimulating and such as to merit close attention and thought.

J Social Psychol 28:295–300 N '48. H. J. Eysenck. Thurstone's *Vectors of Mind,* of which the present volume is a development and an expansion, had a profound effect on American psychology when it appeared some 10 years ago. Factor analysis, which up till then had blushed unseen in England for over 30 years, was suddenly transplanted into the limelight of a new continent; it has survived this change, but not without undergoing modifications which seemed of dubious advantage to those who had tended it in its period of growth. For good or ill, most of these changes are associated with the Psychometric Laboratory of which Thurstone is the head, and in the present volume are summed up "the results of work done during the past decade" in that Laboratory. Certain points should be noted regarding *Multiple Factor Analysis.* It is in no way a textbook, in the sense that Thomson's or Holzinger and Harman's books are. It does not pretend to weigh the points at issue between different schools fairly and squarely. It is a systematic statement of the position which Professor Thurstone himself has taken up, and as such is indispensable to any student of the subject. The main developments in his thinking are discernible in the very much greater stress which he lays on oblique rather than on orthogonal factor structure, and the analysis of the correlations between factors which are the inevitable outcome of permitting the angles between factor-axes to deviate from 90°. There has been no change in his emphasis on the need for rotation, and no abandonment of the simple-structure concept. The main practical outcome of the change of emphasis in Thurstone's recent work is the emergence of a "second-order factor" in the cognitive field; he finds that the various "primary abilities" which he has isolated according to the principles of "simple structure" are themselves correlated (oblique), and that a factor-analysis of the matrix of intercorrelations between factors gives rise to a "general factor of the second order," which he identifies provisionally and very tentatively with Spearman's "*g.*" In viewing the book in terms of what Thurstone set out to do, the reviewer cannot but praise the clarity of the exposition, the simplicity (if not always the elegance) of the mathematical derivations, and the constant stress on logical principles of methodology. Thurstone says that "the brevity of *The Vectors of Mind* was probably responsible for much of the controversy about multiple-factor analysis," he will certainly be entitled to maintain that with the publication of the present book no competent reader should have any doubts left regarding the details of his system. However, agreement in regard to the meaning of what Thurstone says is not the same as agreement with the truth of what Thurstone says. There are two main areas in which the present reviewer would find room for criticism. The first of these is the question of rotation. Thurstone maintains that the original centroid factors suffer from two drawbacks—they are not psychologically meaningful, and they are not invariant. Rotation into "simple structure" is necessary in order to obtain meaningful, invariant factors. Are these contentions justified? Let us consider them in turn. In the first place, rotated factors are often very similar to unrotated factors; this has been shown by the reviewer in reworking Thurstone's original analysis of the intercorrelations of 56 tests (*Brit. J. Educ. Psychol.,* 1939). There it appeared that the unrotated Burtian solution gave rise to a classification which was almost identical with that obtained by Thurstone in his lengthy rotational solution. If the one set of factors is "meaningful," the other surely must be "meaningful" also. In the second place, unrotated factors can often be shown by independent, outside criteria to be meaningful. In one study of 40 social attitudes, the reviewer found a general factor of "radicalism" and showed that factor-saturations on this factor for the 40 statements correlated + 0.98 with the

per cent endorsement differences of socialist and conservative voters for the same 40 items (*Internat. J. Opin. & Att. Res.*, 1947). It is difficult to see how such results can be brushed aside as being "unmeaningful." In the third place, Thurstone makes no attempt to define the term "meaningful" operationally. It appears to signify simply the kind of solution which appeals to Thurstone himself—there is no attempt to consider the verdict of a group of expert, independent judges, for instance, on whether the rotated or the unrotated factors are more "meaningful." In the reviewer's Department it is a regular practice to submit both kinds of factors to impartial experts in the field concerned, in an attempt to decide on the "meaningfulness" of the two methods. It is unusual to find the "rotated" solution preferred. In the fourth place, is the demand for "meaningfulness" anything else but an attempt to judge scientific results in terms of common sense? Is the physicist's description of a chair in terms of electrons, protons, neutrons, positrons, and a large amount of empty space to be judged in terms of "meaningfulness"? Is this demand for an otherwise unspecified "meaningfulness" a reasonable, rational scientific procedure? It is certainly a demand unique to psychology. Thurstone and his many followers have constantly advanced this argument of greater "meaningfulness" in support of their claims, but they have never even attempted to show that the results of their procedures are in actual fact more meaningful. What is more, they have never taken up the challenge to give greater precision to their argument, or to suggest an impartial, objective method of settling this question. We may, I think, conclude that on this point doubt, rather than conviction, is the only attitude possible. If each factor-analyst remains the undisputed judge of what he considers "meaningful," psychology will never emerge from its subjectivity. When we consider "invariance," again, we find that there is a tendency for Thurstone and his followers to repeat the slogan, or even the battle-cry, but to be very hesitant in giving convincing proof. In the first place, it is clear that it is possible to set up problems of such a kind that centroid factors do not remain invariant; this follows from the concept of centroid factors as multi-dimensional averages. It is also clear that it is possible to set up problems in which rotated factors do not remain invariant. Conversely, both rotated and unrotated factors may retain their factor-saturations within the limits of sampling errors when transplanted into other batteries of tests. The reviewer's paper on Primary Social Attitudes quoted above shows this clearly and experimentally. Under these conditions, Thurstone's attempt to prove invariance by using examples typically taken from a nonpsychological situation (measurements of boxes) proves very little; no one has denied the possibility that rotated factors may, in certain situations, remain variant. Reasoning by analogy hardly constitutes proof, and in this particular case the analogy is purposely chosen because the underlying three-dimensional structure is in conformity with Thurstone's theory in the cognitive field. It would be interesting to see what would happen if an analogy had been chosen in which a powerful general factor was primary—for instance, correlations between different ways of measuring the strength of an electric current, differing in efficiency and accuracy. Even without paying regard to the deficiencies of the general argument, the fact remains that in the actual research case there is very little evidence either for or against invariance; only one or two examples come to mind. In the absence of such information on a generous scale, and in connection with genuine psychological problems, rather than with boxes and other geometrical structures, we must again reserve our judgment. The second main area regarding which we must take issue with Thurstone is his discussion of the views of what he calls the "London" or "British" school. Thurstone contrasts his own procedures at every point with what he conceives to be current practice among British psychologists. His case seems to be that adherents of the London school have insisted on the absolute predominance of a general factor, and have regarded group factors as mere disturbers, and as having no psychological interest in themselves (pp. 188, 259, 473). Taking the term "London School" to refer to workers closely linked with University College, London, and to embrace such divergent personalities as Pearson, Spearman, Burt, Garnett, McMahon, Webb, it is difficult to avoid the conclusion that Thurstone's view deviates seriously from historical fact. Far from being in any sense opposed to Thurstone's point of view, as expressed in this book, adherents of the London School have in fact anticipated and explicitly maintained views in all essential details identical with Thurstone's own. To take

but one or two examples, we may begin with Thurstone's contention that multiple-factor analysis is an innovation of recent origin, created by extending the "single-factor theory" of Spearman. Exactly the opposite is true. The very first suggestion ever put forward for carrying out a factor-analysis of a table of correlations was based on a multifactor principle, and made use of the "principal axes solution" which receives Thurstone's highest approval in his new book. This suggestion was made by Pearson in 1901 (*Biometrika,* 1, pp. 209), and led, some 10 years later, to McMahon's paper in the same Journal in which he gives, in 1911, what Thurstone calls the "fundamental factor theorem." Another and even more explicit formulation of this theorem is given by Garnett (*Proc. Roy. Soc.,* A, XCVI, pp. 965, 1919), together with detailed and rigorous proofs for the main formulae of multiple-factor analysis. He also introduced for the first time multidimensional diagrams to represent correlated tests and factors. It is against such a background of "multiple-factor analysis" that Spearman's original paper, which appeared in 1904, should be seen; it followed Pearson's paper by some three years, and may in many ways be regarded as a reaction to it, going to an extreme of simplicity. Thus Thurstone's view represents a return to the original teaching of the London school, not an "extension" of its teaching. Equally erroneous is Thurstone's view that British factorists concentrated entirely on the general factor, to the exclusion of group factors. Burt, who early in the century gave the formula which has now become known as the "centroid" formula, has throughout insisted on the existence and importance of group factors, such as verbal, numerical, *etc.* By 1926 his researches, the first results of which were published in 1917, and which were based on his explicit formulation of multiple-factor theory in 1911, showed as many as 12 different cognitive factors—a list including practically all those "Primary Abilities" since verified by Thurstone. The curious neglect which the work of Pearson, Garnett, Burt, and other members of the London School has suffered in America should not blind one to the facts, and it is a thousand pities that Thurstone's otherwise scholarly presentation is marred by obvious errors of attribution, and by quite mistaken views regarding the teaching of the London School. This matter may be regarded as relatively unimportant, but in actual fact many enemies of factorial methods have fastened on the alleged differences existing between the protagonists of different schools, in an attempt to show that where there is no agreement between experts there can be little useful help for systematic psychology. If it were realized that Thurstone's methods are in no way opposed to those of British psychologists, but present little more than a variant of what has been taught by Pearson, Burt, and others for over 40 years there would be little temptation for non-statistical psychologists to bring up this old and hoary argument. One difference there has always been between the Chicago and the London schools—that relating to the existence of a general factor in addition to the group factors on which there was fairly general agreement. But here Thurstone appears to have changed his previous attitude, and through his recognition of "second-order factors" to have come into line with beliefs held in Britain. In other words, nearly all the differences at issue between the schools are reduced largely to questions of emphasis; there are no irreconcilable divergences. Even rotation is not and never has been categorically rejected by adherents of the London school—it will be remembered that the possibilities of the rotation of factors was originally discussed in detail by Garnett at the close of the first World War. This, to the reviewer's mind, is probably the most important lesson to be learnt from Thurstone's book—agreements among factor-analysts vastly outnumber disagreements, and where certain differences in emphasis still exist factual evidence will no doubt soon serve to resolve them. In arriving at a properly integrated view of factor-analysis, however, a proper concern for historical developments would seem an indispensable prerequisite.

Psychol B 45:85–7 Ja '48. Paul Horst. * The author is keenly aware of the controversies which the simple structure concept has precipitated among students of factor analysis, and much of the book is devoted to defending and clarifying the concept of simple structure as a means of arriving at scientifically meaningful categories which exhibit relative stability from one set of observational data to another. * If there are those who had hoped to see a rigorous mathematical formulation of the simple structure concept together with objective criteria for obtaining unique transformations to the simple structure reference axes, they have been over-

optimistic. The author presumably feels that such criteria and such rigorous formulations are not to be hoped for in the near future and that a large element of subjectivity and personal judgment will continue to be required in transforming arbitrary factor matrices into simple structure matrices. Those students to whom the simple structure concept has had a strong appeal will hope that the author has been unduly pessimistic in this respect. It is highly probable that these students, to say nothing of the author himself, will continue their search for more completely analytical and objective methods for transforming arbitrary matrices into simple structure. It is doubtful whether the detractors from the simple structure concept will ever be convinced by anything short of rigorous analytical procedures, purely objective methods, and quantitative criteria for a satisfactory transformation. One complete chapter is devoted to the subject of the unknown communalities. The author admits freely to those who oppose the use of communalities in the correlation matrix that this practice complicates the analysis and precludes those more elegant solutions available when unity is used in the diagonals. He recognizes further that the number of factors adequate to account for the side correlations in a matrix may result in communalities which exceed unity. Such situations he resolves by extracting additional factors so that no communality exceeds unity. This resolution may not be entirely satisfactory to those concerned with the theoretical implications of communalities greater than unity, but, in any case, the chapter is an extremely provocative one and should stimulate further fruitful research. One of the most interesting and intriguing chapters in the book discusses the role of oblique structure. This, together with the chapter on the effects of selection, shows how the correlation matrices may vary from sample to sample and yet yield simple structure factor matrices which are very similar. One complete chapter is devoted to the subject of factorial invariance and is closely related to the concept of oblique structure and the effect of selection. The concept of factorial invariance has great scientific appeal. If certain students of factor analysis are not impressed by it, their skepticism doubtless does not stem from lack of sympathy with the concept, but rather from the fact that as yet the criteria of similarity from one set of experimental data to another have not been adequately formulated and that a sufficient number of studies based on different samples and different sets of batteries have not yet been published to show explicitly the stability obtained by the methods of the University of Chicago Psychometric Laboratory. The volume is a major contribution not only because of the problems it solves and the solutions it presents, but also because of the further problems for investigation which it raises either explicitly or by implication. It should go a long way toward stimulating further research in the methodology of factor analysis and its implications, not only for psychology but for other domains of science as well. Although no bibliography is included in the volume, it does contain a very usable and complete index.

Psychometrika 13:115–9 Je '48. Raymond B. Cattell. * To say that the purpose of the present volume is to bring the *Vectors of Mind* up to date would....indicate only one aspect of what has been achieved. That momentous work was a pioneer study, in which Professor Thurstone voyaged on strange seas of thought very much alone. His account of what he saw was not easy to follow, for pioneers do not generally approach new ideas from the angles at which they are best presented to the student. An unexpected excellence, therefore, in the present work is the ease and fitness of its order and style of presentation from the standpoint of education. * although this book covers the same basic mathematical notions as the *Vectors,* and some more besides, there is no excuse for any tolerably competent psychology student finding any point of insurmountable difficulty. Following the mathematical introduction, the book begins with a chapter on "The Factor Problem" which, with a fine dignity and economy of statement, presents the basic role and purpose of factor analysis in the general framework of science, and, indeed, of philosophy. * After factoring, it naturally turns to the problem of rotation—rotations for simple structure—in which several methods are demonstrated. The vexed question of estimating the unknown communalities is then taken up, and although the Chicago laboratory has evidently given much thought to the matter, the practitioner of factor analysis is still not offered any royal road to easy estimation. Thurstone's formula 15, which amounts to a minor centroid calculation, on a small cluster of positively correlating variables, is easy to work with and, as Medland has shown empirically, gives the most consistent of nine different

methods of communality estimation. With how small a correlation matrix one can use this formula without having to make a second, iterative analysis remains to be seen. Fortunately the estimation of communalities is seldom a practical difficulty with the majority of factor studies, which now frequently employ thirty, forty or more variables. The theoretical issues are, however, interesting, and Professor Thurstone takes issue with Godfrey Thomson's notion that the aim in estimating communalities is to minimize the number of common factors, asserting instead that the "problem is to determine the communalities which are implied by the given side correlations" (*i.e.*, the matrix). He also brings Thomson's description of the puzzling Heywood case under a clearer general principle. It is interesting—and to the present reviewer gratifying—to note that whereas Professor Thurstone stood very tentatively for oblique factors in his former volume, he has now come out wholeheartedly for following simple structure no matter to what obliqueness it leads. No one with any appreciable experience in rotating for simple structure or in seeking invariance of patterns in factors, can avoid the conclusion that the factors we find in nature are often correlated. And why should they not be, since all entities within a universe are to some extent related? In taking to oblique factors, however, we encounter the problem of whether to apply the term "factor" to the reference vector normal to the hyperplane or to the line of intersection of the remaining hyperplanes. This does not arise among orthogonal factors, where they are identical. For many purposes—particularly in stating the immediate psychologically interesting results of a factor analysis without the labor of calculating the inverse of a matrix—the reference vector is more convenient. And although Professor Thurstone may be right that in the long run the balance of convenience lies with the alternative use of "factor," it seems to the reviewer that oblique factor methods should not be introduced without a discussion of the pros and cons of these two possible conventions. When we cease to pay mere lip service to simple structure, and insist that it is the criterion for determining rotations, we say farewell not only to orthogonal factors but also to the ideal of wholly positive sets of factor loadings. There are still psychologists who will have difficulty over the latter. The situation seems to be that as long as research workers were concentrating on abilities it was *possible,* because of the predominantly positive correlations found there, to maintain positive loadings. It was also psychologically reasonable to do so, since, except in rare cases akin to negative transfer, it was hard to conceive of an ability being a disadvantage in *any* performance. Although Professor Thurstone has not himself worked to any extent in the personality field, he is alert to the demands which the recent applications of factor analysis to personality make upon his method. There it is reasonable to expect that personality factors will impede or suppress as well as aid performances, and Professor Thurstone has made his method flexible to this probability where many psychologists have rigidly continued to seek wholly positive loadings or strictly orthogonal factors, without regard to the natural structure. As Thurstone remarks, "The statistician must not impose the arbitrary restriction that our scientific concepts in the description of people must be uncorrelated, either in the experimental sample or in the general population." Yet it is in regard to the simple structure principle that one may encounter the greatest disappointment in reading this book. In the first place, Professor Thurstone does not discuss any other methods, such as proportional profiles, that have been tentatively suggested for finding the given structure. This is perhaps unavoidable, since the book confines itself to the advances made at the Chicago laboratory—quite enough for one treatise—rather than to a conspectus of all developments in factor analysis. But since the simple structure principle—the only effective principle yet available for guiding rotation—is Professor Thurstone's own idea, one might have expected that attention would be given to developing it further and removing some of its disabilities. Its principal defect has been that occasionally two apparently equally good "simple structures"—or at least equally good hyperplane fits—can be reached from the same data. Many people would say that its defect is the great amount of labor necessary in groping by trial and error to the required position of solution; but the labor is nothing if the ultimate solution is convincing. The task of finding a satisfactory index or expression for "goodness of simple structure" is admittedly a very difficult one, tied up as it is with the still unsolved problem of determining the distribution or probable errors of factor loadings. In default of a complete theo-

retical solution, however, one might perhaps have hoped justifiably for some tolerable empirical solution, based on experience, akin to Tucker's empirical formula, which has proved a useful guide in the parallel problem of determining the completeness of factor extraction. Instead, one is given a more or less arbitrary set of conditions, without adequate discussions and justification, *e.g.*: "Each row of the factor matrix should have at least one zero" (p. 335). Since there are bound to be a certain number of complex variables in almost any battery, this particular criterion is doubtful. At this stage of the subject, some more precise index of fit might be expected, or at least a discussion of avenues along which those with abilities and opportunities to study the matter further might profitably be searching. Following these chapters, there is a treatment of factor invariance, which is delightfully lucid and can be read with great profit, particularly by that group of factorists still trying to obtain factorial invariance without rotation! As elsewhere, Professor Thurstone's treatment has a useful knack of dissecting out the principal source of misunderstanding and displaying it on the point of one or two well-chosen sentences. "In setting up a criterion for what is to constitute an acceptable factorial method, the chief concern is to insure that the method is adequate to discover what is determinate in the data. Factorial method has not been designed to guarantee the discovery of factors which are indeterminate in the data." It is here, in the choice of variables to give the greatest likelihood of well-determined factors, that we perceive the considerable amount of art that enters into all factor analytic research. No one who reads these chapters with understanding can continue with the misconception that factor analysis is a mechanical process of feeding variables into a mill. The treatment brings out very well the craftsmanship required in research design, the special skills that grow up in the art of factor analysis, and the interplay of psychological intuition and research design that is necessary for real advances in this field. The new matter constituting most of the concluding part of the book concerns the intriguing developments in connection with second-order factors and the much debated issue of the effects of selection. Incidentally, Professor Thurstone sticks to the term "second-order factor" rather than "super factor," which some others have suggested. This is probably in the best interests of clarity; for there may be third- or higher-order factors also to be considered. It would have been helpful if other examples of second-order factors, besides the box problem and the general ability factor, could have been introduced here. Our sense of the meaning of factors —and at least our ability to demonstrate that they are not such phantom ciphers as some critics suppose—would be greatly helped by a much richer accumulation of "constructed" analyses in which we know beforehand what tangible entities lie behind the façade of variables. Primary factors, we are told here, are sometimes local and incidental. On the other hand, since the correlations among the primary factors depend on relatively incidental influences of selection, one could argue also that the form if not the existence of the second-order factor is just as local and incidental. A good selection of concrete examples, not only from the physical material world but also from organic and social data, would have done much more than mathematical treatment alone to clarify, at this stage, the meaning of second-order factors. It has long been a matter of concern to psychologists to discover how far factors would survive changes in the selection of a population and whether some might be artifacts of population sampling. In an admirably comprehensive and systematic chapter, Professor Thurstone builds on the earlier solutions of Thomson and Ledermann some gratifyingly definite conclusions. Thomson held, as Thurstone points out, a rather pessimistic view as to the maintenance of identity of factors. Thurstone shows, on the other hand, that the factor transcends changes in population sample and that if a simple structure is discoverable before selection the same structure is discoverable afterwards. Simple structure is invariant under both univariate and multivariate selection; it is only the correlations among variables and the correlations among primary factors that are modified. This supposed weakness in factorial method is strategically turned to an advantage, for "When a simple structure has been found for a test battery that has been given to an experimental population and when a plausible interpretation of the primary factors has been found, these should be regarded as hypotheses to be verified by giving the same test battery to new experimental populations that should be selected in different ways." The critic may well ask himself whether the evident plan of this book to confine itself to the develop-

ments, methods, and approaches of the Chicago laboratory is preferable to a survey by Professor Thurstone of all kinds and conditions of contributions in this area. Interesting and provocative though the latter might be, it would not have provided a book from which one could readily teach the fundamentals of multiple factor analysis or one in which such a solid, systematic statement of the important principles could have been made. Indeed, there is something even aesthetically satisfying—in these days of formless symposia, undigested "surveys" and smug eclecticism—in the architectonic genuineness of a development that has occurred largely through the originality and unremitting toil of one man and his associates. Seen in this light, incidentally, one is not so much impressed by the number of problems that remain unsolved as by the enormous progress that has been made in the short time since Professor Thurstone's first paper on multiple factor analysis in 1931. Historians of science will be interested, in this connection, in the passing reference in the preface to the way in which the germ of this whole new development arose. "When I wrote the tetrad equation (after Spearman)....I discovered that the tetrad was merely the expansion of a second-order minor, and the relation (to a possible multi-factor analysis) was then obvious. If the second-order minors must vanish in order to establish a single common factor, then must the third-order minors vanish in order to establish two common factors, and so on?" In the light of the developed treatment given in this book, that first step appears so simple—now! However, it is of more than historical interest that all of the factor analytic processes now offered for use also appear much simpler than those of a decade ago. Armed with the varied equipment of factor extraction processes, rotation methods, *etc.*, here presented, the researcher can happily tackle matrices of variables the size and complexity of which would have appalled him in the early days of this subject. The danger points have been buoyed, the possibilities of error gauged, and shorter methods introduced without lack of accuracy. Although the psychologist may not be aware of any paucity of psychological illustration, the fact should not be overlooked that this book is and should be written for a wider audience than psychologists alone. The whole development of this remarkable statistical tool, from the centroid method of analysis to the latest methods of rotating to simple structure, is a gift from psychology to science in general. All the newer sciences, and particularly those like sociology, meteorology, economics, and even bacteriology, which have first to discover, from a mass of uncontrollable variables, the significant entities on which to concentrate, urgently need the methods of factor analysis. That factor analysis can proceed to set up an experiment without a particularized hypothesis seems sometimes to have puzzled the novitiate of scientific method. As Thurstone points out, "It is this latter application (discovering the nature of the underlying order)....that is sometimes referred to as an attempt to lift ourselves by our own boot straps....This is probably the characteristic of factor analysis that gives it some interest as a general scientific method." The understatement of this last sentence suggests a restrained irony at the expense of the critics of factorial method value, but the writer does not hesitate also to speak plainly on the true role of factor analysis in scientific method: "Eventually, the factorial methods, which are essentially exploratory, [are likely to] yield to the reformulation of a problem in terms of the fundamental rational constructs of the science involved. It is not unlikely that factorial analyses will point the way in the work of inventing significant and fundamental scientific concepts." On the other hand, we are reminded, with a constant awareness of the wider possibilities, that the present factorial methods are only approximate in their formulation and assumptions. While the treatise has its feet firmly on the ground and is eminently practical in its attention to educational steps, as well as to speed and accuracy in research proceedings, it looks out, at the fringes of the known, into the middle of the unknown, for, as the author says, "It would be unfortunate if some initial success with the analytical methods....described here should lead us to commit ourselves to them with such force of habit as to disregard the development of entirely different constructs that may be indicated by improvements in measurement and by inconsistencies between theory and experiment."

Sci 107:153–4 F 6 '48. Charles M. Harsh.

* The newly recognized study of second-order factors derived from first-order factors is cleverly illustrated and gives promise as a method of verifying hierarchies of generating influences. Although there is no bibliography

and little attempt to relate the discussion to other literature in the field, the neophyte will find clear guidance, and the experienced factorist will find provocative clarification of major issues concerning the uses of this versatile, though imperfect, research tool.

For reviews of the first edition, see 36:B263 and 2:293. Also see B505 in The 1938 Mental Measurements Yearbook.

[294]

★TIPPETT, L. H. C. **The Methods of Statistics: An Introduction Mainly for Experimentalists, Third Edition.** London: Williams and Norgate Ltd., 1941. Pp. 284. 18*s*. ["This edition is the same as the second except for a few minor corrections—and one important addition. The addition is a set of tables...." —Preface to the Third Edition.] *

For reviews of the second edition, see 38: B708 and 2:299.

[295]

★TIPPETT, L. H. C. **Statistical Methods in Industry.** Introduction by E. S. Pearson. London: Iron and Steel Industrial Research Council, British Iron and Steel Research Association, 1943. Pp. 74. Paper. 2*s*. 6*d*. *

J Am Stat Assn 40:408–9 S '45. P. S. Olmstead. * The presentation is clear and nontechnical in character and examples are chosen mainly from the steel industry. The subject matter covered is indicated by the consecutive subheadings: frequency distributions, errors of random sampling, control charts and quality control, analysis of variation, correlation, partial and multiple correlation, sampling in practice, and design of experiments. Although the author is very careful to explain what he does, he has not always explained why he does it. * on page 59....the author somewhat unfortunately uses accuracy as a synonym for precision in discussing the economics of the Latin square arrangement * this pamphlet includes the discussion that followed the lectures. In a number of places, this brought out information of a technical nature to justify certain statistical conclusions and in others raised doubts concerning the statistical processes proposed. * many papers published in this country would make more interesting reading if similar discussions were included. * these lectures, prepared so carefully by an authority in applied statistics, should prove interesting particularly to the development engineer because they show how he may be helped by working with a competent statistician. By inference, they also make it clear that either the engineer or the statistician working alone is apt to draw erroneous conclusions that may be avoided by working together and thereby making use of the technical skills of both. Although these lectures show how some elementary statistical methods may be used in industry, some may feel that they are not an adequate introduction to the role of statistical method in so far as it applies to sampling consumer wants, research and development, design, specification including the setting of tolerance limits, inspection, and operational research to determine that standards are satisfactory, adequate, dependable, and economic. Obviously, all of these come under the general problem of quality control in industry.

[296]

★TIPPETT, L. H. C. **Statistics.** London and New York: Oxford University Press, 1943. Pp. vi, 184. 5*s*.; $2.00. *

Economica 11:160–1 Ag '44. E. Grebenik. * Tippett has given the answer to the teacher's prayer for a non-technical, introductory book on Statistics for students with a very limited mathematical knowledge. Within the short compass of 184 pages he succeeds in presenting very simply and concisely the greater part of the problems with which modern statistics is concerned. His emphasis is mainly on the use of statistics in economic and social problems though he finds time to deal with applications to quality control and scientific experimentation. The emphasis throughout is on the underlying ideas rather than on techniques. Sampling, correlation, forecasting, and market surveys are some of the topics discussed. This admirably balanced book lives up to the high standard that we have come to expect from the Home University Library and should be put into the hands of every student of Economics.

J Am Stat Assn 40:536–7 D '45. Ernest Nagel. * excellent addition to the well-known Home University Library of Modern Knowledge * The book aims to familiarize readers having no mathematical equipment with the central problems, the basic notions, and the major achievements and applications of statistical methods. Mr. Tippett has achieved his objectives admirably. His book is simply and clearly written, and manages to cover much ground without introducing a single algebraic symbol; and while it makes plain the great importance of statistics for theoretical as well as practical investigations, it maintains a critical attitude toward pretentious but influential

claims that have been made for the subject. * The need for systematic methods for representing group phenomena in succinct and revealing ways is explained, the difficulties encountered in gathering and organizing statistical data are outlined, and the more frequently used devices of descriptive statistics are illustrated. * Such matters as random sampling, sampling error, tests of significance, the design of experiments, and statistical laws are explained and illustrated, and common fallacies in statistical reasoning are interestingly discussed. * Tippett quite rightly avoids controversial issues or the discussion of general logical and methodological principles. Nevertheless, he succeeds in conveying to his readers the importance of theoretical assumptions for the interpretation of statistical analysis, and he shows clearly that warranted knowledge is not achieved simply by gathering data and establishing statistical correlations. On the other hand, a more explicit discussion at a few places of the general logical notions underlying the exposition would be desirable. Thus attention is repeatedly directed to the danger of concluding a casual relationship from a high correlation; but while the latter relation is explained, the former is not—as if the reader could be assumed to have clear ideas concerning it. * Tippett's illustrations indicate that he conceives of chance or probability in frequency terms; and yet on one of the rare occasions when he ventures an explicit statement on the subject he declares that "the domain of chance varies with our state of knowledge—or rather of ignorance." (p. 95) Without a fuller account such a remark is neither consistent with the remainder of Mr. Tippett's exposition, nor is it likely to provide his readers with clear ideas on a fundamental topic. But in spite of such minor and perhaps unavoidable inadequacies, the reader for whom the book is intended will obtain from it a substantial understanding of the achievements as well as of the pitfalls and limitations of statistical reasoning.

J Am Stat Assn 40:538 D '45. John H. Smith. * an excellent introduction * Although it has a story-book readability, important principles are explained carefully and accurately. It contains more sound advice on how statistics should and should not be used than the average comprehensive text, and, even more important, it contains fewer fallacies commonly associated with oversimplification. Thus, it might well be required reading, not only for beginning courses, but for more advanced ones as well. It is both surprising and gratifying to find such a lucid discussion of statistical principles, including sampling theory and partial correlation analysis, which leaves so little to be desired from the philosophic point of view. * The fact that detailed developments of technical methods are omitted accounts in part for the merits of the book with respect to integration of statistical principles and effectiveness of exposition. Another important element is the author's keen sense of humor. * The author looks forward hopefully "to the day when....such general introductory books as this will become obsolete," but that day will not come until general statistics texts contain a better approximation to the "complete and....well balanced view of the whole subject" which is presented in this pocket-size volume.

J Royal Stat Soc 106:373 pt 4 '43. M. G(reenwood). A statistician writing an introduction to his subject designed to interest new readers is assailed by three temptations. The first is to "feature" diagrams or tables of data which he thinks "the public" will enjoy. The next is to drop into algebra—*elementary* algebra, of course—which guarantees the scientific respectability of his subject. The last is to be vaguely eloquent on the past, present and future triumphs of statistics in solving important problems. Mr. Tippett has stoutly resisted the Evil One. There *are* some diagrams and tables—but very few; there is no algebra at all; far from boasting of triumphs, Mr. Tippett confesses his early faith that modern methods of statistical analysis "seemed to have unlimited power to penetrate the secrets of nature" has waned. This asceticism is a necessary but not a sufficient condition for the production of a good primer. But Mr. Tippett has also a sense of humour, a sense of literary form and common sense; he is, in fact, of the Yulean School. The result is that one could hardly do better than put the booklet into the hands of any intelligent person who wants to know what statistics is (or are) about. We should select the chapter on Statistical Reasoning as a model combination of wit and wisdom; its examples of propaganda statistics are admirably chosen, those of post–1939 vintage painfully remind us that virtually all statistics of war in all countries are propagandist, but a pre-war example may be quoted. "It is men of exceptional experience who are buying *X*....cars to-day." "87 per cent. of *X*....

cars to-day are bought by men who have owned six other makes of car before." Mr. Tippett comments: "I suppose it is unlikely that as many as 87 per cent. of all makes of car are bought by such veterans as those mentioned in the advertisement, and the purchasers of *X*....cars are probably exceptional, but they may be exceptional in their fickleness—and do the makers of the *X*....cars wish us to believe that they do not get many repeat orders? These are possible interpretations of the data." Another possible interpretation is that the *X*....cars were not very low-priced, and, statistically speaking, salaries increase with age. Mr. Tippett does well to insist that "statistical laws have nothing to do with individuals." This ought to be a truism, but one often meets with ostensibly statistical classifications so fine that the tabulation will be of individuals, and even oftener with complaints that regression equations are not very useful for picking individual scholarship boys. Mr. Tippett's book will encourage readers likely to make good statisticians and discourage those who want an up-to-date magic. That is high praise.

Nature 154:321 S 9 '44. M. G. Kendall. Few sciences are more difficult to present in a concise and readable manner than statistics, which is regarded as a symbol of all that is dull and devoid of human interest. "What you've got," says Idaho Green in one of O. Henry's stories, "is statistics, the lowest grade of information that exists." To give the general reader an idea of the fascination of astronomy, biology and even mathematics is relatively easy; but this is the first attempt I have seen to perform that very useful function for statistics. Mr. Tippett is to be congratulated on having made a success of his undertaking; and indeed, it is hard to think of anyone better qualified to attempt it. His familiarity with both the theoretical and practical sides of his subject, coupled with his interest and experience in the teaching of statistics, have contributed to an excellent Pisgah-view of a complex, dry and extensive domain. He is never at a loss for a practical illustration in point, but does not lose the thread of the main argument as is so easily done in a discussion of statistical examples. Within the limitations imposed by its length—about 50,000 words with a few tables and no algebraic symbols—he appears to me to have done just what is wanted of volumes in the Home University Library, to have given a general review of his subject for those who want to know what it is about and sufficient enticement to those who are likely to want to extend their knowledge further. * The points he makes about pitfalls in the interpretation of numerical data, elementary as they seem, are so important to the average citizen that one wonders whether some part of this branch of the subject should not be taught in schools. I do not quite share his view about the readiness with which unpublished official information is put at the disposal of the private research worker. * A....chapter on statistical reasoning is exceptionally good, and it is a real relief to see someone having a tilt at the prevailing methods of presenting numerical information about the progress of the War. * Tippett....contrives to give a very fair impression of the enormously wide interests of the statistician at the present day. One criticism may be advanced. In the list of books for further reading at the end Mr. Tippett, with misplaced modesty, omits a reference to his own book on "The Methods of Statistics," a useful work which has done a good deal to spread the newer methods among scientific workers.

[297]

★TODHUNTER, I. **A History of the Mathematical Theory of Probability: From the Time of Pascal to That of Laplace.** New York: Chelsea Publishing Co., 1949. Pp. xvi, 624. $4.05. [A reprint of the edition originally published in 1865 by the Cambridge University Press.] *

[298]

★TRELOAR, ALAN E. **Correlation Analysis.** Minneapolis, Minn: Burgess Publishing Co., 1942. Pp iii, 64. Paper, mimeographed. $1.75. *

Math R 4:220 S '43. A. Wald. * A great part of the material included in this book was published previously as part II of "An Outline of Biometric Analysis" issued for the author in 1935 by the present publishers. The book contains the following chapters: I: Differences and Correlation; II: Partial Correlation; III: Multiple Rectilinear Prediction; IV: The Correlation Ratio; V: Curvilinear Regression; VI: The Coefficient of Contingency; VII: Correlation from (2 by *m*) fold Tables; VIII: Correlation between Ranks. *

[299]

★TRELOAR, ALAN E. **Random Sampling Distributions.** Minneapolis, Minn.: Burgess Publishing Co., 1942. Pp. iii, 94. Paper, mimeographed. $2.25. *

J Am Stat Assn 38:133–4 Mr '43. Margaret Merrell. This book is a planographed set of notes rather than a formal textbook. It is intended as an aid to the serious student of science

who, requiring significance test techniques, is neither acquainted with their derivation nor satisfied to use formulas blindly. With this reader in mind, the author relies upon simple algebraic formulations of the argument, largely in terms of the moments of the distributions, and a liberal appeal to the geometry of the problems, presented in 24 drawings. Since one or both of these approaches is within the grasp of most science students, the book should prove to be a real contribution to them. The distributions dealt with are those concerned with significance tests on means, standard deviations, and correlation coefficients. * Of particular value to the applied student approaching these significance tests is the emphasis given to the assumptions from which the algebra flows. These are not only stated explicitly but the limitations which they place upon the interpretation are stressed. * Various controversial issues with regard to the importance of the significance test in statistical reasoning, and the interpretation of the probability attached to a given test are discussed. With regard to the latter, Dr. Treloar does not allow a fractional probability to be attached to the statement that two parameters differ, or that a given parameter lies within a specified range. This probability he allows to be either 0 or 1. Rather, he uses the probability in a subjective sense, to measure the degree of confidence we have in the truth of the statement. However, in the discussion of the null hypothesis, this interpretation does not seem to be strictly maintained, for we have the statement, "If that probability is less than 50 per cent then the odds may be said to favor the difference *not* having arisen from random sampling, and one is therefore disposed to cast doubt on the accuracy of the null hypothesis." The first part of this statement is an inverse probability statement, yet without any consideration of existence probabilities. It seems to be out of line with the rest of the discussion of interpretation of significance tests. The student will find this a book which not only lays a substantial groundwork for the tests he has frequent occasion to use, but also one in which real consideration rather than a pat answer is given to the meaning of the tests.

Math R 4:220 S '43. A. Wald. * Many of the "proofs" and "derivations" given in the book hardly deserve to be considered as such; they merely make the results plausible to the reader. However, this may be excusable, since the book is written primarily for readers with little mathematical background. There are a few statements included in the book with which many mathematical statisticians will not quite agree. For instance, the reasons given by the author for the statement on page 64 that the 5 percent level should be used with great caution in the application of the *t*-test when the number of observations is small will hardly be acceptable to many mathematical statisticians. The statement on page 58 that the statistic given in formula (15) has the *t*-distribution is unfortunately not correct. On the credit side one may say that several notions of statistical inference, especially that of a test of significance, are very clearly described. The book contains many figures and illustrations which facilitate reading.

Plant Breeding Abstracts 13.95 Ja 1 '43. O. Kempthorne. * The author....shows that the geometric method, which cannot in general give the definitive equations of random sampling distributions, can be effectively used to describe the properties of the distributions which enable them to be of use for the interpretation of data. * less space could have been spent on the distribution of means *etc.* and more, for example, on the analysis of variances. The diagrams which illustrate the derivation of the distributions are, in general, very clear. A short inadequate description of estimation by the Method of Maximum Likelihood is given, and the special advantages of this method are slurred over.

[300]

★United States Department of Agriculture, Bureau of Agricultural Economics. **The Preparation of Statistical Tables: A Handbook, Slightly Revised.** Washington, D.C.: the Bureau, September 1942. Pp. ii, 39. Paper, mimeographed. Gratis. * [Reprinted in April 1949 as "slightly revised," same pagination.]

[301]

van Ormer, Edward B., and Williams, Clarence O. **Elementary Statistics for Students of Education and Psychology, Third Printing.** New York: Longmans, Green & Co., 1945. Pp viii, 111. Paper. $1.75. * [Except for the Preface and minor corrections, this edition is identical to the 1940 edition.]

Cath Ed R 44:53 Ja '46. Urban H. Fleege. * not a text for a course in statistics, but rather a handbook to accompany courses in educational psychology, educational measurements, and any other course in education where some elementary understanding of statistical methods is desirable * The book fills a need for the student who wishes an acquaintance with the funda-

mentals of statistics without becoming involved in mathematical formulae.

J Am Stat Assn 40:409–10 S '45. Paul S. Dwyer. * There is little material on sampling theory * It is to be expected that a mathematical statistician would be somewhat critical of the results of an attempt to explain methods which are inherently mathematical without the use of mathematical concepts which are essential to the clarity. The present reviewer reacts as expected on this point. * This reviewer is not entirely satisfied with some of the basic explanation. The explanation of class limits used in grouping leaves something to be desired. He also feels that the authors do not always separate the basic hypotheses of a problem from the assumptions (linear interpolation for instance) used in getting an approximate answer to the problem. On the whole the authors are to be commended for their efforts to emphasize the understanding of basic statistical terms and methods. Though it deals only with the more basic concepts and makes no contact at all with modern sampling theory and methods, this book is undoubtedly a useful manual for those for whom it is designed.

[302]

VAN UVEN, M. J. **Mathematical Treatment of the Results of Agricultural and Other Experiments, Second Edition.** Groningen, Holland: P. Noordhoff, Ltd., 1946. Pp. viii, 310. $5.80. * [Same as first edition (1935) except for the addition of a 2-page preface listing errata in first edition.]

J Am Stat Assn 44:329 Je '49. G. A. Baker. The present tendency in the design and analysis of field trials seems to be to carry the elaboration of the mathematical models first devised by R. A. Fisher to greater and greater extremes of complication. The theory of many such models is well worked out and tables provided so that the probabilities of the errors in decision made in any trial can be estimated. The difficulty is that the Fisherian models, in many cases, do not sufficiently approach reality in their fundamental assumptions about the behavior of soil fertility. Professor van Uven is refreshingly careful and thorough in his fundamental assumptions about the behavior of soil fertility. He assumes that soil fertility is a continuous function of position that changes slowly. His methods in this respect agree with Neyman's method of parabolic curves (1929). There is some evidence that, in some cases at least, this assumption of slowness of change in soil fertility is not sufficiently realistic. Professor van Uven's tests of significance are based on estimates of mean differences and standard errors obtained by the methods of least-squares and asymptotic averaging. Reference is then made to the normal probability curve regardless of the sample size and character of the population distribution. The whole discussion of significance is naive as compared with those of J. Neyman, E. S. Pearson, and R. A. Fisher. Professor van Uven discusses some of the simpler Fisherian designs in detail. In this respect he says that although sometimes the influences at work on the yield will not fully justify the hypotheses yet in many cases they will be very well applicable. This remark, of course, applies to situations with which Professor van Uven is familiar. * The book is well and logically written and proceeds on the basis of assumptions that are clearly stated. It will well repay study by anyone interested in the analysis of field trial data.

For additional reviews, see 38:B719.

[303]

VON MISES, RICHARD. **Lecture Notes on Mathematical Theory of Probability and Statistics.** Harvard University, Graduate School of Engineering, Special Publication No. 1. Cambridge, Mass.: the School, 1947. Pp. 300. Paper, mimeographed. $4.00. *

J Am Stat Assn 44:326–7 Je '49. Benjamin Epstein. * the author has....given an excellent presentation of some of the most fundamental ideas in probability and statistics. It is a pity that these notes are not generally available. They would represent a welcome addition in a field where the really good elementary texts can be counted on the fingers of one hand. The frequency concept of probability is the dominant theme throughout the text and the author gives a very clear introduction to the basic notions underlying his approach to the axiomatic foundations of probability. * this reviewer prefers the treatment of statistics as given by Cramér * However....it would be a mistake to make the preference so strong that one becomes blind to the originality and the basic character of the von Mises approach. While there appear to be grounds for preferring the measure-theoretic approach (which is of course at heart also a frequency theory) to that of von Mises, one should recall that von Mises was a pioneer in the field of probability and that he grappled, as far back as 1919, with many of the problems underlying the foundations of probability. This reviewer, when reading the text, was made

keenly aware more than once of the fact that the author is a master in the field and is a man who is not satisfied with a superficial glossing over of difficulties. He meets difficulties head on and brings them out into the light of day where they can be analyzed. This is particularly true in Chapters 3, 6, and 9. In these chapters he deals with (*a*) the weak law of large numbers; (*b*) Bayes' theorem and its relation to the problem of inference; (*c*) certain aspects of the Neyman-Pearson theory of testing hypotheses; (*d*) the contrast between Bayes' theorem and the Neyman-Pearson theory of testing hypotheses; and (*e*) the confidence interval concept. He shows very clearly the role played by the *a priori* distribution of the unknown parameter or parameters in determining the kind of probability inferences that one can draw from a sample. These are precisely the sort of things which should be brought to the attention of the student who is just entering the field of statistics. The short sections on runs and Mendelian heredity are also very good and illustrate important statistical concepts. Another valuable feature of the book is that many of the problems given to the student are non-trivial and thought-provoking. The problems are drawn from many fields and help to illuminate parts of the theory that might otherwise have remained unclear to the student. The treatment throughout is rigorous and the author does not hesitate to call on techniques in modern analysis which are about on the level of those given in Whittaker and Watson's *Modern Analysis*. Theorems are carefully stated and where concepts are involved the author takes the trouble to point out what would happen if certain underlying assumptions were not satisfied. The selection of certain sections or chapters for special comment is not to be taken to mean that the rest of the book is not well presented. The reviewer has only picked out a few of the things that were treated *unusually well* in this book and that are either omitted or glossed over in most texts. Some of the other topics are taken up as well in a book such as Cramér's. By way of summary, it is my opinion that the continual emphasis by von Mises on underlying concepts makes good sense scientifically and pedagogically. I also feel that this book gives the student some insight into the historical development of the subject and into the nature of the early difficulties and paradoxes. It is particularly the beginning student who needs to be reminded over and over again of just what assumptions are made when one makes a probability statement or an inference from data. It is refreshing to find an author who is honest enough to make the following explicit statement (Chap. 6, p. 16): "It remains an invariable fact, dominating all problems in mathematical statistics, that *no substantial inference can be drawn from a small number of observations if nothing is known 'a priori,' i.e., preliminary to the experiments, about the object of experimentation.*"

[304]

★WAGNER, CHARLES C.; JOHNSON, EVAN, JR.; HAGEN, BEATRICE L.; AND GRAVES, CLYDE H. **Introduction to Statistics, Revised Edition.** Ann Arbor, Mich.: Edwards Brothers, Inc., 1945. Pp. iii, 139. Paper, lithotyped. $1.75. * [Later editions are reprintings of this 1945 edition.]

Q R Biol 22:384 D '47. A. Chapanis. * The contents are mainly concerned with descriptive statistics. The one chapter on sampling goes no farther than to show how the difference between two means is tested for significance. This is a pretty good little book—as far as it goes. The mathematical derivations are easy to follow, it is liberally interspersed with problems, enough answers to the problems are given so that a student may check his computations, and the problems are eclectic—not chosen from one field of science, as is so frequently the case. But the reviewer's problem is this: To whom should he recommend such a book? It is much too brief for a semester course in statistics. It certainly will not satisfy the research worker—even if he uses statistics only occasionally—because the book ends without covering most of the important formulae the research man needs, *viz.*, the reliability and sampling statistics. Perhaps its chief usefulness will be for those individuals who know nothing about statistics and want to learn a little about it by themselves. But even then, the reviewer can think of several other introductory texts which are more complete than this one and no more difficult.

[305]

★WALD, ABRAHAM. **On the Principles of Statistical Inference: Four Lectures Delivered at the University of Notre Dame, February 1941.** Notre Dame Mathematical Lectures, No. 1. Notre Dame, Ind.: Department of Mathematics, Notre Dame University, 1942. Pp. ii, 50. Paper, lithotyped. $1.00. *

B Am Math Soc 48:639–40 S '42. Jerzy Neyman. * four lectures on modern theory of statistics, delivered by one of its most brilliant proponents * The little book is lithoprinted and lithoprinted very well, with all the formulas

perfectly legible. Still, in a printed form it would look much better. * Having in view a mathematical reader the booklet has nothing in common with numerous books "on statistical methods;" is not concerned with applied problems of a particular character but deals with fundamental conceptions, actually covering about all the most important that were achieved during the last 25 years or so. * the presentation of certain sections [is] necessarily short. This applies especially to the first 28 pages, given to the description of what had been done before Dr. Wald himself appeared as an active contributor to the theory of statistics with his conceptions of asymptotically most powerful tests and of general statistical inference. In spite of the shortness of presentation the book is exceedingly informative. In fact, it could be used as an excellent source of information for all those mathematical readers who, without hunting for articles spread in a number of journals, would like to get a bird's eye view of what is being done in the field of mathematical statistics. There are just two gaps that one can regret in the latter respect. When speaking of the problems of estimation by intervals the author indicates the distinction between the theory of confidence intervals and that of fiducial argument as developed by R. A. Fisher. However, while giving an outline of the former the author does not present any information about the latter, except for references to several papers by Fisher. Another gap is the omission of at least a few details concerning tests of composite hypotheses and problems of estimation of some but not all the parameters that may be involved in the probability law of observable random variables. As these statistical problems have created problems of pure analysis, those of the so-called "similar regions," not previously considered, their description in a book like that under review might have contributed to its value and increased the chances of the problems getting a speedy and more satisfactory solution than the one that is available now. However, to say that a book meant to be short is actually short, should not be considered as a criticism.

J Am Stat Assn 37:557–8 D '42. Mark Eudey. * For the mathematician or statistician who wishes to get a brief over-all review of the progress that has been made in mathematical statistics, and of some of the major problems still unsolved, Dr. Wald's paper may be highly recommended. * Unfortunately, the briefness of the publication has led to the omission of many interesting topics, notably testing composite hypotheses, estimating one unknown parameter when there are several unknown parameters involved in the probability distribution, and Fisher's theory of fiducial limits. However, despite their briefness and the consequent omissions,....[the first] four chapters give a very good outline of the basic ideas used in the theories of Fisher, Neyman and Pearson. Dr. Wald's own recent work in developing asymptotically most powerful tests and asymptotically shortest confidence intervals is treated in Chapter V, and several interesting results are given. * Although briefness has led to omissions of subjects and of detailed developments, this very briefness has the advantage of letting the reader obtain quickly an excellent grasp of the entire field of statistical inference, and of the concepts used in modern statistical theory.

Mech Eng 65:277 Ap '43. Harold A. Freeman. * Among the literature of modern statistical theory there is as yet no treatise and only one systematic advanced textbook, the latter being, at the moment, out of print. Wald's survey is therefore especially useful. It gives the reader a broad view of modern statistical theory or at least of (*a*) certain theories of estimating parameters and (*b*) the Neyman-Pearson theory of testing hypotheses, together with asymptotic results, for both theories, obtained in recent years by Wald. It should be said that in his discussion of estimation, the author is principally concerned with Neyman's method of confidence intervals; the systems of estimation associated with the names of Bayes, Fisher, and Markoff are briefly noted. * Wald's survey, which is admirably organized and clearly illustrated by simple examples, should be read by all industrial statisticians who wish to get a better view of the foundations of their field. *

[306]

★WALD, ABRAHAM. **Sequential Analysis.** New York: John Wiley & Sons, Inc., 1947. Pp. xii, 212. $4.00. (London: Chapman & Hall, Ltd. 24s.) *

Ann Math Stat 19:122–3 Mr '48. M. A. Girshick. The development of sequential analysis as a new tool of statistics is by and large the work of Abraham Wald. This fact in itself would make the appearance of a book by him on this subject an important event. However, Wald in this book did more than discuss the present status of sequential theory. He has, in fact, written a very lucid treatise on the general sub-

ject of statistical inference—a treatise which is likely to have great influence on statistical thinking. While this book is not written for the mathematically untrained, a knowledge of differential and integral calculus will suffice to follow all the arguments except perhaps for some sections in the appendix where the more complicated proofs have been placed. * Of special interest in [Chapter 5]....is the derivation of the exact characteristic function for a large class of tests and the development of upper and lower limits for the effect of grouping on the *OC* and ASN curves. * Part III consists of two short chapters and deals with multi-valued decisions and sequential interval estimation. The results in these chapters are not definitive answers to the two outstanding problems in statistical inference but are merely suggestive of a possible approach to them. Nevertheless, from the point of view of stimulating future research these 2 chapters are perhaps the most valuable sections of this book. * The Appendix, together with the main body of the book, forms a fairly exhaustive treatment of sequential theory. A notable exception to this is the lack of any mention of the published research on sequential point estimation. This is probably accounted for by the fact that this research came too late to be included in the book. Other minor omissions that may be noted are references to the generalization of the Fundamental Identity to more than one dimension and other theorems on sequences of functions of random vectors which have appeared in print. Also no mention is made of the similarity of sequential analysis to the problems of the random walk and the gambler's ruin. This, in the opinion of the reviewer, is regrettable. This book will make a very suitable companion to the book *Sequential Analysis of Statistical Data: Applications* prepared by the Statistical Research Group, Columbia University * While there is some overlap in the material covered, the two books differ in emphasis. Wald's book, though not highly technical, is more in the nature of a textbook on the theory and application of sequential analysis. The SRG book, on the other hand, was prepared mainly for statisticians who may wish to use sequential analysis in practice. The latter book is therefore more detailed and puts less emphasis on the theoretical aspects of the sequential procedure. The book is surprisingly free of typographical errors which is a tribute to the high quality of the editorship.

Ind & Eng Chem, Anal Ed 19:819 O '47. John W. Tukey. * Sequential analysis was foreshadowed by Dodge and Romig's double sampling plans, where the results of testing a first sample were classified as satisfactory, unsatisfactory, or inconclusive, and in the third case another sample was taken and tested. At the urging of Friedman and Wallis, the development of a general theory of such step-by-step procedures was undertaken by Wald, who solved the basic problems in an amazingly short time. Sampling plans and testing procedures based on this theory were then rapidly put into use in both government procurement and private industry. This book can be recommended to scientists who feel at home with mathematical notation and who are familiar, as the preface suggests, with college algebra and one course of calculus. They will be able to work slowly but surely through the body of the book, greatly enhancing their background in statistical theory. Any scientist who is willing to read a sentence, stop and ask himself what it means, draw a sketch or two, and then go on, can learn much of the best current approaches to the testing of hypotheses from the 70 pages spread through the book which concern this subject. Since testing hypotheses is one of the principal functions of a scientist, the time will be well spent. Those scientists or engineers fortunate enough to have a mathematician in their organization will do well to see that this book is available to such collaborators and that substantial parts of it are read. In general, the author gives a precise and concise account, in mathematical language, without extended exposition. The one annoying feature of the book, to this reviewer, was the style of the figures, where quantities known to range between 0 and 1 are represented on coordinate axes which extend to 2 or to 3, and then have an arrow pointing onwards! The paper and binding seem adequate.

J Am Stat Assn 42:658–64 D '47. G. A. Barnard. Professor Wald, his publishers, and all those associated with the rapid production of this book deserve congratulations. At the beginning of 1943, the idea underlying sequential analysis had not yet been formulated. * And now, in 1947, we have a book which gives an authoritative, up-to-date account of the whole theory. Such speed and enterprise in the spreading of new scientific developments is rare. * It is undoubtedly true that much of the book could be understood by someone with such elementary

mathematical equipment—in fact, enough, of sufficient importance, to make it well worth while for such a person to attempt to work through it. But the full impact of the book will be best felt by those with a little more familiarity with mathematical ideas. In particular if the work is to be used as a manual for practical procedures, a warning should be given that, for example, some of the logarithms in the formulae can be common ones, while in others, natural logarithms have to be used. More numerical examples would have helped in this connection. For the more mathematical reader, the exposition has a clarity and a unity which make it exceedingly attractive. * a most stimulating number of unsolved questions are raised. But it is the aesthetically satisfying unity of the exposition which is, perhaps, the main defect of the book. In a book such as this, one has the opportunity, denied in most scientific papers, of presenting the same matter from several points of view. This has not been done here. No mention is made of the fact that the sequential procedure in the case of discrete populations is exactly analogous to a game of chance. Many of the probability problems raised are identical with those solved by the classical founders of the subject—de Moivre, Huyghens, Laplace—and it would have been helpful to have dealt with some of the problems by the methods of these writers. Again, the analogy of the continuous case with the diffusion problem is not mentioned; for physicists, applying sequential methods, this would have helped them to gain insight into what was happening. At another point in the discussion of the problem of testing the mean of a normal distribution against two-sided alternatives, the final result is arrived at in accordance with the general theory of weight functions over the parameter space. Yet this final result, to a sufficiently close approximation, could have been arrived at directly from the one-sided case. We could argue that to test whether a mean is zero, against positive or negative alternatives, we could simultaneously test the zero mean against positive alternatives, and the zero mean against negative alternatives. Provided we suitably allow for the *two* chances of wrongly accepting the zero mean, we arrive at approximately the same test as before. There are three points on which this reviewer would register disagreement. First, on page 109, Professor Wald persists in an incorrect statement he has made earlier, to the effect that the classical test procedure for 2×2 tables (in Fisher's form for small samples, or in Yates' form for larger ones) is not applicable to cases where the probabilities vary from trial to trial. These methods are applicable, exactly, if and only if the proper randomization procedure has been carried out—regardless of variations in probabilities. The second point is a query, rather than a disagreement. Something seems to be wrong with the sequential t-test as given by Professor Wald. Sampling experiments seem to show that if this procedure is replaced by a much simpler one, in which we use the signs ($+$ or $-$) of the observations only, then there may be an actual *gain* in efficiency. Furthermore, if one takes the line of argument indicated earlier in this review for this case, involving the non-central t distribution, one arrives at a test almost, but not quite, identical with Professor Wald's. Something remains to be cleared up here. The third point of disagreement is rather fundamental. In his opening words, Professor Wald says, "Sequential analysis is a method of statistical inference whose characteristic feature is that the number of observations required by the procedure is not determined in advance of the experiment." Such a statement would imply that sequential methods of analysis are not applicable to such things as long-term agricultural experiments, where material circumstances demand that the number of observations should be fixed in advance. But if the argument we have outlined at the beginning of this review is sound, it would follow that the characteristic feature of sequential, as opposed to classical analysis, is that *we allow for the possibility, in any finite case, of not being able to decide;* and that the likelihood or probability ratio method of analysis is applicable, not only to the fields in which observations can be taken successively, in large numbers of small groups, but *to all questions where the choice lies between a finite number of exclusive alternatives.* If this latter opinion is correct, it leaves the theory of sequential testing almost unaltered; but the sphere of applicability is much wider than might otherwise be thought.

J Am Stat Assn 42:664–5 D '47. Robert Ferber. Professional statisticians will welcome this book as a very useful and well-written reference work on the theory of one of the latest statistical techniques, written by the one who developed the subject and who, consequently, is most qualified to write such a book. * written very

concisely and systematically. Though occasional repetitions do occur (*e.g.*, compare pages 72–73 with pages 78–79), they are not likely to prove too irksome to the professional statistician and will be welcomed by the beginning student who will probably have enough difficulty with it as it is. The one unsystematic part of the book, in this reviewer's opinion, is Chapter 9 where the author fails to state or even mention the operating characteristic or average sample number formulas for testing the mean of a normal distribution in a two-sided alternative. This is contrary to the practice followed in the previous four chapters on applications. * relatively small number of misprints * An unfortunate aspect of this book is the continual reference to sampling inspection and to physical science situations for illustrative examples. Although it is true that sequential analysis was first developed to aid physical science, the fact that the method can equally be applied to problems of social science and of commercial research does not seem to have yet gained wide recognition, either among mathematical statisticians or, consequently, among practical commercial researchers. This reviewer has yet to see an illustration of the application of the method to commercial research in a publication on sequential analysis. Until the applicability of sequential analysis to these problems is generally recognized, the market for such books as the present one is artificially restricted to professional statisticians and to physical scientists.

Sci 106:303–4 S 26 '47. Frank M. Weida. * very useful and valuable * should be possessed and digested by every teacher of statistics and by every professional statistician * sequential analysis is not the last word in testing procedures for the general problem of efficient testing. Too little attention appears to be given to operational testing situations to determine the pertinent factors that are involved. However, the technique appears to be useful when the test is destructive and when the cost of testing an item is large. The book is divided into three parts and an appendix. Part I includes: (1) an elegant discussion of the elements of the current theory of testing hypotheses, (2) a clear and concise general statement of a sequential test of a statistical hypothesis, (3) the nature and meaning of a probability ratio test, and (4) an outline of a theory of sequential tests of simple and composite hypotheses against a set of alternatives. In Part II we have certain simple applications of the theory to very special cases involving the binomial and normal distribution functions. It would have been interesting and useful to have had, in addition, illustrations of less common cases. Part III outlines a possible approach to the problem of sequential multivalued decisions and estimation. As is well known to the author of the book, this field is unexplored, and in it there is much left to be done. In the appendix the author gives certain mathematical derivations pertinent to the theory of sequential testing. * the book is well and clearly written and may be read and understood by those who have no advanced mathematical training.

Sci Progress 37:345–6 Ap '49. H. O. Hartley. [Not excerpted because of copyright restrictions.]

[307]

★WALD, ABRAHAM. **Statistical Decision Functions.** New York: John Wiley & Sons, Inc., 1950. Pp. 201. $5.00. (London: Chapman & Hall, Ltd. 30*s*.)

[308]

★WALKER, HELEN M. **Elementary Statistical Methods.** New York: Henry Holt and Co., Inc., 1943. Pp. xxv, 368. $3.25. *

Am J Psychol 58:568–70 O '45. Quinn McNemar. * This text, with its fundamental soundness, clarity of verbal exposition, adequate illustrations and well-thought-out aids to understanding, would qualify as the answer to the prayer of instructors in statistics were it not for (1) a formal notation which, though necessary in more advanced courses, is apt to bewilder rather than help the beginning student, and (2) a plethora of formulas. For instance, the battery of formulas contained on pages 225–228 for calculating regression coefficients could be greatly simplified, with no loss of rigor, by defining these coefficients in terms of r and standard deviations. In other words, the reviewer doubts that the first standard set forth in the preface ("complete clarity, simplicity, self-teaching") has been met. Due attention has been given to "underlying concepts and to interpretations" save for the conspicuous absence of even an elementary discussion of probability. The aim to "insure a satisfactory foundation for more advanced study," with its consequent emphasis on formal notation, is an important consideration only for those teachers who have a low student mortality-rate at the end of a first course. The book is unusually free from the nuisance errors, typographical and otherwise,

which so frequently plague statistical texts. There are a few specific, though minor, points which the reviewer questions. The errors of measurement attached to the scores on page 141 are unrealistically rectangular in distribution. A footnote (p. 159) incorrectly states that the "normal curve does not properly describe the distribution of the means of small samples,"—this is an obvious slip since the author presents the correct idea elsewhere (pp. 275, 284). The student who happens to plot the frequencies in Table xliii against the derived T-scores will have some difficulty in appreciating just how T-scaling normalizes a distribution. This can be remedied by a more fortunate choice of illustrative material. The question as to whether a test is reliable enough to use for individual work is answered (p. 253) by resort to the error in estimating score on one form from score on another, instead of the more usual and sounder error of measurement. In discussing how to combine two or more samples, drawn from the *same* universe, in order to obtain the best estimate of each population parameter, Professor Walker advocates (p. 285) formulas for the best estimate of the population variance which are based on the within (samples) sum of squares. This is, of course, the proper procedure when independent estimates are needed in testing significance via analysis of variance, but for the purpose elsewhere set forth (p. 284), the best estimate would be obtained by using the total sum of squares or the equivalent, Walker's formula (30a) with N_c replaced by $N_c - 1$. Suppose we take an extreme example: 100 samples of 3 cases each. The variance estimate by Walker's formula (94) would be based on 200 degrees of freedom whereas that based on the total sum of squares would involve 299 degrees of freedom and hence would be more accurate. Except for the cumbersome notation and the failure to minimize the number of formulas (to be "memorized"), the reviewer places this text ahead of its competitors.

Am Math Mo 51:283–4 My '44. A. H. Copeland. * written for students with extremely meager mathematical backgrounds * the question is whether this textbook is a competent piece of work for what it attempts to do * the answer is decidedly in the affirmative. The author herself evidently has a clear understanding of statistical theory but she is also capable of taking the point of view of the students who cannot follow the various mathematical derivations. * the mathematical theory of sampling has been somewhat slighted and that additional space in the appendix might well be devoted to this subject. One further criticism. The following statement on page 271 is misleading. "It can be proved mathematically that the sampling distribution of the mean is characteristically normal, and the frequency distribution of any observed set of means obtained from random samples of uniform size will tend toward the normal if enough samples are taken. Note that it is the *number of samples* which must be increased in order to produce this result, not the *number of cases in a single sample.*" The author refers to samples of fifty taken from a large but finite parent population. Under such circumstances the normal distribution cannot be obtained as a limit by increasing the number of samples. Moreover the size of the samples does affect the degree of approximation to normality. These criticisms however are minor. On the whole the book is very readable, it is intelligently written and should prove to be a useful text.

Am Sociol R 9:342 Je '44. Thomas C. McCormick. * designed for only a single semester's work * written for students of education, although the fact is not betrayed by the title. The emphasis is distinctly pedagogical, the book being based on several years of careful classroom experimentation. One result of this is a special chapter to acquaint the student with the use of statistical symbols. Apparently another is a queer mixture of passages of almost grade-school level at some places and of highly abstract nature at others. One is surprised to find little use made of realistic problems as a pedagogical means of approach to the technicalities of statistical method. A characteristic feature is the frequent occurrence of extracts from the history of statistics, a penchant for which the author is well known. Some of Fisher's methods appear in Walker's book also, but only in a final chapter on sampling. In that chapter the exercises for students are centered upon Fisher's refinements of technique rather than upon sampling problems of special importance in educational research. However, the author does explain at some length how to take random samples, and develops a part of the logic of random sampling rather fully, although she does not go far with tests of significance which are the final objective. Probability is not defined and the logic of probability is not developed.

Stratified sampling....is briefly described, but no standard error formulas for this important type of sample are given. An appendix is devoted to derivations of formulas presented on faith in the text, including, with no recognition of incongruity, some that require a knowledge of moderately advanced calculus. * [The text does not face] the issue of how much and what kind of mathematical training a student must have before he can hope to be able to make effective use of statistics as a tool of investigation in any field of knowledge. * [The author merely adjusts her text] to the immediate fact that the students....[she knows] have usually studied no mathematics beyond high school algebra, and that well forgotten. One could wish that Walker, with her rather unusual professional interest in pedagogy on the one hand and in mathematical statistics on the other, had conducted studies designed to answer this basic and debated question in the teaching of statistics, and then built her text accordingly.

Ed Res B 25:28 Ja 16 '46. James E. Wert. * The content....differs but little from that found in similar books published during the last ten years for students of education. The book is well written; the chapters on "Symbolism in Statistics" and "Sample and Universe" are unusually interesting and well done. The former will be appreciated by students who somehow have acquired a feeling of fear for symbols. The latter will be useful in orienting the student into sampling theory, so essential in educational research. The author implies, and the reviewer wholeheartedly agrees, that the last chapter, satisfactory though it is, constitutes only a springboard to the attack on educational problems. She proposes a companion volume dealing with statistical inference. This should be a distinct contribution, and its early publication is eagerly awaited by this reviewer.

J Am Stat Assn 38:489–90 D '43. Laverne K. Burke. * Well-chosen quotations and historical references which add to the interest of the book are frequently given. * a number of unusually good exercises are given throughout the book. Beginning statistical workers who might expect this to be a reference book containing explanations of all the usual statistical techniques set forth in an elementary manner may be disappointed: the topics of partial and multiple correlation, measures of reliability, time series, and index numbers are not discussed. The list of formulas in the appendix are not especially adapted to ready reference since they are shown without names; nor are formulas for the standard deviation and the correlation coefficient shown in the forms best adapted to machine calculation. A characteristic of the book which may be troublesome to beginning students is that statistical terms are used many pages before they are defined or explained. *

J Ed Psychol 35:188–9 Mr '44. Miles A. Tinker. * Many noteworthy features of the book should receive special mention. The exposition is simple and clear. Underlying concepts and interpretation receive special attention. Since the material is in harmony with recent developments in the mathematical theory of statistics, it will furnish a sound foundation for more advanced study. The treatment of symbolism is adequate and exceedingly helpful. Putting exercises at appropriate places in the text is an effective teaching method. Particularly noteworthy are the discussions of the normal curve and of sampling. Throughout the organization is such that the text is almost self-teaching. Some instructors will be disappointed by apparent incompleteness along certain lines: (1) The treatment of reliability of differences and of test scores is meagre, (2) Test and item validity as well as multiple and partial correlation are not discussed or are barely mentioned. Presumably many of these items will be covered in the author's forthcoming Book II which will be devoted to further development of statistical inference. This excellent book will find wide use. Many instructors will welcome it as just the text they have been waiting for.

Nat Math Mag 19:103–4 N '44. H. T. Davis. * Appendix E lists 100 statistical formulas. Because of its comprehensive nature, this is one of the most useful sections of the book. * The text is principally adapted for those who wish to apply statistics to sampling problems. Such topics as index numbers, time series, curve-fitting, *etc.* are omitted. The author also does not venture into the more advanced theories of correlation, since this text is essentially an introduction to statistical methods.

Q R Biol 19:71 Mr '44. This book is designed ....to acquaint the student with a variety of statistical techniques, the logic underlying them, the methods of computation, their limitations and powers, and the interpretations to be given them. * The author is very successful in her endeavor. The procedures are explained with great clarity and with a wealth of detail which

is helpful to the beginner. At the same time the objectives stand out clearly and certain philosophical issues and underlying principles which affect the interpretation of results are more fully discussed than in most texts. The discussion of the nature of scale (p. 187) is particularly welcome, as it is fundamental to any consideration of the statistics of measurements and yet very often is awarded no critical consideration at all. The balance between presentation of mechanical detail and of important concepts is achieved partly through sectional subdivisions of the treatment of a given subject. For example, the sixty pages devoted to regression and correlation are grouped into three chapters of about equal length on general concepts, computations, and interpretations, respectively. This has the advantage of isolating the mechanical side of the matter so that it may be given completely without at the same time subordinating the meaning and interpretations. Many of the algebraic proofs and notes are given in appendices. Although the book is very free of errors, it may be well to call attention to two or three which the reviewer noted, as well as to certain places where the discussion seemed a little limited. In the frequency diagrams (pp. 38 and 39) the ordinate is labeled as frequency instead of frequency per unit of the abscissa, in spite of the fact that in the text the student is warned that it is area and not ordinate which represents frequency. On page 125 it is stated "....both variance and standard deviation are expressed in units of the original distribution." Although what the author is pointing out is that they are dimensional, the statement as worded seems to say that they have the same dimension. The discussion of mean deviation and standard deviation (p. 114) implies that it is algebraically unsound to use absolute values, and that the only purpose of squaring deviations is to get rid of sign. In the discussion of the use of symbolism (p. 80), the opening sentence reads "The scientist resorts to symbolism because words often fail to meet his needs for clear, precise, and unambiguous statements." This implies that the symbols are more precise than the words which define them, and this implication is strengthened by the discussion which follows in which it is stressed that "A vague idea....can be conveyed by words, but precise ideas are excessively difficult to achieve without the use of symbolism." This view, that the symbols mean something in themselves apart from the words defining them, may account for the emphasis that is given to the value of standardization of symbols. Although such standardization may make the beginner more readily able to turn from one page of algebra to another, it has the danger that it may lead to the kind of inflexibility that prevents some students from doing a geometry proposition when the letters are changed. The desirability of having symbolism "fit like a straitjacket" (p. 81) is open to debate. Any good book which deals with such concepts at all will always arouse debate on some issues. This book should, therefore, be a stimulating one to use in the classrooms as well as an excellent introduction to the subject for the student who goes it alone.

[309]

★WALLACE, W. N. W., EDITOR. **Lectures on Statistical Methods of Inspecting and Controlling Quality: Delivered During a Course of Instruction Arranged by the Department of Munitions for Members of the Technical Staff: Held at the University of Melbourne, August, 1944.** Commonwealth of Australia, Ministry of Munitions, Quality Control Lectures, Melbourne, 1944. Melbourne, Australia: Explosives Factories, Munitions Division, Department of Supply and Development, 1944. Pp. 236. Paper, mimeographed. Out of print. *

J Am Stat Assn 41:266–8 Je '46. Edwin G. Olds. Early in 1943, Mr. A. L. Stewart of the Standards Association of Australia, and Mr. R. G. Moore, Works Manager of the ammunition factory at Footscray, were sent to America by the Australian Department of Munitions to study the application of Statistical Quality Control. While in this country, they conferred with leaders in the field and visited a number of companies where quality control was in operation. Mr. Stewart attended several of the intensive eight-day courses sponsored by the Office of Production Research and Development of the War Production Board, and Mr. Moore visited at least one such course. Impressed by our success in using statistical methods to improve the quality and increase the production of war material, they returned home convinced that education in the techniques should be made available to Australian manufacturers. Accordingly, an intensive course of instruction was scheduled at the University of Melbourne, August 9–16, 1944, by the Department of Munitions, for those members of its technical staff responsible for the quality of production. A total of eighty-seven men attended the sessions held on the opening day and forty-seven of these remained for the entire course. The

book under review is a mimeographed report of the intensive course of lectures. It is assumed that a stenographic record of the proceedings was made and the result carefully edited. The copy read by this reviewer was struck off from badly-worn stencils, and is illegible in spots, but in so far as it can be read, the book has a surprisingly small number of minor errors. Most of these have been noted on a correction sheet at the end of the book. The reviewer found the book tremendously interesting, and believes his interest will be shared by a great many of the nearly two thousand men who attended O.P.R.D. Quality Control courses in the United States during the war period. Moore and Stewart left the United States while our course was in an early stage, yet the further developments in the two countries followed surprisingly parallel lines. Students of quality control who have been wishing for a complete record of the O.P.R.D. course will find this book an excellent substitute and, in many instances, will have considerable difficulty in convincing themselves that the lectures they are reading are not the ones to which they themselves listened. Other persons will find the book a valuable introduction to the field. * In comparison with the O.P.R.D. courses, the Melbourne course seems to have devoted considerably less time to demonstration lectures, and to laboratory work by the students. On the other hand, somewhat more theory was included, and such subjects as Fisher's *t*-test, the estimate of sigma from successive differences, testing the reliability of chemical analyses, and rational sentencing of ammunition by use of 5-defect samples were included. Otherwise, the courses were very similar, relying on much the same reference material and using about the same order of presentation of topics. Even the reports on applications by special lecturers sound very familiar. * the book will be fascinating to "alumni" of the O.P.R.D. courses, and should be stimulating reading for anyone who wishes to deepen his understanding of the methods and applications of statistical quality control.

[310]

★WALLIS, W. ALLEN, AND MOORE, GEOFFREY H. **A Significance Test for Time Series and Other Ordered Series.** National Bureau of Economic Research, Technical Paper 1. New York: the Bureau, September 1941. Pp. xii, 59. Paper. Out of print. *

Am Econ R 33:401–2 Je '43. Leonid Hurwicz. * The usual techniques of least squares estimation are not directly applicable in case of time series since the postulate of independence of observations is not satisfied. The basic properties of estimates derived by the least squares method have not been systematically investigated, but it is known that these estimates are not always unbiased. If we try to fit a set of regression coefficients to, say, national income series we have the choice of either using the least squares method with its unknown bias or resorting to some alternative criteria, for instance, that of maximum likelihood. On the other hand, there still remains the question of randomness of any given time series. This topic is not new and the authors....sketch its history in Section IX of their paper. While the authors' approach is essentially based on the number and sequence of reversals of trends of time series or "phase duration," an alternative method was recently adopted by Professor von Neumann (*Annals of Mathematical Statistics,* 1941). The latter has investigated the distribution of the ratio of the mean square successive difference to the variance. Given the sample value of that statistic and the significance level, we can determine whether the hypothesis of randomness is to be accepted or rejected. Wallis and Moore received a similar result by considering the distribution of the phase duration and checking the goodness of fit by means of a statistic which they denote by χ^2_p which has properties similar to those of the ordinary χ^2. They state (p. 19) that they have not been able to determine mathematically the sampling distribution of χ^2_p but have found what seems a satisfactory working solution. In Section VIII they show how the tests can be applied to economic data: the sweet potato production, yield per acre, and acreage harvested in the United States, 1868–1937. It is noted that the technique applied lacks sensitivity to primary trend, but this is not regarded as a serious drawback. It must be realized, however, that the use of data in the χ^2_p test is rather incomplete since only the signs of first differences are considered, but not their numerical magnitude. In spite of its shortcomings the new test has very interesting possibilities of application, especially since it can be applied to series of residuals. It can be used in estimation of the regression coefficients by postulating that the residuals series should have a minimum value consistent with the maximum of randomness as measured by the probability of the sample value of χ^2_p. This, in a sense, would be

a generalization of the ordinary least squares methods.

[311]

★WAUGH, ALBERT E. **Elements of Statistical Method, Second Edition.** New York: McGraw-Hill Book Co., Inc., 1943. Pp. xxi, 532. $4.50. * (London: McGraw-Hill Publishing Co., Ltd. 38*s.* 6*d.*)

J Pol Econ 52:379–80 D '44. Harry Pelle Hartkemeier. * the author would have done better to have written a second volume or an advanced textbook, instead of revising the elementary one. For example, it is difficult to believe that an explanation of the Pearsonian system of frequency curves, an illustration of fitting a skewed Type III curve, and a discussion of and a fitting of a Poisson series belong in an elementary textbook. The beginning student who wades through these parts of the book will be surprised to find later on in the book the statement that a straight line is "one with no bends"! Even in the first edition, the author "assumed that the reader has a good command of college algebra." This is even more necessary for the revised edition, which is more suitable for graduate students or Seniors than for Freshmen or Sophomores. For mature college students the book will serve well to cover the usual subjects if the professor chooses the assignments wisely and helps the students over the advanced parts or eliminates them. In the limited space available the reviewer must usually point out some of the disadvantages which he believes exist in the book. Waugh makes frequent use of the probable error, which is a vanishing practice in modern statistical methods. The reviewer does not like Mr. Waugh's phrase "chance is ruled out" when the probability of an event's being a random fluctuation is small enough to permit us to accept the event as reliable evidence. Chance is never really ruled out. Waugh also states: "Odds of 40 to 1 are not certainty to a statistician." A good statistician does not and should not require certainty, nor should he spend his time searching for certainty. The author is an optimist. Only fourteen pages after he begins to explain the method of least squares in the measurement of secular trend, he states: "By now the method of least squares should be second nature to the student, and very sketchy description of the method of fitting a geometric trend, or semilogarithmic curve, should suffice." The teaching of students who learn this rapidly would really be a pleasure. Most students have to do quite a bit of statistical work before the method of least squares becomes second nature. On page 255 Mr. Waugh repeats McCall's suggestion (made in 1923) that in computing standard errors of the mean and standard deviation "we use $N - 1$ in place of N when the number of cases is between 20 and 30, that we use $N - 2$ instead of N when the number of cases is between 10 and 20, and that we use $N - 3$ in place of N when N is less than 10." Waugh does not present any reason for, or proof of, this unorthodox practice of using $N - 2$ and $N - 3$ in the computation of the standard error of the mean. This fact, coupled with the absence of any explanation of the concept "degrees of freedom," makes the book less satisfactory for a modern approach. The reviewer strongly disapproves of the author's apologetic presentation of statistical method as "a poor second choice" (p. 3) * there are many cases in which the statistical method is superior to the experimental method, and statistical analyses have revealed weaknesses in the experimental method by detecting a lack of control where there was assumed to be experimental control. The reviewer noticed a few errors. *

For reviews of the first edition, see 38:B727 and 2:314.

[312]

★WAUGH, ALBERT E. **Laboratory Manual and Problems for Elements of Statistical Method, Second Edition.** New York: McGraw-Hill Book Co., Inc., 1944. Pp. xiv, 216. $2.00. * (London: McGraw-Hill Publishing Co., Ltd. 17*s.*)

For reviews of the first edition, see 2:315.

[313]

★WEATHERBURN, C. E. **A First Course in Mathematical Statistics.** London and New York: Cambridge University Press, 1946. Pp. xv, 271. * For latest edition, see 314.

Am Math Mo 55:41–2 Ja '48. C. C. Craig. This book has a good many points of similarity to the even more recent text by Hoel [Introduction to Mathematical Statistics] * It is written at about the same mathematical level and for the most part....deals with the topics found in the other book. It is, however, even more concerned with the mathematics of statistics, so far as its mathematical level permits, and by not including an account of some of the more recent developments dealt with in Hoel, space is found for a fuller treatment of some of its subjects. Greater mathematical clarity seems to be obtained at points, especially in the first half, but

the discussion of the meaning of the results from the viewpoint of application to experimental work is even more brief. This is primarily a book for a comparatively mature student who already has a working knowledge of methods of statistical investigation, who wishes to gain a sounder understanding of their validity, and who has a good command of the calculus or a little more as his mathematical equipment. For students who are quite new to statistics, a good deal would need to be added by the instructor to keep a course based on this book from being quite formal. The first five chapters deal with moments, probability, the binomial, the univariate and bivariate normal and the Poisson frequency functions and finally bivariate regression theory. Confined to 105 pages the discussion is necessarily often brief. Here also the moment generating function is introduced and freely used and Weatherburn goes beyond Hoel in deriving Sheppard's adjustments (as corrections good on the average) and in defining and using Thiele's seminvariants (or cumulants). The introduction to probability is not so very compressed as in Hoel's book and the student is likely to feel better prepared to go on to the study of frequency laws. As the author says, he has deliberately avoided the more modern mathematical formulations of the theory of probability, but the reviewer would be better pleased if it were at least mentioned that there are logical difficulties in the concept of the limit of an observed frequency ratio as the number of observations increases indefinitely. * Interesting features are the introduction of the Γ- and B-type distribution functions as the basic functions for the distributions used for the exact tests in samples from normal universes, and the derivation of the χ^2 distribution by the method used by Fisher in 1922. There is a chapter on the analysis of variance and covariance in which the exposition is clear for the simple two, three and four component (Latin square) analyses of variance but is less clear for the one and two component analyses of covariance dealt with. The final chapter on multivariate regression theory also seems to suffer from an effort to achieve brevity. A great deal of what the reviewer said in a general way concerning Hoel's book could be repeated here. Again it is very pleasing to have another book on mathematical statistics at this level that one can recommend to students as mathematically sound and adequate. There are good lists of problems and some of them embody additional theoretical developments that could have been included in the text. Computing methods are not given a very prominent place. There are a good many places where the reviewer would like to see fuller discussion and illustration; fewer where he would want to revise what is said. In the discussion of the standard errors of sample parameters there should be some mention of the efficiency of a statistic as well as its bias and the two concepts should be distinguished from each other. The development of the large sample standard error of a sample variance and the account of the approximation obtained is really not satisfactory. Presumably the author doesn't mean to say on page 179 that the sum of two stochastic variates could be independent of either summand. In the comparison of two sample means by the Student-Fisher t test, the assumed equality of the variances in the universes sampled needs emphasis and the fact that this assumption can be tested by the use of the variance ratio needs to be included and illustrated. In fact the student is not shown at all how to find the probability that the variance ratio be less than a given proper fraction. The relation between the variance ratio with one degree of freedom and the Student-Fisher t ought to be pointed out. But these are minor criticisms. We really have here another very useful reference book and an excellent text for a properly prepared class. The lack of books where statistical mathematics could be found at this level has been a serious handicap in statistical instruction and this book and Hoel's will be of much aid to both students and teachers.

Biometrika 34:373 D '47. F. N. David.

* Weatherburn has taken a rather formal mathematical exposition of the subject, and mathematical students will find his book both interesting and profitable to read. Numerical examples are given for the reader to apply the appropriate mathematical technique. It is possible that these would have been of greater utility if they had contained the material in its crude state, and had not been streamlined so that the application of the technique is immediately obvious, but nevertheless many new examples are there. I am not sure whether this book will be entirely useful to students of other subjects than mathematics. While the mathematical analysis is undoubtedly clear it is possible that many will not be able to follow it in detail, and the conclusions of the analysis are not emphasized strongly. We may contrast with

this Fisher's *Statistical Methods for Research Workers,* where no analysis is given, but where the relevant formulae and their interpretation are stated unmistakeably and their applications to material in its crude state set out so that the student may calculate for himself. Probability theory is the foundation stone on which the whole of statistical theory is built. It is disappointing therefore to find that it is given somewhat perfunctory treatment in one chapter and the part it plays in (say) statistical tests of significance is not brought out and emphasized. There is a tendency nowadays in applying statistical technique to regard the 5% and 1% levels of significance as sacrosanct and those coming fresh to the subject should learn that custom is the only reason for their choice. In spite of the criticisms which I make, however, I would recommend this book to students who have obtained some idea of the aims and objectives of statistical theory, and who are desirous of learning the development of the mathematical technique as well as its application. Professor Weatherburn's mathematical analysis makes pleasant reading and may well throw new light on old methods for those who have learnt the rudiments of the theory.

Economica 14:239–41 Ag '47. E. Grebenik. * Weatherburn....presupposes some mathematical knowledge in his reader, and the exposition is at a level between Yule and Kendall's well-known *Introduction* and the more advanced texts of Kendall, Wilks or Cramér. The need for a book of this kind has long been felt, and Professor Weatherburn is to be congratulated on filling it so admirably. The conventional subjects are dealt with, but special mention must be made of the author's treatment of small sampling distributions. He devotes a lengthy chapter to the properties of three distributions, and then shows that most of the sampling distributions in common use may be regarded as sums, products or quotients of these variates. The treatment is remarkably lucid and brings out well the connection between the different distributions, and the underlying unity of the subject. It is, however, a pity that Professor Weatherburn should not have added an appendix on orthogonal transformations which are used in explaining degrees of freedom. Orthogonal transformations are the only algebraic concept used in the book and an explanatory note would have been welcome. Among other subjects treated are correlation, simple, partial and multiple regression, and the analysis of variance and covariance.

J Am Stat Assn 42:344–5 Je '47. Walter Leighton. * a worthy contribution in a distinguished tradition. The book is carefully written, and the result is a high order of clarity throughout. It is not a little astonishing to realize after reading the book how much both of theory and of example has been set comfortably in 271 pages. * His treatment of probability is quite adequate for the purpose of his book. He does not cast his lot with any of the more vociferous schools of thought on this subject, and....he quite properly avoids a critical and comparative analysis of the more generally accepted approaches to the subject. An innovation is the author's use of the properties of Beta and Gamma variates to derive the sampling distributions of those statistics which are fundamental in the more commonly used tests of significance. * This reviewer was very favorably impressed by the unity and coherence which the use of Beta and Gamma variates brings to this type of exposition at a relatively elementary level. Some readers will regret that the treatment of small samples is deferred until the last third of the book (pp. 185 *ff.*). Its central importance nowadays in applications would seem to suggest very early attention. The typography of the book is excellent, and the rare misprints which were observed were not misleading. This is a book every statistician will want in his library.

J Am Stat Assn 42:345–7 Je '47. Charles P. Winsor. * covers much of the same ground as Hoel's *Introduction to Mathematical Statistics* * The author makes little attempt at mathematically rigorous or precise definitions of his fundamental concepts. In fact, after several readings, the reviewer is not clear what definition of a frequency distribution would be consistent with the statements in the text. * On this point Hoel seems definitely clearer. * Neither Weatherburn nor Hoel seems entirely satisfactory in the treatment of correlation and regression. Neither distinguishes clearly between the case of a random sample drawn from a bivariate population and the case of a selection of values of the independent variable. Both give as the standard error of estimate from a regression line, $\sigma\sqrt{1 - r^2}$, without consideration of the uncertainty of the estimate of the regression equation. Weatherburn's treatment of nonlinear regression is brief. He gives the least squares

solution for a parabolic regression and indicates that some nonlinear expressions may be linearized by transformation. He does not indicate that such linearization will not give the least squares fit to the original equation unless suitable weighting is used. Hoel seems sounder on this point. Weatherburn's chapter on analysis of variance and covariance is brief and not too helpful to the applied statistician. Hoel's discussion (which omits covariance entirely) is even briefer but does bring out clearly one of the main uses of analysis of variance, the elimination of irrelevant variation both from the estimates of effects and from the estimates of error. There is no adequate discussion in Weatherburn of the principles on which methods of estimation or tests of significance should be chosen. The first topic is untouched; the only discussion of the second (in §91) seems likely to mislead a careless reader. In this section we find the following. First, "By means of it [the χ^2 test], however, we merely test the rareness of the sum of squares Σx_i^2. Clearly, before accepting the sample as not a rare one, we must be satisfied about other points also." And he goes on to say that "a set of n statistically independent variates may be formed in many ways from the given variates, each of which provides a further test of the rareness of the sample." While the antecedent of "which" in this sentence is perhaps not clear, it does seem clear that the industrious statistician ought always to be able to find some test which would show that his sample is a rare one; and apparently he has Weatherburn's authority for such a procedure. Hoel recognizes that problems do exist in connection with methods of estimation and choice of significance tests, though one may wonder whether his treatment is adequate to clarify the mind of the student. (Incidentally, it is a little surprising to find no reference in Hoel to Neyman and E. S. Pearson; their names are not even mentioned in the discussion of Type I and Type II errors.) Rather surprisingly, Weatherburn gives no discussion of contingency tables. His discussion of significance tests for the difference between observed proportions in two samples deals only with the large sample case. Hoel discusses contingency tables in general but gives no special treatment for the 2×2 case. Weatherburn's policy in regard to references seems, to the reviewer, preferable to that of Hoel. Weatherburn lists about a hundred titles starting with Helmert's 1875 and 1876 papers and coming down through Wilks' and Kendall's books. Hoel gives references to the original literature only (apparently) where no textbook is available. There are a few rather surprising omissions from Weatherburn's references. Thus, Fisher's classical paper of 1922 is not cited, nor is Pearson's 1895 paper on skew variation. The latter omission is the more surprising in that the 1894 paper on the decomposition of a distribution into two normal curves is listed. The only reference to Neyman and E. S. Pearson is to their 1931 paper on the problem of k samples. The reviewer's general conclusion is that both Weatherburn's and Hoel's books should be on the shelves available to students but that most teachers will probably feel that neither is completely satisfactory. This is perhaps a good thing; it will force the teacher to decide for himself what his students should be taught.

J Royal Stat Soc 109:506–7 pt 4 '46. J. W(ishart). * The subject has been dealt with competently and well, so far as it is taken * A very good idea of what the subject is about generally, and of how it is dealt with by modern exponents, can be had from this book by anyone who has a moderate mathematical knowledge and who possibly finds Kendall's two volumes too formidable and time-consuming. It would be a good idea if mathematical teachers, who all too often know nothing about statistics, would read this text; they would find it written simply in their own language, and could not advance the same objections that they are inclined to raise with books written for biologists without mathematical proofs. The reason why this course is recommended is that the subject has yet to find an established place in the curriculum of many mathematical schools, and a wider knowledge of the field is likely to lead to the realization that more must be done to cater for the needs of students who are interested in the subject, either for its own sake or, more often, because interesting and lucrative avenues for employment are open to those who have been trained as statisticians. It should be emphasized, however, that the book is only an introduction, and if the teaching is entrusted, as it should be, to the specialist in statistics, such a man will be required to go beyond what is written here. Most of the content of the book should by now be standard knowledge. An innovation is the introduction of the Gamma and Beta distributions, which are used to define three classes of variate having general properties

which are set out and proved. This is an attractive way of approaching distributional theory (on the usual assumption of normality in the parent population) because the standard results can be at once applied (*e.g.*, to χ^2 or the Variance Ratio), provided the groundwork is complete. The only major criticism the reviewer has is that the author should have gone further than he did. He proves (Theorem III) that if the sum of two independent positive variates is a Gamma variate with parameter $l + m$, and one of them is a Gamma variate with parameter l, then the other is a Gamma variate with parameter m. But there is no reference to Cochran, or to his theorem, of which a special case, in the present language, is: if the sum of two positive variates, which are themselves Gamma variates with parameters l and m respectively, is a Gamma variate with parameter $l + m$, then the two variates are independent. It is this theorem, extended to three and more variates, which is required in the analysis of variance. The author realizes on p. 212 that it is necessary to demonstrate the independence of the two estimates of variance in the "one criterion of classification" case, in order to use the Variance Ratio test, but says nothing on p. 216 (or on later pages) about the necessity for a similar demonstration in the two and higher criteria of classification cases, despite a reference at the end to Irwin's paper on the independence of the constituent items. The demonstration does not follow from Weatherburn's theorem, but from Cochran's, and this theorem is rightly regarded as important by Kendall and Wilks. The same lack of completeness in proof is shown in the treatment of the analysis of covariance. At this stage the book becomes almost completely descriptive of methods, without the mathematics, and while it is very useful to have the methods set out, the theory requires a great deal more attention to be paid to it than is possible in a short account, particularly along the lines of what circumstances justify the covariance analysis and what can be learnt from it. Only the case of a single concomitant variable is studied, and the following chapter on multivariate distributions does not return to the subject, nor does it refer in dealing with partial correlation coefficients to the value of their calculation in certain circumstances from the "error" line of an analysis of variance and covariance table.

Math Gazette 31:125 My '47. Frank Sandon.

* a sound and workmanlike volume * Chapter VIII on Beta and Gamma functions is a feature special to the author's treatment of the subject; he uses this chapter very successfully in his later chapters on various tests and analyses. In this way he gets a very neat text with some elegant work in it. He deals rather more fully perhaps than is usual with the analysis of covariance and with non-linear-bivariate regression. * The book is well printed and bound. * The book will ....be perhaps rather more advanced than the average undergraduate student in the sciences mentioned will be able to deal with comfortably. Other minor criticisms are (i) the assumptions about normality and size of population of sample are not always clearly stated; (ii) it is a pity that the author does not give graphs of his various functions on, *e.g.*, pp. 149, 153 and 188; (iii) where he does give diagrams or graphs they are often (*e.g.* on pp. 52, 70, 88, 172 and 197) rather too sketchy with insufficient legends to be of much help to the average student. *

Math R 8:392–3 Jl–Ag '47. J. Wolfowitz.

* assembles the formal derivations of many results used in elementary statistics. The student will find it a convenient collection * Numerous exercises enhance the value of the book as a text. This book is not in the modern manner. A test of significance is described as based on the occurrence of a very rare event. No mention is made of the idea of power, and hence of why certain very rare events are held to confirm the null hypothesis and others to contradict it. Moreover, on pages 195–196, the author speaks of "the need of supplementing the χ^2 test with others, before deciding whether a given sample is a rare one." The subsequent example shows that the author considers a sample "rare" if it falls into the critical region of any one of a number of tests. This procedure distorts the level of significance; if enough "supplementary" tests are applied, the size of the critical region may be considerable and a significant sample far from "rare." Fiducial limits for a mean μ are described simply as "the limits within which μ must lie, in order that the observed sample mean should not be significant at the prescribed level of probability." This is, of course, a correct formalization of a special procedure, but no mention is made of the operational significance of the idea. The maximum likelihood method is described for a special case without mention of its significance.

Nature 159:826 Je 21 '47. Godfrey Thomson.

* does not make such demands on mathematical ability as Cramér's [*Mathematical Methods of Statistics*] and is addressed more to practitioners. It is indeed based on lectures to graduates and undergraduates whose researches and studies were in agriculture, biology, economics, psychology, physics and chemistry. They cannot, however, have been a random sample of the students of those disciplines, I imagine. For those who can follow, however, Weatherburn's book is excellent. The chapter on the properties of Beta and Gamma functions, the use of which in discussing tests of significance is a feature of the book, thoroughly justifies the author's claim that it is clear and simple and does not demand any previous knowledge of these functions. Moment-generating functions are used quite a lot (as also by Aitken), in contrast to Cramér's book, where they are never mentioned except possibly in one exercise. I am surprised that the psychologists at least among Weatherburn's hearers did not ask for an earlier treatment of partial and multiple correlation. When he does come to them, he deals very neatly with the maximum correlation between one variable and the weighted sum of two others, and then simply directs attention to the validity of the argument also for n others. He does not mention, however, the problem of maximum correlation between two "batteries" of variables, nor refer anywhere to Harold Hotelling. Neyman, too, receives only a passing reference, in a footnote, and Egon Pearson the same. * Its great virtue is its compactness of argument, which facilitates seeing the whole. For example, he deals with fiducial limits in two paragraphs only, for the fiducial limits of a mean, using σ in the earlier paragraph, and its unbiased estimate in the later [*sic*]; but the principle is shown clearly, though the words "fiducial limits, or confidence limits" on p. 122 rather suggest a confusion of the theories of Fisher and of Neyman-Pearson. Similarly, the term "maximum likelihood" occurs only once in the book; but the paragraph which contains it (par. 77) puts the matter with extreme clearness. It may be, however, that anyone not knowing of its importance beforehand would pass over the paragraph without full appreciation. That is the danger of compactness and austerity. Kendall's book is warmer and more inviting.

Sankhyā 8:285–6 O '47. Birendranath Ghosh. An ideal text-book on statistics should effectively co-ordinate a lucid exposition of the basic logic and concepts of statistical theory, with a thorough (and, if possible, rigorous) elucidation of the auxiliary mathematics needed. Such ideal tests are, unfortunately, rare, and most of the standard books on statistics emphasize one of these aspects at the cost of the other. The author of the book under review has, however, explicitly restricted its scope to be "a mathematical text on the theory of statistics" only, and since well-written books of this type also are comparatively scarce, it will be a welcome addition to the already existing texts. * Within the self-imposed restrictions, the author—a reputed writer of mathematical texts —has dealt with the subject admirably. Apart from the merits of the book as a text on Statistical Mathematics, it will also be a useful help-book for the students of the degree course in Statistics, when read in conjunction with the usual texts. * A useful innovation....is the discussion of what are called the Gamma and Beta distributions (Pearson's types III, I and VI), which have been used rather skilfully and elegantly for deriving the sampling distributions. Two interesting tests discussed....also deserve special mention, one developed by Sawkins to detect any unusually large value in a sample of standard normal variates, which cannot be detected by the chi-square test for the whole sample (section 91), and the other to judge the homogeneity of a number of sample values of correlation co-efficients (sec. 96). * The final chapter describes the case of multivariate distributions, the formulae in which have been derived directly for three variates only, and their generalizations to n variates indicated; it would have been better, however, to include methods for their evaluation in the general case of n variates directly. A number of useful statistical tables have also been given. * Though minor modifications in the arrangement can be suggested,....the arrangement of the subject-matter, it seems, is a sound one. The topics follow one another quite naturally. The numerous examples and exercises have been well-chosen to provide an intimate grasp of the details and develop an insight into the principles. The book is, moreover, easy to read, requiring only "an average mathematical equipment, including an ordinary knowledge of the Integral calculus," to start with. The book presents a fair picture of the major domain of mathematical statistics, and is complete in itself. One misses, however, several more or less important topics,

which, the reviewer feels, might find their in place [*sic*] even in an introductory text on statistical mathematics, as the book is designed to be. The most striking omission is the description of the standard systems of frequency-distributions (*e.g.* the Pearsonian system, and the Gram-Charlier system). The author has, of course, allotted a separate chapter for the "Beta and Gamma distributions," but these have been introduced only for deriving the sampling distributions of the statistics; the systems of frequency-curves, however, are also important for the description of the statistical populations as such, apart from their use in sampling theory. Some other topics also might be included for the sake of completeness, and a few are mentioned here for illustrative purposes. Tsebysheff's Law of Large Numbers, the Central Limit Theorem, the use of the chi-square statistic for combination of different tests of significance, the role of the Linear Hypothesis in problems of analysis of variance and covariance and the elements of the theories of Estimation and Testing of hypothesis. The book is written in a lucid and elegant style and does justice to its title. The reviewer has no doubt that it will be widely appreciated by the students of statistics.

[314]

★WEATHERBURN, C. E. **A First Course in Mathematical Statistics, Second Edition.** London and New York: Cambridge University Press, 1949. Pp. xvi, 272. 15*s.*; $3.50. * ["The call for reprinting has given an opportunity to correct a number of small errors and misprints throughout the book, and to add a new reference here and there. Paragraph 91 on page 195 is new to this edition."—Preface.]

For reviews of the first edition, see 313.

[315]

★WELD, WALTER E. **How to Chart: Facts From Figures With Graphs.** Preface by Allan C. Haskell. Norwood, Mass.: Codex Book Co., Inc., 1947. Pp. xiv, 218. $3.00. *

J Am Stat Assn 43:613–6 D '48. Kenneth W. Haemer. This is a book for the businessman who knows only a little about charts or about how to make them. On the other hand, several of the seventeen chapters discuss chart uses and methods that even the experienced chartist —businessman or not—might employ with profit. * the author's style of writing....is easy to read, free of unnecessary technical terms, and effective in conveying the author's idea. It can be summarized as conversational rather than academic. The illustrations are excellent, plentiful, and well drawn; they accurately illustrate the point under discussion, a feature more often absent than present in books about charts. * Throughout the book, the charts are explained in terms of specific business applications. Although this approach has the mild disadvantage of seeming to restrict the chart to only one type of use or application, it does succeed in bringing the charts to life and in pointing up exactly how each fits a particular type of business activity. It should be an effective means of introducing charts to any businessman who is just beginning to discover the extent of their usefulness. The principles of chart presentation are skillfully explained. It is perhaps regrettable that Mr. Weld does not accept the principle that simple bar comparisons (1-scale measurement) are generally best shown as horizontal bars, and that the vertical arrangement is best reserved for 2-scale bar presentation. Also, in his discussion of multiple-vertical-scale presentation he has mentioned only the advantages and has neglected to point out the considerable disadvantages. In almost all other respects, however, the graphic principles set forth are beyond reproach. Considerable space is given to instruction on how to prepare charts. * these instructions....should be extremely helpful to the beginning chart maker. Some of these practical hints are especially valuable because they so seldom find their way into print. For example, Mr. Weld points out that since the color light blue does not photograph, lines and other markings that are *not* to appear on the reproduced copies should be made on the original with a light blue pencil. * This book focuses attention on three types of charts that in many other books are discussed only briefly or are not mentioned at all. Each of them is a type developed from a special kind of scale: of the three, the semi-logarithmic chart properly receives the most emphasis. However, the other two, probability scale and reciprocal scale charts, are discussed at sufficient length to explain how and when they can be used to advantage. The first of the two chapters on the semi-logarithmic chart provides an excellent introduction to the mechanics of this form of presentation. Of course, it is possible to quibble with some of the things the author has to say about the semi-logarithmic chart: it is a subject that can be quibbled about with very little effort. For example, he says "....it is often desirable and extremely helpful to know the *rate* of change,

or percentage of gain or loss. The kind of chart which gives this information is called a ratio (or semi-logarithmic) chart." This reviewer holds to the belief that a semi-log chart shows only *relative* rate of change. But the preciseness of the term is indeed a minor matter and does not detract from the general soundness of the exposition. In Chapter 7, which discusses the uses of semi-log charts, Mr. Weld not only explains when the type of presentation is appropriate, but repeatedly points out that it should not be used with the mistaken idea that it can simultaneously serve the purpose of an arithmetic chart. This one point alone, if thoroughly absorbed by the reader, would be worth the price of the entire book. The author's discussion of the probability scale and its uses in business charting (Chap. 8) is easy to read and is informative. Here, as elsewhere throughout the book, the statistical propriety of the applications cited, or the conclusions concerning these uses, are not considered to be within the scope of this review: Judged solely as an explanation of its function as a tool of graphic analysis, this chapter is a good introduction to this type of chart. Although the reciprocal chart is primarily a means of computation rather than of presentation, Mr. Weld makes a good case for devoting a chapter to it (Chap. 9). His explanation of its wide usefulness should encourage a more extensive use of this little-known chart. * two other chapters deserve special mention. Chapter 15, "Charts of Various Kinds," is a quick review of assorted chart varieties—from progress charts to trilinear charts—which the author feels warrant inclusion. This chapter provides a useful, if limited, supplementary "idea" file. Chapter 16, "Exhibits Good and Bad," is a chart clinic in which seventeen selected examples are subjected to critical examination. These should be two of the most valuable chapters in the book for the novice in chart presentation. * the emphasis in the book seems faulty. It appears to be designed to focus attention on the major interests of the author rather than on the probable interests of the reader. * For example, stock market analysis charting and business forecasting fill three chapters and parts of others. * On the other hand, the subject of map presentation is covered with one illustration and a few sentences. So fragmentary a treatment of so important a subject seems scarcely worth including. In several spots, the sequence seems unnatural. * There is a considerable amount of overlapping. * much of it has the appearance of being partly incidental and partly accidental * the Codex Company or its products are mentioned one or more times on 18 pages throughout the book. It is only fair to point out that several of these mentions include invitations to call on the Codex Company for further advice or guidance. Nevertheless, this reader found it disturbing to have the publisher's name thrust forward with such artless frequency. * Although it makes for ease of reading and a fast moving exposition, the author's penchant for singling out one device or one method and neglecting to mention the alternatives, does a disservice to the reader who wants to know the best way rather than just a good way. * Weld has....succeeded very well in presenting the principles of simple charting, spiced with enough specific applications to make them appetizing and easy to digest. Although it is directed primarily to businessmen, this book has something to say also to nonbusiness chart makers. In addition to providing a helpful introduction to the beginner, this book fits neatly onto the bookshelf, next to more voluminous works, where it should serve as a compact reference to the author's special field of interest.

[316]

WEST, CARL J. **Introduction to Mathematical Statistics, Revised Edition.** Columbus, Ohio: College Book Co., 1941. Pp. 159. $2 50. *

J Am Stat Assn 36:575–6 D '41. Franklin E. Satterthwaite. This edition is almost identical to the original edition (1918) in subject matter. Many of the illustrations and exercises have been changed and the text partially rewritten. Very short chapters have been added on the significance of differences and on small sample theory. In subject matter this text covers curve plotting with references to interpolation, smoothing, and frequency curves; averages and measures of dispersion leading up to a study of the normal curve; correlation theory including the correlation ratio, coefficient, and index, and rank, multiple, and partial correlation; moments; significance of differences; and small sample theory. The author states in the preface that there is no real reason why the theory of statistical methods should remain in obscurity and that the necessary mathematics is largely elementary arithmetic. The presentation is quite good for one limited to the understanding of a student with a good background of high school algebra. An attempt, only partially successful,

appears to have been made to avoid the half truths so often appearing in texts as elementary as this.

[317]

★WESTMAN, A. E. R. **An Extension Course in Statistical Quality Control.** Reprinted from *Manufacturing and Industrial Engineering.* Toronto, Canada: University of Toronto Press, 1947. Pp. 58. Paper. $1.60. *

J Am Stat Assn 43:350–1 Je '48. A. C. Cohen, Jr. * a welcome addition to the quality control library of anyone concerned with the training of quality control personnel. It is particularly recommended to anyone confronted with the task of setting up and conducting a course of instruction in statistical quality control at the elementary level. Unfortunately its usefulness is marred by a somewhat lengthy list of errata. Most of the errata are typographical, but several involve formulas which if not corrected will certainly prove confusing and annoying to the uninitiated reader. A more clearly stated distinction between sampling for process control and sampling for acceptance (*i.e.* disposition) of product would be desirable. In this connection, although Lesson 12 is concerned with acceptance sampling, that fact is not explicitly stated, and the reader having no previous knowledge of the subject will likely find the omission confusing. *

J Am Stat Assn 43:351–2 Je '48. Paul Peach. During the war, in connection with the 8-day courses in statistical quality control organized by the U.S. Office of Education and the War Production Board, there was prepared a study manual by Professors Holbrook Working and Edwin G. Olds which more or less stabilized the pattern of instruction for those courses. That manual was never published, but several of its legitimate children have attained the dignity of print. Dr. Westman's pamphlet contains an introduction in which this parenthood is specifically acknowledged. * The presentation is....an improvement over previous ones; the style is clear, and each lecture is illustrated by diagrams, tables of data, and similar aids. * for the most part it follows the pattern which was created in the years 1942 to 1944, treating the customary subjects in the established way, with just about enough novelty to justify a separate existence. There may be some difference of opinion about these novelties. Dr. Westman includes less theoretical statistics than did the old WPB course, and I should be inclined to go even farther and eliminate theory altogether. The avowed viewpoint of the pamphlet is that statistical quality control is a branch of industrial engineering, and while I disagree with this idea, yet I agree entirely that a short course for engineers should skip the statistical theory. * Westman's final chapter treats control charts for composites, correlation, and the chi-square test. Presumably this chapter is intended as a sort of bonus, since it seems unlikely that any lecturer would attempt to cover this much ground in a single period. Here again we may ask whether, when we can at best do so little, it would not be better to do nothing. Nevertheless, since the chapter comes at the end, the instructor can if he likes omit it, and no harm is done. * most of the present literature on statistical quality control ends in a blind alley; the student who wishes to learn advanced methods has to retrace his steps and start all over with new definitions, new concepts, and a new notation. In his first twelve chapters Dr. Westman follows the current writings on control charts, and of course is in a difficulty in his thirteenth. He cannot escape introducing the "degrees of freedom" concept, and gives formulas for the number of degrees of freedom appropriate to correlation coefficients and contingency tables; I am afraid that with this much introduction the concept will still seem pretty esoteric to his readers. There is room in our educational system for a manual that will do what Dr. Westman has done, but with a viewpoint and notation that will enable the student to study further if he likes without discarding most of his elementary instruction. A word about typography may be in order. Most printed works, especially first printings, contain typographical errors; with these I am not concerned. Print shops not accustomed to mathematical text usually have trouble with it, especially with equations and other algebraic expressions which must be set by hand. Frequently, if special mathematical types are not available, it is necessary to use makeshifts. A lot can be done in this way if the author and the typesetter work closely together; but in the present work the handset portions are really a mess. Dr. Westman was also done dirt by in other ways; for instance, his publishers have not even bothered to use uniform style for chapter headings. The presswork and paper are good, but some of the editorial work is plain slovenly.

[318]

★WHARTON, A S. **Quality Through Statistics.** London: Philips Lamps Ltd., 1945. Pp. iv, 60. Paper. (Highland Park, N J.: Gryphon Press.) * For latest edition, see 319.

Gen Elec R 49:75 Mr '46. R. O. Swalm. Although *Quality Through Statistics* purports to be written for the practical man, it cannot be recommended to anyone lacking a good knowledge of statistical quality control theory. For even if the uninitiated were able to cope with such terms as "standard deviation" or "Poisson distribution" (which occur without definition), they would not be in a position to know under just what conditions the many rather rough approximations in the book are valid. On the other hand, the book does offer to the serious student of quality control a refreshingly different approach than that of the commonly used texts. Unfortunately, in the author's unrealized aim of appealing to the so-called practical man, he omitted many basic formulae—indeed, even the assumptions on which they were based. Therefore, a little pencil-pushing and much cogitation are necessary before the various methods and relationships in the book can be applied to situations other than those for which they were specifically intended. To one who finds such work an interesting challenge, this British publication will be found possibly useful —but certainly stimulating and thought-provoking.

J Am Stat Assn 40:411–3 S '45. H. F. Dodge. * sets forth in readable fashion statistical methods that have been found most useful in improving manufacturing quality in the factories of Philips Lamps Ltd. * The determination to keep the presentation at an application level will be welcomed by many, though in places this may have been responsible for some inadequacies of technical explanation. * On the subject of batch-by-batch inspection, a special table of sampling plans has been devised to provide what is spoken of as a "control" at any one of several values of per cent defective, ranging from ½% to 10%. A feature is the required selection of five equal random samples from each batch, with provision for taking a second set of five such samples under specified conditions. Just what the "½% control" or "5% control" means for a particular plan is not clear from the context, although the impression is gathered that this represents a permissible upper bound to the per cent defective in an individual batch. However, a few calculations indicate that for the specified procedure and plans given in the table, the chances of accepting an individual batch having a per cent defective equal to that shown in the table heading generally lie between 50 and 100 and 75 in 100—roughly 2 in 3 for many of the plans. Taking a specific case—2% control, an initial set of five samples of size 10, and a critical number (P) of 1—the chances of acceptance are about 5 in 10 for a 2% defective batch; and about 1 in 10 for a 5% defective batch, that is, a batch 2½ times as bad as the 2% table figure. The latter feature, chances of 1 in 10 of accepting lots considerably poorer than the table figure, is inherent, of course, in many sampling plans, though the reader might infer from the author's analysis of other published tables that this was an objectionable feature to be overcome. The inclusion of a few numbers or curves showing probability of acceptance vs. per cent defective in submitted batches, would certainly have clarified the significance of the sampling tables. However, the tables undoubtedly do provide a systematic basis for regulating the quality of incoming material, and as the author brings out, this is greatly to be desired in contrast with prevailing practices of 100% inspection and "spot" inspection. Further, his program for detailed analysis of the percentage of rejects, subdivided into types of faults, can be warmly endorsed, judging from experience gained along like lines in this country. Some question exists in the mind of the reviewer with respect to a formula on page 11 for determining probable quality of a batch, which "only functions in connection with the Philips Table." Expression of this formula in words rather than in symbols would appear to hinder rather than aid understanding. On the subject of controlling quality during production, several simple control chart systems are presented with well-designed forms that should require a minimum of paper work. All follow the usual pattern, covered by publications in this country and abroad, of inspecting hourly or half-hourly samples of 5, 10, or 20 articles. * The manner of setting action and warning lines on the control chart, whereby the engineering tolerance limits are presumed to represent 1 in 1,000 chance limits for individuals, may be questioned technically as a standard practice, in view of the widely varying relationship between precision of process and closeness of tolerance limits encountered in production. This

over-simplification may thus be found too restrictive. In spite of these matters, this section of the book is full of ideas which show how the practical man is thinking on this general subject. The third general subject treated is one that needs to be emphasized time and again, namely, that we should make more use of collective inspection data (*a*) for improving our knowledge of the performance of individual machines, of individual operators, and of whole departments, and (*b*) for establishing over-all standards of performance. * The book as a whole has been successful in explaining the usefulness of statistical methods in improving quality and does this almost entirely without mathematics. While many of the schemes outlined have appeared in one form or another in various publications, the book represents a contribution, for among other things it has sorted out and presented under one cover a set of specific control techniques that have been found highly useful. All in quality control work will be interested in the simplified charts and forms presented. Where greater refinements are wanted, reference may be made to the more technical literature cited.

R Scientific Instruments 17:151–2 Ap '46. Walter A. Shewhart. * Some interesting detailed forms for control charts on attributes and variables are presented and many suggestions are given throughout the discussion that should be very helpful to the beginner in the use of such techniques.

[319]

★WHARTON, A. S. **Quality Through Statistics, Revised Edition.** London: Philips Lamps Ltd., 1946. (Highland Park, N.J.: Gryphon Press, 1946. $1.75. *)

J Am Stat Assn 42:200–2 Mr '47. Benjamin Epstein. * The differences between the first and second editions appear to be very minor. The first review can still be considered a most competent evaluation of the book and, therefore, it seems unnecessary to give a detailed and systematic review. * In my opinion, it is regrettable that many writers on sampling—and Mr. Wharton is no exception—do not discuss the power of a sampling plan, the meaning and significance of operating characteristics, and producers' and consumers' risks. It is most unsatisfying and uninformative to write down a set of sample sizes and acceptance numbers without giving at least some indications of what the sampling plan will actually do toward rejecting or accepting a lot which is $p\%$ defective. In a sense, all one has is a skeleton devoid of flesh and blood. It is true that it may require some ingenuity on the part of writers on sampling to keep the discussion on an elementary level and yet give all the essential details, but the results will be worth the effort. It is also the opinion of this reviewer that if Mr. Wharton is willing to go so far as to consider taking five separate random samples, with the possibility of taking another five such samples under certain conditions, then he might well consider the possibility of making his sampling sequential in character. The advantages of such a procedure are twofold: (*a*) it is rigorous from a statistical standpoint and (*b*) it would force the consideration of criteria of acceptability, non-acceptability, and risks of the first and second kind. Mr. Wharton seems to feel that shop people prefer diets unspiced with "higher mathematics." It appears that the work of the Columbia Statistical Research Group on the simplification of sequential procedures for plant use may meet Mr. Wharton's stringent criteria. It is interesting to note that on pages 35 and 37 the author considers a problem where only a very small per cent defective can be allowed (*e.g.*, 0.1%). Clearly, to handle such a problem requires either the taking of measurements on fairly large samples in connection with some formal control chart procedure or, as a possible alternative, work with go-not-go gauges which are set to limits so tight that a marginal lot will be expected to have as high as 5% (or perhaps 10%) defective with respect to the tighter limits (while it is still only .1% defective with respect to the full limits). The procedure is in the nature of an increased severity test and could undoubtedly be used with profit in situations where the underlying populations can be taken as normal with fairly stable standard deviations. The preliminary investigation needed to establish the validity of a procedure such as Mr. Wharton hints at may well lead to subsequent savings in the amount of sampling required to control the quality of product during production or to control the quality of incoming or outgoing lots. A cumulative defectives chart facing page 39 showing a 5% defective line and a 10% defective line is rather interesting in that it is sequential in spirit. The chart is erroneous, and the author apparently recognizes its inadequacies by saying, among other things: "This scheme, however, is not to be recommended, although it is in use in several large works. The objections to

it are that it is not sensitive enough and if, after taking some 20–30 samples production gets worse, the change in the tendency will not be noticed until several samples have been taken which will mean that quite a lot of scrap may have accumulated. As the scheme does not take into consideration the laws of chance, it is unscientific and can only act as a rough guide. For some types of unskilled work, however, where some easy quality indicator is required, it may well be found useful and will be readily understood by the works people." To put rigor into the procedure one needs to use, of course, the methods and formulae developed by A. Wald and his co-workers. Two important points—one essentially theoretical, the other of a practical nature—seem not to have been mentioned. No discussion is given as to when one can have reasonable assurance of the existence of the state of statistical control which is necessary for some of the recommended procedures. It also seems that some consideration should be given to tool-wear trends and their effect on the determination of control limits. It would be interesting to see how Mr. Wharton's Quality Bonus Plan would thrive in the United States. It is conceivable that it would make the amicable settling of disputes between labor and industry even more difficult and involved. It might be most embarrassing to certain people if questions were raised as to the validity of the control limits used to determine whether the worker is to receive a penalty for poor quality or a bonus for good quality or whether the fault is with the worker, the material given to him, the condition of his machine, or countless other possible sources of trouble. In conclusion, it is the reviewer's opinion that the book represents a contribution to the literature of quality control which is valuable in the sense that it gives a reasonably uniform procedure for checking or controlling quality at various places in the production process. The book contains a wealth of practical hints, and there is little doubt that a conscientious observance of the procedures recommended (with possible modifications) and an acceptance of the author's philosophy of quality control will lead to better quality. However, it is to be regretted that the author makes it a point in more than one place to stress the need to keep the mathematics at a minimum. While it is perfectly true that he does not say that mathematical statisticians are too theoretical or too far removed from practical problems, there may be some industrial people who will read this into his statements. This would be most unfortunate since one of the hopes for progress in a field such as quality control by statistical methods is the encouragement and support on the part of large industries of fundamental work by first rate mathematical statisticians. Some of the practically important results obtained in this country by statistical research groups during the war point to the long-run wisdom and necessity of such support.

For reviews of the first edition, see 318.

[320]

★WHARTON, ALLAN S. **Statistical Quality Control Procedure.** Reprinted from *The Time Study Engineer.* London: Time Study Engineer, 1950. Pp. 29. Paper. 2*s.* *

[321]

★WHELDON, H. J. **Business Statistics and Statistical Method, Third Edition.** London: Macdonald & Evans, 1948. Pp. ix, 233. 7*s.* 6*d.*

For reviews of earlier editions, see 38:B730 and 2:321.

[322]

★WIENER, NORBERT. **Extrapolation, Interpolation, and Smoothing of Stationary Time Series: With Engineering Applications.** New York: John Wiley & Sons, Inc., 1949. Pp. ix, 163. $4.00. (London: Chapman & Hall, Ltd. 32*s.*) *

J Franklin Inst 249:259 Mr '50. A. D. Hestenes. * this book is identical to that issued as a classified report during the war years. The theory set forth is widely used and has guided modern thinking in filter and predictor theory. * Two appendices by Dr. Norman Levensin are welcome additions to this book. The first discusses the Wiener root mean square error criterion in filter design and prediction while the second gives an exposition of Wiener mathematical theory of prediction and filtering.

[323]

★WILCOXON, FRANK. **Some Rapid Approximate Statistical Procedures.** New York: Agricultural Chemicals Division, American Cyanamid Co., 1947. Pp. 12. Paper. For latest edition, see 324.

[324]

★WILCOXON, FRANK. **Some Rapid Approximate Statistical Procedures, Revised Edition.** New York: Agricultural Chemicals Division, American Cyanamid Co., 1949. Pp. 17. Paper. Gratis. *

[325]

★WILKS, S. S. **Elementary Statistical Analysis.** Princeton, N.J.: Princeton University Press, 1948. Pp. xi, 284. Paper. $2.50. * (London: Oxford University Press. 14*s.*)

Am Math Mo 56:429–30 Je–Jl '49. E. L. Lehmann. * The present book—breaking away

from....unfortunate tradition—has as its goal the understanding of statistics rather than manipulative proficiency. * a satisfactory account of the fundamentals of statistical inference * A few minor points may be raised: (i) One wonders why in the theorem asserting linearity of the operation of expectation, independence of the variables is stressed. The theorem is true, useful, and essentially no harder to prove when the variables are dependent. (ii) It seems a pity that the power of a test is never mentioned explicitly and that in connection with estimation no mention is made of the justification of the method of least squares from the point of view of unbiased estimation. (iii) A section on the χ^2-distribution and some of its applications would fit well within the framework of the book, and would be of great value to most of its users. By providing an elementary course that can be taught to students in many fields of application, and in which the objective is the teaching of concepts rather than rules, Professor Wilks has made an important contribution to elementary instruction in statistics. One may also hope that his book will encourage the centralization, within universities, of elementary statistical teaching

J Am Stat Assn 44:458–9 S '49. T. A. Bancroft. * The text....is designed as a basic general service course, presumably to be offered in a mathematics or statistics department at the latter part of the freshman year. It should be noted that the mathematical prerequisite implies an acquaintance with the elements of calculus which would apparently limit the availability of the text for freshman use to those colleges in which the elements of calculus are taught in the first semester or first two quarters of the freshman year. Within such a college the availability of the text would further be limited for the most part to freshmen whose curricula require the prerequisite mathematical analysis course. In some colleges this would eliminate altogether the students for which the text was primarily prepared, *i.e.*, those in the biological and social science. * In allotting ten chapters to the elements of sampling statistics and only three to descriptive statistics, the reviewer believes that Professor Wilks has made a valiant attempt to provide pertinent material for a modern basic course to be centrally taught in elementary statistics. The text is remarkably free of typographical errors. No list of references is included. Although it is stated that the material is primarily for students in biology and the social sciences, many problems and examples are taken from engineering, industry, and the physical sciences. The reviewer believes that more attention should be given to experimental sampling and that a basic course in statistics should be conducted with benefit of a computing laboratory. Professor Wilks' experiment in teaching such materials in a central freshman-level course should be observed closely. It represents an approach by a mathematical statistician to provide teaching material for this type course. Attempts to satisfy this need from another approach are being made at other institutions by applied or experimental statisticians. In the reviewer's opinion, the two approaches should supplement rather than compete with one another. Possibly ideal teaching materials for such a course will be the outcome of cooperative efforts of several statisticians with as many viewpoints.

Math Gazette 33:154 My '49. Frank Sandon. * Wilks tends to attach more importance to the cumulative frequency curves than to the frequency curves themselves * the treatment is original * in Chapter 9 we have the beginnings of a new approach: it deals with Sampling, both from the mathematical and from the experimental directions. Chapter 10 breaks away from the traditional line entirely. It is entitled Confidence Limits of Population Sampling: it deals, *inter alia*, with Student's *t*, and the Clopper-Pearson (1934) *abac.* * The book can be highly recommended. It is sound and scholarly. The questions are good, though there are no answers. * There are few misprints. There is a useful index but no bibliography. The book is based on some of Wilks' original work and is an original treatment of the subject: but though it is described as "elementary" it will put the reader on the right lines.

Psychometrika 15:73–6 Mr '50. Frederick Mosteller. * The figures are well drawn and there are few typographical errors. * There is a brief section on geometrical probability (which could easily be omitted). * We now take up sôme of the unusual features of the book. The summation notation is introduced on pages 34, and $\sum_{i=1}^{n} X_i$ is replaced by $S(X)$. It might be remarked that the denominator of the variance is usually written on the left-hand side as $(n-1)s_x2 = S(X^2) - \frac{1}{n}[S(X)]^2$. It is not

clear....whether this practice is used deliberately by the author to make formulas look less impressive to the student, or whether this is merely a device to save space in the printing. Similarly when the mean is defined, $n\bar{X}$ is found on the left of the equation. On page 38 we find a rather unusual explanation of degrees of freedom for an elementary text, where it is indicated that the sum of the squares of the deviations from the mean can be reduced in the case of a sample on n terms to the sum of $n - 1$ squares. The definitions of probability seem....unusual. Two definitions on page 61 are given below—the first is to handle cases where the theoretical probability can be deduced by argument, as in the case of coins, while the second is for more complex cases where probabilities can be derived only from observation.

Definition I. If an event E can happen in m cases out of a total of n possible cases which are all considered by mutual agreement to be equally likely, then the probability of the event E is defined to be m/n, or more briefly $Pr(E) = m/n$.
Definition II. If (a) whenever a series of many trials is made, the ratio of the number of times event E occurred to the total number of trials is nearly p, and if (b) the ratio is usually nearer to p when longer series of trials are made, then we agree in advance to define the probability of E as p, or more briefly $Pr(E) = p$.

And on page 96 an additional definition is given of geometric probability:

Definition of Geometric Probability. If an event E can happen by the occurrence of a point in a region R_E within a region R, all points in R being considered by mutual agreement to be equally likely, then the probability of the event E is defined as C_E/C, or $Pr(E) = C_E/C$, where C_E is the content of R_E and C is the content of R.

It will be noticed that the first and the third definitions depend on the concept of mutual agreement. This seems a fairly useful way of defining probability, but it certainly leads to operational difficulties. For example, with respect to Definition I, it might be mutually agreed by some people that when two coins are flipped, the three cases are: 2 heads, 1 head, and 0 heads, and that these cases are equally likely (one of the exercises request the student to explain what is wrong with this formulation). Definition II based on observational evidence might therefore be used to verify or refute the agreement reached in Definition I. The wording of (a) in Definition II undoubtedly helps the student with the notion that sample values cluster around population values. But if we assume a thousand coin tosses to be "many trials" as the author does in the illustrative material, then if we ever had the rare fortune tc observe 75% heads in even one such sample out of many thousands of samples, it could be argued that .75 is not "nearly" ½, and therefore that the probability could not be ½ even though part (b) of the definition held. These definitions may go through more revisions by the author, but they do indicate that one of our foremost statisticians is grappling with the problem of making probability an operational concept in the elementary statistics class. * In the chapter on runs (or randomness), the statement is made that "Naturally occurring causes or factors which produce *very many short runs* do not occur very often." However psychologists may feel that in their material this problem does arise frequently, in particular with alternations of rats running mazes or with people giving too many short runs when they call color sequences of cards such as red or black. Nevertheless, a table for use in testing for too many runs as well as too few runs is given. * In the discussion of fitting more complicated curves such as

$$Y = Ae^{bx}$$

the author proposes the usual device of using least squares on the logarithm of the equation, but fails to point out that the fitted curve so obtained is not identical with that gotten by minimizing

$$\Sigma(Y - Ae^{bx})^2.$$

All in all, the book is a fairly stiff one for freshmen. It requires quite a little elementary mathematical skill, but the freshmen will have come prepared with a good mathematics survey course and will perhaps be eager to work on the many examples taken from subject-matter fields. The examples given in the text are pretty heavily devoted to real data drawn from the literature of chemistry, biology, physics, industry, and sociology. This is not quite so true of the exercises. *....[an] analysis of exercises suggests that if the course is designed for biologists and social scientists, it would be worth the author's while to increase the proportion of exercises drawn from these subject-matter fields. * This book could be used....even by students who do not have the requisite mathematics, providing the instructor were careful to indicate the sections and derivations the student would not need to undertake. If, in the next revision, the author reduced the number

of mathematical and ball and chip problems, trading them in for more examples drawn seriously from the social sciences, this book will bid fair to provide an answer to the ever-growing number of introductory courses in statistics in subject-matter fields. * Even as the book stands now, it is easy for a student to see that useful inferences can be drawn by the same technique in a wide variety of subject-matter fields. With the help of a strong instructor, the student will get the notion that he is learning statistics to apply anywhere and not just to his own problems. Such an integrated course has the added advantage that a change of subject-matter fields will not result in the student having to take a new elementary course in statistics. Psychologists who are teaching elementary courses will be pleased with the treatment and the discussion, but will be sorry to see the lack of psychological examples. They would do well to have this book on their shelves because in many cases the elementary treatments are different and suggestive. Persons teaching freshman and sophomore statistics courses as service courses for a university but not as mathematical statistics courses should certainly consider this text.

Q R Biol 24:180 Je '49. A. Chapanis. * characterized by heavy emphasis upon sampling theory and techniques. Long before the student has read a quarter of the way through the book, he is deep in a discussion of probability. This is a stiffer dose of probability and sampling than one finds in most elementary books. Wilks' approach has much to commend it * light on the descriptive statistics. The mean is the only measure of central tendency discussed, the standard deviation the only measure of variability. Kurtosis and skewness are not mentioned. But the chapter on the Poisson distribution is one of the best the reviewer has seen in any textbook, elementary or advanced. The exercises are generally suitable for students in the biological sciences. Although the author claims that the text "presupposes one semester of elementary mathematical analysis," the book requires a better mathematical background than many others at a comparable level.

[326]

★Wilks, S. S. **Mathematical Statistics.** Princeton, N.J.: Princeton University Press, 1943. Pp. xi, 284. Paper. $3.75. (London: Oxford University Press. 25s.) *

Economica 14:239–41 Ag '47. E. Grebenik. * severely theoretical in its nature. It covers most of modern statistical theory, but no examples are given, and the reader is expected to have a good mathematical equipment. The chapters on the theory of estimation and on multivariate analysis are particularly valuable.

J Am Stat Assn 38:491–2 D '43. Abraham Wald. * The author has performed a very valuable service....by writing the present excellent book. * It was impossible to cover in great detail all important developments of the theory or to give very extensive illustrations. However, the book contains the basic material in a concise form and gives an excellent introduction to the more recent developments of the mathematical theory of statistics. * The reader will particularly welcome the chapters on Combinatorial Statistical Theory and on Multivariate Statistical Analysis. These theories are of growing importance and substantial advances in them have been achieved recently. Unfortunately, the literature on these topics is widely scattered and not sufficiently well known. Although the presentation of this material is necessarily brief, the reader will find it exceedingly useful. In the discussion of problems of analysis of variance (Chapter IX) the author brings out clearly the fact that these problems can be considered as problems in regression theory, a fact which is not so generally known. Readers with some mathematical background will find the book an excellent introduction to the modern developments in the theory of mathematical statistics. Also teachers of mathematical statistics will find it very helpful in their classroom work. The book can be highly recommended to everyone interested in this field.

J Pol Econ 52:277–9 S '44. Tjalling Koopmans. * Wilks has done a great service to the cause of statistical theory by making available in book form notes from a two-semester course given at Princeton University. This book is a first step toward a systematic exposition of the mathematical theory of statistics and will provide a most valuable framework for further systematizing efforts. The text is written in the crisp language of mathematical reasoning and will be enjoyed most by those who have trained themselves in reading that form of prose. * The treatment is distinguished by great mathematical elegance and generality, and care is taken to show the common elements in widely diverse applications. For instance, the analysis of variance and its applications in agricultural ex-

periments are developed in a very instructive manner as a special department of normal regression theory. In the chapter dealing with the general theory of statistical estimation the concepts of confidence intervals, point estimation, and tolerance intervals are developed in succession. The subject of tolerance intervals has been developed recently, particularly by the author himself, in connection with problems of quality control and the estimation of probable limits of variation of products manufactured under controlled conditions. The subject is here fitted into its proper place among other estimation procedures. It appears to the reviewer that the author's teaching experience has led him to give greater prominence to educational considerations, in the selection of material and in the method of treatment, than was done in the earlier publication referred to. Some difficulty is experienced, however, in reconciling this consideration with the desire for mathematical generality of treatment. For the latter reason, the method of moment generating functions is used throughout for the derivation of sampling distributions, including cases where more elementary (but more elaborate) methods of proof are available. But the general proposition on which the method of moment generating functions is based is stated without proof in order not to transcend the level of the course. The hope may be expressed that this proof—and that of the efficiency of maximum likelihood estimates—will be inserted when the author comes to fulfil his intention of issuing the book in permanent form. Meanwhile, those who like to go to the bottom of things will find it helpful to use the previous lectures in conjunction with the present work. * this book contains: (*a*) a succinct and clear exposition of the general theory of statistical inference, and (*b*) a wealth of specific theory designed to meet the conditions of a great many fields of application. In the contents of this book economists thus possess both a general theoretical framework and instructive examples, which will be of invaluable assistance when they set out to develop the statistical theory specifically adapted to the estimation problems concerning economic time series and the relations between them.

J Royal Stat Soc 106:279–80 pt 3 '43. M. S. B(artlett). * In the introductory chapters I and II on probability and distribution functions, the author's earlier emphasis on the von Mises approach has changed in favour of the more orthodox model, in which the probability concept, with its own axiomatic rules, has been abstracted from empirical sequences of trial results. The reader must be prepared to grapple by himself with the finer points of the abstracting process, for such ideas as stochastic convergence and the law of large numbers, which determine the logical relevance of the theory, are not very satisfactorily discussed. A more serious criticism which soon forces its attention on the reader is the complete absence of tables of distributions and other ancillaries of the practical statistician. It may be argued that the book is not intended as a practical manual, and that such are better obtained elsewhere; nevertheless, an interesting chapter on combinatorial statistical theory, with some useful recent results in the theory of runs, is incomplete when the reader has to go back to some of the original papers for assistance in the numerical use of these results. Incidentally, the place of this chapter in the book is a mystery, for combinatorial theory is in principle one of the most primitive parts of statistical theory, yet here it is as Chapter X, well after the general theory of estimation (Chapter VI) and tests of statistical hypotheses (Chapter VII). The subjects of the chapters still to be mentioned are III, Special distributions. IV, Sampling theory. V, Sampling from a normal population. VIII, Normal regression theory. IX, Analysis of variance. XI, Multivariate statistical analysis. It will be seen that the last four of these form a natural group, and it is odd that they are separated by chapters with no logical connection with them. The introduction of multiple correlation and the multivariate normal distribution in Chapters II and III seems very premature, and might well have been left until a thorough study of elementary distributions had been made. Among the omissions referred to in the preface are seminvariants and characteristic functions. The use of moment-generating functions in place of the latter is taken a very long way, but is a retrograde step from the author's earlier publication. Their use in the book is moreover so systematic that the student is in danger of forgetting that direct methods may prove more illuminating. In the derivation of second-order moment distributions from univariate and bivariate normal systems (Chapter V), the brief reference in *Statistical Inference* to geometrical methods has disappeared entirely. In the multivariate case

(Chapter XI) there are tardy and still only occasional references to geometrical ideas; thus it is not pointed out, in connection with Hotelling's generalized Student test, that the sampling orientation of a single vector in n-dimensional sample space to the "plane" of k vectors is determined if *either* the variation of the single vector *or* of the "plane" has "spherical" symmetry in the complete space. This duality links multiple normal regression with Hotelling's problem, or equivalently with discriminant functions (which the author does not mention). The rest of this last chapter on multivariate analysis is valuable in its presentation of comparatively recent results in canonical variate theory, but it is feared that many readers will find the abstract discussion, without appeal to examples, too rarefied an atmosphere for long sojourn. In this respect the book as a whole shows considerable unevenness. There is a comparatively utilitarian section on sampling inspection problems in the chapter on combinatorial theory. The analysis of variance chapter inevitably suffers from the absence of numerical examples; the algebraic detail does not emphasize strongly enough the arithmetical virtues of this technique. Turning to the two general chapters on statistical inference, the reviewer found himself comparing them unfavourably with the earlier publication. The present chapter on statistical hypothesis is very sketchy; it omits, for example, any discussion on the relationship of sufficient statistics with most powerful tests. The preceding chapter begins with "interval estimation" and only later proceeds to "point estimation." The latter came first historically, and is still the more relevant problem in many fields, so that this inversion hardly seems justified. The limiting properties of the maximum likelihood estimate are discussed (assuming unnecessarily, however, the existence of the third derivative); the property that this estimate has smaller variance than other estimates with asymptotic normal distributions is stated, but not proved. No mention is made of the relation of the maximum likelihood statistic to the unbiased statistic with minimum variance of Aitken and Silverstone. This book will be useful to the professional mathematical statistician; also to mathematically-minded students provided that they are not solely reliant on it; it is not recommended to the amateur, nor to the student who is more interested in method than in theory.

Math Gazette 28:223 D '44. Frank Sandon. * incorporates much work not otherwise readily accessible: the bibliography has practically nothing but recent works in it, chiefly British and American, the latter being slightly in the majority. Very few French and German workers are quoted, and hardly any others. The book covers a wide field and a high standard of mathematical technique is required. But even apart from this the book is heavy going. The lithography is confusing to the eyes, particularly in some of the more complicated mathematical formulae and symbolisms, for which this typography is not suited. The verbal expression is not always given in simple form. Thus at the very beginning (p. 2, top) the writer speaks of tossing a coin successively where x is the number of heads in a single toss. Punctuation and, at times, very difficult symbolisms, add to the awkwardness. And the practical statistician will find no applications in examples: there is no pandering to arithmetical taste here. * there is a good discussion of confidence and tolerance limits and intervals. Among the minor and less commonly treated topics is an interesting section on the theory of runs.

Math R 5:41–2 F '44. J. Neyman. In a sense the book under review is unique. The great number of books on the market dealing with statistics and probability is notorious. All these fall roughly into two categories. The majority describe "statistical methods," frequently ignoring the basic ideas and the mathematics behind these methods, occasionally misinterpreting them. The books of the other category, some of them excellent [Borel Series, Cramér, Kolmogoroff, Uspensky], deal with mathematical theory of probability with only occasional glimpses on some particular questions pertaining to statistical theory. In contrast, the aim of Wilks is to give the students an organized source of information concerning the theory of statistics as such. The need of such a source is great and the book under review deserves general recognition. * Chapter (II), covering 42 pages, gives a somewhat hasty sketch of the mathematical theory of distribution functions, including the integral of Stieltjes, the moment generating functions and the problem of moments. The reviewer is inclined to think that this chapter is less successful than the others, mostly for reasons beyond the author's control. The students interested in statistics are usually ignorant of various sections of analysis which are

prerequisite to the theory of statistics. Hence the dilemma arises as to whether to begin with an introduction to the theory of functions (with a risk of not being able ever to embark on the theory of statistics itself) or to commence with an enumeration of results in the analysis which are to be used later (with the risk that the students will misunderstand these results and then will fail to follow the main topic). Failing an adjustment in the curriculum in pure mathematics, some sort of compromise between these two extremes appears to be unavoidable and, almost invariably, the corresponding chapter is sketchy and superficial. It seems that Chapter (II) did not entirely escape the dangers of this situation. Chapters (III), (IV) and (V) are given to the study of the most important particular distributions, first of a single variable and then of several variables and of various functions of them. Here a student dissatisfied with the mystery of various tables reproduced and used in the popular books on "statistical methods" will find all the information he needs. Beginning with the binomial, multinomial and the Poisson laws, the author proceeds to deduce and to discuss the Pearson curves, the distribution of means (including the limiting case) of the sample S.D. of χ^2, of Student's t, of Snedecor's F and of the sample correlation coefficient. The next chapters, (VI) and (VII), are given to what may be considered as the theory of statistics proper, namely, to the theories of estimation and of testing statistical hypotheses. The idea of confidence intervals is explained and illustrated in several important examples. The author also discusses single estimates and their classification. However, the important problem of a rational choice between systems of confidence intervals is not treated in detail. In chapter (VII) the author explains the λ criterion for deducing statistical tests and briefly discusses the conception of the power function of a test. One feels inclined to compliment the author on the omission of anything relating to "fiducial distributions," a fertile source of various misunderstandings. Chapters (VIII) and (IX) deal with the λ tests applied to hypotheses specifying numerical values of several linear combinations of population means of n mutually independent normal variables, as first treated by Kolodziejczyk. Introductory simple examples are followed by the general case and this then is applied to deduce Fisher's analysis of variance. The important experimental designs of randomized blocks, Latin squares and Graeco-Latin squares supply useful illustrations. In connection with these chapters one is led to regret the omission of the discussion of the tables of probabilities of errors of the second kind, which are basic for a rational design of experiments. Chapter (X) gives an interesting outline of the recent results concerned with "runs" and "matching," followed by the description of sampling inspection methods by Dodge and Romig. The last chapter (XI) compiles the results of the author himself, of Fisher, Hotelling, Hsu, Wishart and others, all concerned with multivariate normal populations and connected with the λ tests of various statistical hypotheses. The book as a whole is a very useful one. As mentioned, it is as yet the only book where a student can get information on the theories of testing hypotheses and on estimation. Besides, it contains a wealth of information on the distributions of various important statistics. Actually distributions of statistics seems to be the main "center of gravity" of the book with the λ tests of hypotheses being a secondary one. The references in the text seem to be somewhat uneven. Occasionally some secondary result is credited to its author by name [for example, on page 135 the reviewer gets credit for a result of obviously second rate importance]. On the other hand some bigger sections of the theory, representing the results of difficult research, are given without a direct credit to the authors. For example, the exposition of properties of the maximum likelihood estimates does not include any reference either to Doob or to Hotelling who were the first to prove them. However, the list of literature for supplementary reading at the end of the book is quite extensive. The book would probably gain if it were supplemented by a few more examples, particularly with a few numerical examples. However, as it stands, it is an excellent addition to modern statistical literature.

Nature 153:8 Ja 1 '44. R. A. F(isher). In the preface Dr. Wilks makes the remark, "If and when the present notes are revised and issued in a permanent form," which suggests that the author does not need reminding of the disadvantages of giving his work to the world in a paper-covered volume of litho-printed typescript. The reviewer has certainly found this format uncomfortable. As to substance, it is clear that Dr. Wilks has industriously gathered much material from the periodical literature,

rewritten it in a consistent, if austere, mathematical notation, and thrown overboard as superfluous almost all discussion of relevance and applicability. Whatever value the course of lectures on which it is based may have to the mathematical students who take them, it seems to give no insight into *why* any particular problem should be propounded, or as to the function of mathematical reasoning in improving statistical methods. Time after time a perfectly competent, though perhaps arid, section closes with a note of finality, without a hint of the wider horizons which might have been disclosed. The book as it stands may well be useful to some, who occasionally need to refer to a careful and precise statement on some special point. They will not find it elaborated, or exemplified; and may well be disappointed, on the purely mathematical side, by the author's pedestrian style, for the development of mathematical statistics has not really been poor in those flashes of originality and penetration which mathematicians sometimes call "artifices." Dr. Wilks should not disdain to reproduce such work, for, like all good artistry, it gives much pleasure, without detriment to practical aims.

Plant Breeding Abstracts 15:177–8 Ap 1 '45. *S. N. Collings.* The production of a text-book of mathematical statistics is an onerous task, which the author has here attempted with noteworthy success. His book is in fact one of the very few of its kind, and treats its subject in a very thorough and exhaustive manner. Early reference is made to the theory of sets of points and Borel measurable functions under the most general conditions, more perhaps to give an idea of the rigorous background to the subject than for other reasons. At times, however, a precise formulation of unproved theorems in terms of these concepts is used in the logical development, an important example being the theorem giving a sufficient condition for the existence and uniqueness of a distribution given its moments. Much attention is given to distributions possessing a probability density function, the general method of attack making repeated use of moment generating functions. In view of the steady development of the subject, there is necessarily a good deal of back-referencing, also the notation may not be familiar on sight; it is, however, quite possible to understand one particular section of the work following the references given. There are a few misprints of an unimportant nature. The general approach to the subject is abstract; in fact it is almost a theory of functions. No attempt is made to define randomness or probability, and a distribution function is introduced mathematically, its connexion with reality being merely the limiting form to which an empirical function appears to tend. Some theorems on general cumulative distribution functions are deduced, but scarcely used in the ensuing work. * The multivariate normal distribution brings in the first of the many pages devoted to transformation theory in linear algebra, and one wonders if matrix notation could not have been used at this stage with possibly a greater freedom in the assuming of stock results. Pearson curves appear with no explanation or justification, but are at least accepted gracefully and used, which is more than can be said for the Gram-Charlier series. One extremely pleasant piece of work which may not be widely known is on distribution free tolerance limits, in which an estimate is made of the true proportion of an infinite population lying between two values derived from a random sample. * Presumably a test based on a confidence region must have some form of optimum properties, but the subject is not pursued, even in the section on the Neyman-Pearson theory. For point estimation, only the maximum likelihood method is supplied; and then the impression conveyed is that the optimum properties are, from one point of view, rather arbitrary. It is proved, however, that when certain conditions (which in practice are easily verifiable) are satisfied, that the estimates have in the limit a normal distribution about the true value with a certain minimum sampling variance property. What may be considered an omission in this section is the ignoring of what have been called "closest estimates." For the testing of statistical hypotheses, the Neyman-Pearson approach is given, but an early mention of confidence intervals obscures the fact that the Neyman-Pearson theory is completely general, and may be used for providing a test to satisfy any conditions (if such a test exists), and that among such tests will be those involving confidence intervals. It is in fact true to say that the confidence interval tests (if they exist) are best because they satisfy certain quality criteria laid down by Neyman and Pearson. The likelihood ratio test is introduced with no apology for arbitrariness, and is found very useful in later chapters. From chapter eight onwards, proofs are given of certain results fundamental to normal regres-

sion theory, that is of the situation where a statistical variate is distributed normally about a mean value which is a linear function of a set of variables. Precise clear phraseology may be difficult to find to define the situation, but one feels that the form actually adopted would have been less obscure if the word "variate" had been reserved for the statistical entity, and "variable" for an entity regarded mathematically as the independent variable on which the variate depends. Whether or not the above independent variable is in fact a statistical variate is not relevant to how it is regarded in a particular context. The word "fixed" appears to indicate that an independent variable which takes one value in one experiment will take the same value in a replicated one. *

Trans Actuarial Soc Am 45:434–5 O '44. * to some extent an enlargement of the author's "Statistical Inference" * Moment-generating functions are now used in place of characteristic functions, and the whole treatment has been elaborated and extended. The methods, however, are still highly condensed and intensively mathematical; indeed, the author has been so successful in his "attempt....to be as brief and concise as possible and to keep to the mathematics with a minimum of excursions into applied mathematical statistics problems" (to quote the Preface) that the presentation will be useful only to those actuaries who wish to give attention to the mathematical intricacies rather than to the practical applications of modern statistical theory. The mathematical theories of estimation and the testing of hypotheses are again treated comprehensively, as in the author's earlier volume.

[327]

★WILLIAMS, DONALD. **The Ground of Induction.** Cambridge, Mass.: Harvard University Press, 1947. Pp. ix, 213. $3.00. (London: Cambridge University Press. 16*s.*) *

J Am Stat Assn 42:487–8 S '47. C. West Churchman. Williams develops a theory of induction which follows closely and critically the "classical" notion of probability based on the principle of insufficient reason. He argues that his theory of induction is as much "logic" as is the traditional theory of the syllogism, and as much rooted in man's approach to his problems. As a consequence, such a basic problem as that of "randomness," which so insistently besets the practicing statistician, is handled in a thoroughly impractical manner: "a selection is fair unless it is known not to be fair" (p. 72). The quality control engineer is thus asked to determine his state of ignorance in finding out whether his samples are representative of the lot. One wonders what happens to the producer's and consumer's risks in this case. States of ignorance are now known to be experimentally determinable, and the suggestion of a principle of sufficient ignorance makes as thorough demands on the *a priori* knowledge of the practicing statistician as do the distributional presuppositions which Williams discards. Indeed, it may be far less safe to assume a state of ignorance than it is to make other "stochastic" assumptions demanded within the frequency theory of probability. It is to be feared that the treatment of statistical data outlined in Chapter 4, on "The Probability of Induction," leaves something to be desired in the way of rigor, though the author's inaccuracies may be a result of a desire for simplification. In any case, he should have cautioned the reader against the universality of his rules concerning ranges involving the standard deviation. Again, the cumbersome derivation of a confidence interval for a true probability of an event on the basis of a sample (pp. 100–101), and its equally cumbersome explanation, could have been made more accurate and at the same time more understandable by following the usual techniques. Finally, in addition to expounding an eighteenth century probability theory, the author now expounds an eighteenth century (Kantian) philosophy of science; he asserts that the "principles of 'inductive methodology' are as....necessary as any of the theorems of mathematical logic" (p. 124). The tone of this assertion leads the reader to suppose that methodological principles are not checked by empirical science; this is consequently a return to an age of psychological innocence in which man was supposed to view nature in his own way, but his own way of viewing nature was not investigatable by the empirical sciences. The academician can still be seen to preach the isolation of man's reason from the consequences of his actions.

[328]

WINTNER, AUREL. **The Fourier Transforms of Probability Distributions.** Baltimore, Md.: the Author (Rowland Hall, Charles and 34th Sts.), 1947. Pp. v, 185. Paper. $3.00. *

J Am Stat Assn 44:330–1 Je '49. J. Wolfowitz. * The reviewer immensely enjoyed reading the book. Since it is a set of notes it does

not treat the subject exhaustively and gives us only glimpses of the author's attractive mathematical style. Yet it proceeds pleasantly and easily, and readily absorbs the reader's attention. The reviewer would, however, like to take exception to the choice of subjects and certain aspects of their presentation. In spite of its name, this is not a book on Fourier transforms; it is a book on distribution functions studied with the aid of Fourier transforms. For example, the question of when a function is a characteristic function is barely discussed. To the best of the reviewer's knowledge the phrase "chance variable" or its equivalent is never mentioned. Yet the author is in effect compelled to introduce chance variables to clarify certain concepts. His section on "Examples" discusses mappings which are in effect chance variables of only moderate interest for the student of probability theory. There seems little point to so scrupulous an avoidance of the customary terminology of probability theory, with its attendant values of brevity and suggestiveness. All the "chance variables" which occur in this book are independent; this is often an unnecessary limitation. The question of the convergence of a series of independent chance variables is given considerable attention, yet neither the law of large numbers nor the central limit theorem are even mentioned. The reviewer was disappointed by the extreme paucity of appropriate references. The zero or one law, which is due to Kolmogoroff (generalization by Paul Lévy) is wrongly ascribed by the author to Borel; the reference is *Rendiconti Palermo,* Vol. 29, 1909, where a special case of the strong law of large numbers is proved. The following minor remarks occur to the reviewer: (1) The proof (p. 168), that the distribution of Student's ratio is the same for all underlying joint distributions which are radially symmetric, can be considerably shortened. It suffices to note that Student's ratio is homogeneous of degree zero; the statement is really valid for all such functions, provided only that the functions are undefined on at most a set of probability zero. (2) A simple proof by means of Fourier transforms of the fact that the totality of marginal distributions of every linear combination of k chance variables uniquely determines the joint distribution of the k variables (p. 160) is due to Cramér and Wold and to be found in the former's book, *Random Variables and Probability Distributions.* The reviewer is of the opinion that, while no advanced worker in mathematics will want to be without a copy of this book, it is not particularly suited for statisticians or elementary students of probability theory. This is a great pity, and it is to be hoped that the distinguished author can be persuaded to treat the subject more comprehensively and systematically in a future book.

J Royal Stat Soc 111:80 pt 1 '48. M. H. Q(uenouille). * The author....has approached statistics with the purpose of introducing rigour into the mathematics, and has consequently written a book on statistical mathematics as opposed to mathematical statistics. There is no pretence by the author to the contrary and, although in parts of his text he "translates his results into the language of statistics," it must be emphasized that this text is primarily for those undeterred by Borel sets and Baire functions wishing to adopt a rigorous approach to the theory of limiting distributions and characteristic functions. The book covers in greater detail than can be found in any other text the basic theory of characteristic functions or Fourier transforms as outlined in chapter four of Kendall's *Advanced Theory of Statistics.* After a brief introduction to distributions functions, Fourier transforms and the relations between moments and Fourier transforms are dealt with. Further chapters are added on convolutions or the distributions of sums of variables, infinite convolutions and convergence in measure, leading up to the "three-series criterion," originally given by Khintchine and Kolmogoroff, for the convergence of an infinite convolution. However, the latter part of the book dealing with inversions and projections appealed more to your reviewer, partly because it seemed to be of more immediate application, and partly because the unusual notation used by Professor Wintner was becoming more familiar. The proof of Student's distribution for any set of radially symmetric variables and the general theory of Fourier transforms of radially symmetric distributions were in particular very interesting. As a whole this book represents a very reasonable review of this fundamental theory, but it is not without its faults. The numerous cross-references given in the text make its reading complicated and the lack of an index will prove a further drawback, although several pages are devoted to the history of the development of this theory. It is obviously impossible to keep any highly mathematical

work free from errors and misprints, but unfortunately this text, which is mimeographed, seems to have significantly more than its fair share of misprints, and in particular omissions.

[329]

★WOLD, HERMAN. **Random Normal Deviates: 25,000 Items Compiled From Tract No. xxiv (M. G. Kendall and B. Babington Smith's Tables of Random Sampling Numbers).** University of London, University College, Department of Statistics, Tracts for Computers. London and New York: Cambridge University Press, 1948. Pp. xiii, 51. Paper. 5*s*.; $1.25. *

J Am Stat Assn 44:331–2 Je '49. H. Burke Horton. Statisticians are indebted to Professor Wold for substantially increasing the number of random normal deviates available for general use. * The items were derived from the Kendall-Smith tables of random numbers, column by column. It is unfortunate that Professor Wold's labor was doubled, due to the fact that use of the Kendall-Smith tables by rows yielded a set for which the variance was too large by a significant amount ($P = 0.7\%$). In the words of the author, "It is difficult to decide whether the failure with the first set [*by rows*] is accidental or due to some slight defect in the construction of Kendall-Smith's tables." If the latter possibility is the source of trouble, such difficulties may in the future be avoided, or at least minimized, by the use of recently developed convergent processes to generate the underlying set of random digits. *

[330]

★WOLFENDEN, HUGH H. **The Fundamental Principles of Mathematical Statistics: With Special Reference to the Requirements of Actuaries and Vital Statisticians and an Outline of a Course in Graduation.** Published for the Actuarial Society of America, New York. Toronto, Canada: Macmillan Company of Canada Ltd., 1942. Pp. xvii, 379. $5.00. (Chicago, Ill.: Society of Actuaries. $5.00.) (London: Macmillan & Co. Ltd., 1943. 25*s*.) *

Am Econ R 33:397–9 Je '43. L. A. H. Warren. This book constitutes one of the greatest single contributions yet made in the field of statistics. The contribution lies not so much in the way of new theorems developed or new proofs of old theorems, though there are many such, but in the fact that the author has brought together into one ordered whole the known results in practically every field of statistics. Heretofore when one wished to find out what had been written on any special topic he had to search the length and breadth of countless books and special articles in the various journals. Mr. Wolfenden has performed an inestimable service for students of statistics in compiling a most complete reference list on each topic. The complete title of the book....suggests something of its scope. It indicates, moreover, that this is not "just another book on statistics," like many which have appeared in the past fifteen years, where the author had little new to contribute either in subject matter or method of presentation. Many authors have attempted to present what is essentially a mathematical subject in non-mathematical language and, when stuck, simply gave the mathematical formula required, without attempting to give its derivation. Mr. Wolfenden has given us a logical development of the fundamental formulae, and frequently an alternative development, or has given a reference to where a proof of the formula may be found, or both. While all students of statistics will find much in this book to interest them, if they have the necessary background to build on, it is of special interest to actuaries and those engaged in statistical investigations. It is not simply a textbook which the statistician will want to read through once....but it is a book that he will want to keep at hand as a ready reference, for if he cannot find here just what he wants he knows that it will tell him where to find exactly what he wants. This is strictly true in the case of the special fields to which I have referred. The author has not included a few topics generally treated in books on statistics, such as index numbers, time series and correlation, and he barely mentions the finding of regression lines and the analysis of variance. The outline of the book is rather unusual * In....[the first] 148 pages consideration is given to almost every worthwhile topic discussed in modern statistical journals, accompanied by references to the various papers where full discussions of the topics may be found. * The outline of the course on graduation is certainly a boon to the actuarial student. * [Sections A, B, and C] show a most exhaustive knowledge of the literature on the subject. * [The examples] illustrating the Lexis theory are simple and interesting, as is also the application of the Poisson exponential. *

Am J Pub Health 32:1175–6 O '42. John W. Fertig. * Essentially....an exposition of the subject of probability in the classical manner, with emphasis on the theory of errors and least squares. * The exclusion from the main text of the treatment of history, mathematical proofs,

and applications inevitably leads to a degree of discontinuity. The reader interested in all aspects of a given topic must refer continually from section to section. This reviewer feels that the bird's-eye view of statistics given in the main text is inadequate for an elementary student without considerable mathematical attainment and that a mathematically versed student would prefer to have the later sections appropriately inserted. * The use of the modulus of the normal curve instead of the standard deviation will seem awkward to many readers. * The sampling theory of means and standard deviations for large and small samples are adequately treated, but it is unfortunate that the distinction between the theory appropriate for the sampling of attributes and that of measurements is not more sharply drawn. * The author takes up in some detail topics considered only briefly or not at all in many treatises on mathematical statistics. These include a demonstration of the standard errors of functions of a variable, in some cases by the use of a Taylor's Series. Thus he evolves the standard errors of the life table functions. Consideration is also given to the multinomial law and its relation to the normal surface and to chi-square. There is an excellent discussion and comparison of various methods of curve fitting and graduation, as maximum likelihood, least squares, moments, minimum chi-square, together with criteria for testing goodness of fit. Another unusual feature is the presentation of the method of fitting transcendental trends by the use of Taylor Series. Some of the more recent advances in mathematical statistics, as confidence limits, testing of hypotheses, analysis of variance, are mentioned only briefly. This book should be an exceedingly useful reference manual to the vital statistician, since many of his special tools are given more adequate treatment here than in most works on mathematical statistics.

Am Math Mo 50:444–5 Ag–S '43. B. A. Lengyel. * The....five pages on *recent* (italics ours) researches are hardly more than a syllabus of the literature. The main body of the book is concluded by an outline of a course in graduation. This section is a valuable review of the literature for an actuary who is already familiar with his subject. Summation and interpolation formulas are suppressed in the text and the subject can be comprehended only by consulting the references. Appendix A....section might be valuable to those interested in the development of the subject from the beginning, as careful references are given to the early literature. * It seems unfortunate that a book written by an author thoroughly familiar with his subject should contain a number of lax and misleading statements. On page 8, for instance, we read that Bernoulli's theorem may "evidently" be interpreted as meaning $\lim_{n\to\infty} s/n = p$, where p is the *a priori* probability of success and s is the number of successes in n trials. The text contains terms which are only carelessly defined or not defined at all. While great emphasis is placed on the controversies and discussions of the past, modern statistics is virtually excluded from the text. The analysis of variance is given 18 lines and fiducial limits are disposed of in slightly more than a page. The book is valuable as a historical summary and as a source of references, but it is not suitable for study. A beginner would soon be confused by the maze of cross-references and the lack of logical order in presentation. He would find no exercises on which to test his knowledge. An advanced student would be discouraged by the lax use of mathematics and by the lack of consistent, straightforward development of theory. We can conclude with the hope that, perhaps with the aid of the bibliographic work done in this book, a well integrated textbook on statistics will be written which will satisfy the mathematician as well as the educator, and will convey to the student the results of modern research in a clear, concise form.

Economica 9:396–8 N '42. E. Grebenik. * an attempt to bridge the gap between mathematical theory and its statistical applications. Nevertheless, it is doubtful whether the author has succeeded in producing a book which will be of use to the ordinary student who is reading it without any previous knowledge of the subject, and without guidance. This is largely due to the rather curious arrangement of the book. * some of the mathematical proof are in the text, some are in the appendix, and the reader is constantly required to refer from one to the other if he is to follow the reasoning. If he wants to see the methods applied to actual data he has to refer to yet another place. The text itself is very concise, in places it is indeed almost in note form. All this makes the book difficult to read for the private student, though it would probably be valuable as a supplementary text to a lecture course. As regards the contents, a larger amount of space than is usual in such

works is devoted to the theory of curve fitting and graduation. This is no doubt due to the fact that the book is mainly addressed to actuaries. Hardly any mention is made of correlation theory and the reader is referred to the standard works on the subject. Another strange omission in a work which is addressed to vital statisticians, amongst others, is the complete absence of any mention of the work done on Population Dynamics by Lotka and others. On the other hand most of the modern tests of significance are explained and it is pleasant to see that the author, unlike some others, continually reminds the reader of the limitations of these tests due to the assumption of normality in the parent population. Our criticisms have been criticisms of form and arrangement rather than of substance, but in a text-book of this kind form of presentation is after all one of the most important factors. If Mr. Wolfenden were to rearrange his material and expand his text a little, the usefulness of his book would be greatly increased.

J Royal Stat Soc 105:350–1 '42. W(illiam) P(alin) E(lderton). * includes....a satisfactory outline of a course in the graduation of mortality and sickness tables in addition to those subjects which are more usually associated with mathematical statistics. The author takes the view that to understand the subject properly the student should "absorb the history of the mental processes which have guided its development," and, appreciating "the distractions which inevitably arise when the many essential discussions and extended mathematical analyses are inserted in the main text," he has given in the first 148 pages a condensed presentation only, so that the principal ideas can be acquired in the first instance, leaving subsidiary questions, mathematical proofs, applications and, to a large extent, the history to be dealt with in subsequent sections which cover about 200 pages. * The idea is attractive * The most obvious difficulty is that when the reader is going through the condensed presentation he is interrupted by references to the later sections, and so is distracted from the story almost as much as if the later matter had been inserted. In any such work, however historically minded an author may be, he is bound to select or his book will become unwieldy and, as soon as any one of us selects, he finds that someone else would have included what he has decided to exclude. Moreover, having decided on his selection, he must bring his historical treatment into alignment. In this connection it may be suggested to anyone reading the book who dissents from the particular selection and bibliography that he should, himself, set down his own selection and his own subdivided bibliography, and he would find that any statistical friend to whom he showed it would be able to pick plenty of holes. Though, therefore, my own choice would have differed from Mr. Wolfenden's, I feel that mine might be just as much open to criticism, and I shall therefore refrain from adverse comment on his selection of subjects and his bibliography, merely pointing out the sort of things that have been excluded. There is no mention of periodicity, and while correlation, frequency surfaces, confidence and fiducial limits, orthogonal polynomials and analysis of variance are mentioned, they are not discussed in detail, though references are given to other works where the student can obtain information. Largely, I think, because his approach to the subject is algebraical, Mr. Wolfenden, in his section on applications, gives little guide as to how arithmetical work should be done, and his numerical examples are scanty, though here also he gives references to books and papers where examples and help can be found. Mr. Wolfenden has had much experience of teaching the subject to actuarial students and, no doubt, he expects anyone using the book to have a tutor who will set arithmetical examples. As the result of experience in using the book and of further research, there will be alterations in any future edition, and the opportunity would be taken to correct one or two slips, the most important of which is that the author appears to have overlooked, in connection with "Student's" t-test, that "Student" assumes that the observed sample is all that is known except that the parent population is normal, and consequently it is unnecessary to insist on an unexceptional value of s. The book is excellently printed and well got-up. We look forward to its being of great help to those for whom it is intended.

Math Gazette 26:234–5 D '42. Frank Sandon. * the author....has attempted to assemble and coordinate those portions of the theory and application of mathematical statistics that are needed in the highly specialised studies and practical work of the actuary. The book accordingly gives more prominence than is usual in English statistical textbooks to the work of

other actuarial statisticians and to the Scandinavian school, though the English workers, *e.g.* Edgeworth, Karl and Egon Pearson, Student, and R. A. Fisher, are on the whole fairly dealt with as far as their work is relevant. The author, with the actuary's distrust of assumptions of homogeneity, makes a special point of tests of homogeneity, and so Lexis is more fully considered than is common. The writer says that he assumes only the elements of probability and of the calculus, but actually there are large parts that would require a good working knowledge of finite differences. In this connection we may note that the sections on graduation are exceptionally fully done. The conflicting demands of the tests of "fit" and of "smoothness" are specially emphasised. The frequency of change of sign rule does not commonly appear in statistical books, and the warning that the good fitting curve will not necessarily give a better prediction is well put. The book is really an outline of a course, but it would present, I think, great difficulties to any unaided student. It is in four parts. The body of the treatment gives a condensed presentation of the elements of the subject. This takes 148 pages: it is not stated how many hours (or terms or years) the student would have available to master it all in the author's course of lectures. This part is followed by three others dealing respectively with historical notes—to give background—technical analysis—mathematical glosses and interpretation—and a section on applications and examples. This treatment results in many awkward cross-references: the order in which the parts should be read is not clear, as the curious tense usages (*e.g.* on pages 29 and 132) indicate. There are two bibliographies—works of historical interest and those of present value. The apparent distinction intended by the writer breaks down, in the opinion of the reviewer, in practice. Books appear in the P section and their reviews in the H section; a number of modern papers are in the H section that might, it seems, as well have appeared in the other. Together the bibliographies are very useful, though their value would have been increased had references been given more fully. Often it is difficult to know if a title is that of a book or paper, especially as publisher and journal are sometimes omitted. One edition, not always the latest, is listed in cases where volumes have run into more than one edition. The lists would have probably been of greater value if there were collected together references to those publications which contain tables, nomograms, *etc.*, likely to be needed by the actuary. In the courses dealing with curve-fitting we are given useful references to data that have been fitted with curves of various types. Although the idea of the book appears to be quite definitely to send one to the sources and to standard works, yet we find reproduced here a number of old friends—Arne Fisher's urn drawing illustration for the Bernoulli, Poisson, and Lexis sampling (this is in the mathematics section), the Prussians whom Bortkiewicz found kicked to death by horses (this is in the history and the applications parts), the soporific efficiency of dextro- and laevo-hyoscyamine hydrobromide ("applications" section), and Weldon's 26306 throws of 12 dice ("applications": even if the test gives .3376986 as a more likely value of p than .333...., it surely is not correct to say "that there is no reason to doubt the hypothesis that the probability for each die of throwing 5 or 6 was actually the figure .3376986"). The author seems to have information not available to the distinguished actuary who reviewed *Facsimiles of Two Papers by Bayes* in the *Math. Gazette,* 1941, July, XXV, 265 (p. 177), for (p. 165) he describes Bayes as "a dissenting minister, Thomas Bayes, F.R.S." There are a few diagrams, chiefly of the Pearson curves; it is a pity that none of the U curves are depicted. The perspective views of smooth curves in space should not give the sharp points of C1 (p. 201) while there seems no justification for interchanging the axes of the ogive (p. 193) to get vertical asymptotes (see figure, p. 199) instead of the usual horizontal ones. The book is well printed, both in the straight text and in the mathematical parts, and we have found very few misprints. * In all, we have here a sound and useful volume, and the student who is fortunate enough to "plan his reading systematically" with the help of this book, to have the guidance of a good teacher, and to have access to a library containing the works in the bibliography, will have a real appreciation of statistical method as applicable to actuarial and allied problems.

Math R 4:18 Ja '43. A. Wald. * contains very little on the modern developments in the theory of estimation and testing hypotheses. On the credit side one may mention, in particular, the chapters on frequency distributions, fitting of curves and graduation which meet especially

the requirements of the actuary. The reader will also welcome the numerous references given in the text and the bibliography included at the end of the book.

Nature 150:196 Ag 15 '42. R. A. Fisher. * an original book. It is scarcely what its title (on the cover) claims, a presentation of "The Fundamental Principles of Mathematical Statistics," but rather an introductory course of reading for actuarial students, and "an Outline of a Course in Graduation." * The stress laid by the author on the importance of history is most refreshing * One valuable use of a historical as contrasted with a mathematical section might be to separate the living from the dead. The contributions of the twentieth century have, however, suffered in Mr. Wolfenden's hands. "Student's" method is much ill treated, and I read with pain of the analysis of variance "arising from Lexis's theory, based in fact upon the 'correlation ratio.'" Such comments are not historical. I venture to suggest that the first two hundred papers, at least, employing the analysis of variance do not make any use of Lexis's theory, or of the correlation ratio; and, for such part as I had in developing the method, I was at that time strongly conscious of the failure of the methods developed by Lexis and Pearson to solve even the simpler problems of this type which they discussed. *

Social Forces 21:118 O '42. Margaret Jarman Hagood. * especially appropriate for the increasing number of sociologists who are engaging in research in the field of population * this book may be sampled at will by the reader if he has the level of facility with mathematical symbols usually attained in a first course in calculus * Advantages for population students of this over other texts in mathematical statistics are that the basis of selection of theory seems to be relevance to vital statistics and that the illustrations and applications are drawn largely from that field. Although the treatment is sometimes sketchy, especially in the chapter on Graduation, which is claimed to be only an outline, nevertheless ample references to more detailed and advanced treatments are provided. The excellent bibliography is functionally divided into a list of publications of historical significance and one of present value *

[331]

★Working, Holbrook. **A Guide to Utilization of the Binomial and Poisson Distributions in Industrial Quality Control.** Stanford, Calif.: Stanford University Press, 1943. Pp. 15. Paper. $0.25. (London: Oxford University Press. 2s.) *

J Am Stat Assn 40:413–5 S '45. H. G. Romig. This pamphlet, although small, contains a wealth of valuable information. It consists of four parts covering: (*a*) binomial distribution, (*b*) devices for facilitating use of the binomial distribution, (*c*) the Poisson distribution, an aid to its utilization, and (*d*) approximations in the application of statistical theory. The first part indicates how individual and cumulative terms of the binomial distribution may be computed and the field of application of this distribution. Since these probability values are basic to much of sampling theory covering attributes, the material in this article, presenting for the most part material scattered in different sources, should be mastered by those entering this field. * no mention is made in the text or bibliography that cumulative probability values for the binomial distribution may be obtained from Karl Pearson's "Tables of the Incomplete Beta Function," for $n = 1$ to 50 and $p = .01$ to .99. The actual probability values for control limits based on $\bar{p}n + 3\sigma_{pn}$ and $\bar{p}n - 3\sigma_{pn}$ are discussed for various values of $\bar{p}n$, n and $\bar{p}$ values to indicate the difference between the point binomial probability values and the corresponding normal law probability value of .00135. This detailed analysis of probability values is invaluable to those using control limits and shows the impossibility of setting exact control limits based on a fixed probability value. The areas in which the Poisson distribution may be used to determine approximate probability values for the binomial values are discussed in detail. The errors arising from its use for $\bar{p}n = 1$ and $pn = 2$ appeared in Table 2 for $\bar{p} \leqq .2$ and are depicted on an excellent diagram portraying clearly the three elements: (*a*) relative frequency, (*b*) sets of $\bar{p}$ and n values for $\bar{p}n = 1$ and $\bar{p}n = 2$, and (*c*) number of occurrences per sample. The Poisson distribution appears as the limiting distribution. This same excellent diagram form is used to show the changes in the shape of the distribution for $\bar{p}n = 0$ to $\bar{p}n = 8$. Poisson probability limits with $P = .00135$, .005, .1, .9, .995, and .99865 are given on this second diagram. These two diagrams, to the best of my knowledge, have not appeared elsewhere and should be found to be one of the most valuable parts of this paper, giving a clear-cut picture of the nature of the binomial and Poisson distributions. The choice of P values

only for discussing control limits is unfortunate. Using $P = .001$ and $P = .999$, in line with other presentations, would appear to be more useful in practice than $P = .00135$ and $P = .99865$. It would be helpful to have presented the 2-sigma and 3-sigma control limit values since these have been found most useful in practice, requiring little time for computation. If they were used, their associated probability values would be in the range ordinarily assumed satisfactory for practical purposes. For example, the upper 3-sigma control limit curve for values of $\bar{p}n$ of 5 or less would be slightly less than .995 but for larger values of $\bar{p}n$ would have values about halfway between .995 and .99865. As is pointed out in the text, it is impossible to achieve the probability values stipulated, and they are used essentially as guides in selecting proper values of c for control purposes. The author should have emphasized the fact that these probability values are true for the Poisson distribution and are therefore only approximations to the binomial probability values. He does point out that in determining these probability values, they cannot be considered as being exact probabilities when the sample represents a considerable fraction of the lot. This concept may be misleading, depending upon the nature of the probability under discussion. It would have been wise for the author to have extended his remarks as many are confused by the fact that the probability of acceptance for product of $\bar{p}$ quality under a given sampling criterion differs from the probability of acceptance for a single lot of $\bar{p}$ quality. In fact, many have considered them identical. Two charts for the Poisson distribution are presented covering: (a) probability limits, and (b) cumulative probability values. This second chart is a reproduction of the same chart appearing in the *Bell System Technical Journal*, January 1941, as noted. The first chart is derived from it for ease of application, but is restricted in the sense that it gives only a series of values covering six probability values, whereas the original chart covers a range of probability values from $P = .00001$ to .99999. The directions for use of this modified chart are clear. Similar directions might have been included covering the second chart indicating its field of application since it may be considered the basis for deriving the other. The paper is very readable and the points brought out are of sufficient importance to justify its amplification in certain instances. The charts are on a sufficiently large scale so that it is possible to easily obtain readings from them. Considering the paper as a whole, it may be considered an excellent presentation.

[332]

★Work Projects Administration, Federal Works Agency. **Tables of Probability Functions, Vol. I.** Prepared for the City of New York as a Report of Official Project No. 65-2-97-33. Arnold N. Lowan, Technical Director. Conducted under the sponsorship of the National Bureau of Standards. Washington, D.C: Government Printing Office, 1941. Pp. xxviii, 302. $2.00. *

B Am Math Soc 48:201 Mr '42. Virgil Snyder. * The present Tables extend the range of all existing ones and provide a smaller tabular interval. * Both functions have been calculated to fifteen decimal places at intervals of 0.0001 in the range between 0 and 1 and at intervals of 0.001 in the range from 1 to 5.6. A short supplementary table (Table II) is included giving the values of $H(x)$ and its derivative to eight significant figures for x ranging from 4 to 10 at intervals of 0.01. *

[333]

★Work Projects Administration, Federal Works Agency. **Tables of Probability Functions, Vol. II.** Prepared for the City of New York as a Report of Official Project No. 165-2-97-22. Arnold N. Lowan, Technical Director. Conducted under the sponsorship of the National Bureau of Standards. Washington, D.C.: Government Printing Office, 1942 Pp xxi, 344 $2.25. *

B Am Math Soc 49:31–2 Ja '43. Virgil Snyder. * The bibliographical data provided give valuable information concerning uses of the tables. The extensive and systematic tests for accuracy are as in the earlier volumes of the series.

Q R Biol 18:301 S '43. * These tables are a valuable extension of previous tables not only because they save the trouble of interpolation and extrapolation frequently required in using more condensed tables, but because they furnish a source from which various types of condensed tables may be taken. The work has been done with the careful supervision for avoidance of error that has distinguished the other tables prepared by this group.

[334]

★Worthing, Archie G., and Geffner, Joseph. **Treatment of Experimental Data.** New York: John Wiley & Sons, Inc., 1943. Pp. ix, 342. $5.00. (London: Chapman & Hall, Ltd., 1944. 40s.) *

Am J Physics 11:354 D '43. Probably every physical scientist has in the course of his work experienced irritations similar to those described by Professor Worthing in the Preface

to this book; namely, of too often encountering tables of unsmoothed values, tables and graphs that lack suitable legends, graphs with poorly chosen coordinate scales, reference to the significance of a so-called knee of a curve when the location of the knee was a function of the chosen coordinate scales, lack of understanding of how to determine, express and apply precision indexes, blind faith in a least squares computation regardless of the assumptions and limitations, and many other faults which the present authors demonstrate can be remedied with reasonable effort. * Carefully planned and written, it is suitable for use either as a textbook or as a reference work for physicists, chemists and engineers.

Am J Sci 242:53–4 Ja '44. Henry Margenau. The book departs from the usual treatments of adjustment of data and theory of errors in several important and noteworthy respects. First, it is not so much an orthodox systematic development of the work in these fields, but a lucid and most readable presentation of useful procedures flavored and annotated by the authors, handled with a degree of skill that can come only from wide experience in actively applying and teaching the subject. Second, the treatment abounds with well chosen modern examples which alleviate the learning of rules. Last, but not least, the book impresses by the frankness and adroitness with which the authors call attention to common mistakes and fallacies to which experimenters are prone. Their willingness to devote considerable attention to such shortcomings and to guide the experimenter by giving practical hints and detailed advice are among the features which make the book wholesome and commendable. * Of interest to physicists and chemists should be the chapter on correlations which, though useful, is not often stressed in books of this sort. An appendix contains a simple treatment of determinants, easily readable and helpful to the uninitiated. The authors' feeling, expressed in the preface, that the book has a worthwhile message for physicists, chemists and engineers seems well substantiated to this reviewer.

Chem & Eng News 22:1508–9 S 10 '44. Francis W. Power. * of particular interest to engineers and physicists, although....it is a book which chemists also should know about. The latter should welcome, for example, the chapters on the construction and uses of tables and graphs where they will find much information and many practical suggestions which most of them have had to learn the hard way. Instances of these would be the location of "kinks" in plotted data and their possible significance; the excellent collection (on page 57) of graphs of frequently used equations; the clear and simple explanation of the uses and properties of determinants; and the treatment of the mathematical and mechanical methods available for evaluating slopes and definite integrals from both graphed and tabulated data. The authors are a little hard on the old "cut and weigh" method of integration when they call it "relatively inaccurate," fit only for "rough work," but this is doubtless a matter of opinion, and much depends on how good the data and the graphs are to begin with. With regard to many other important points, however, the book is not a very trustworthy guide to a reader unfamiliar with certain modern branches of applied mathematics. The authors do their best to base their whole treatise on frequency distributions on the old-fashioned form of the normal law,

$$y = \frac{h}{\sqrt{\pi}} e^{-h^2 x^2}$$

where the dispersion measure h is the so-called modulus of precision, and in Appendix 2 they actually give a probability table based on this nomenclature. They admit that the standard deviation σ is used much more often, but do not seem to realize that their emphasis on h rather than on σ "dates" the entire treatise. This same stricture applies with equal force to their use of Chauvenet's criterion for the rejection of outlying observations. The reviewer can recall only two other books in this general field, modern in the sense that they have appeared in the past 10 years, that pay any more attention to the "precision modulus" and the criterion of Chauvenet than they would to any other outmoded mathematical material. The authors, on the other hand, do a good job in their general evaluation of the place of normal distribution theory in the handling of concrete data. The chemist who follows the standard procedure for calculating dispersion measurements as found commonly in modern statistical treatises will not have to bother, however, with the probability table given in this book, since the two handbooks most commonly found in chemical laboratories give the table in its usual form, with areas and ordinates as functions of $t = x/\sigma$. The odd part of it is that the authors have

included in their bibliography at least two references which would put the reader in touch immediately and explicitly with an enormous amount of modern statistical literature from which he could easily deduce for himself the adverse criticisms given in this review. * As to errors of omission: Deming's treatise on Least Squares, which in its original form was available to the authors, is not even mentioned in their bibliography; they know of the theory and use of orthogonal functions in fitting polynomials to a set of data, but do not refer to them by this name, nor to Fisher's excellent treatment of this subject in his book just mentioned. They should at least make some allusion to Shewhart's fundamental contributions to applied statistics,....the book of Simon "Engineers' Manual of Statistical Methods" published....in 1941 and the monograph of Shewhart and Deming "Statistical Method from the Viewpoint of Quality Control" published in 1939 * In this last publication, the reader will find an analysis of the identical data used by Worthing and Geffner in their Table III and Figure 11 of Chapter VII; namely, the measurements of the velocity of light published by Michelson and his associates in 1935. The chapter on correlation is brief but clearly presented; the calculations, however, look so formidable that the reader should be referred to any one of the several charts available on the market which make the process practically painless, once the original bivariate frequency distribution has been set up. Even in view of the third paragraph of their preface, the authors might at least have mentioned a few of the many excellent treatises on correlation, most of which deal with applications in the field of educational measurements. It is strange not to find in a book of this kind some reference to the technique of the analysis of variance, which to many writers is the be-all and end-all of modern applied statistics. The reviewer can think of several reasons for not going into the subject to such an extent as this, but here again it does seem that the reader should be given at least a brief explanation of what problems may be solved via variance analysis, or (if the authors do not care to go this far) what problems are commonly supposed to be solved by this technique. It is understood that the authors cannot be expected to cover the entire field of applied mathematics in a book of any reasonable size and cost, but it does seem they have made many serious errors of omission. If a revised edition should ever be contemplated, the attention of the authors should also be directed to their anomalous treatment of the so-called coefficient of flatness of a frequency distribution curve. This quantity (called β_2 by the authors in accordance with standard practice) is defined, in all the other books with which the reviewer is familiar, in such a way as to have a numerical value greater than 3 for sharply peaked frequency distributions and less than 3 for those with "flatness," the value of exactly 3.0 being that of the normal curve of distribution. The authors, however, present their Figure 9 (page 183) to show a "flatter" distribution than normal and which they say has a β_2 value greater than 3, and their Figure 11 (page 186) to show a "peaked" distribution with a β_2 value less than 3, just the opposite from the convention adopted in the books referred to in the bibliography. From the points already mentioned, it would be unwise and unsafe for the average chemist to make this book his sole or even his chief guide to the handling of experimental data according to the best modern practice. Taken in connection with other books along the same general line, however, it has enough good points to warrant its inclusion in the chemist's library.

J Am Stat Assn 39:119–22 Mr '44. W. Edwards Deming. The reviewer is in the awkward position of having agreed to write the review and then realizing after the book was received that he himself had just written one on the same subject, published by the same publisher, and is therefore in position to appreciate a few kind words. One must admire the enthusiasm of the authors for their subject. Their delight in writing about it glistens through the lines. However, one might insist that something more than "a long series of irritations" (preface) should impel an author to do such a dastardly thing as to write a book. Although there are many good points of science in it, and while many of the methods expounded are correct and useful, the book is a disappointment to anyone looking for either something new in methods or in compilation of old ones. It is an example of what can happen when a good scientist without statistical training attempts to write in statistics; the results can be expected to approximate what a statistician without engineering training would produce in the field of engineering. Many of the devices expounded are crude, even when simpler and more elegant

ones could have been copied from existing literature. Unfortunately, many statements are even incorrect. There is a paucity of advice to the reader, and some of that little is bad. A large part of the book seems to be a museum with little bearing on the title. The subject of least squares is stated in as many ways as there are types of problems, whereas in reality it can be stated once for all and the procedure unified. A few examples will illustrate the foregoing remarks. As for incorrect statements, an unfortunate propagation of error occurs on page 263 where it is stated that "It is sometimes possible to obtain more than one least squares value for a given constant by using the same basic relation differently." The same thing occurs on page 247 where it is stated that "The three methods [three ways of writing the equation] will normally yield different best values...." Apparently the authors missed seeing papers by R. Meldrum Stewart in 1920 (*Phil. Mag.*, vol. 40) and Horace S. Uhler in 1923 (*J. Optical Soc.*, vol. 7), and even forgot their own advice on page 249 where they say (correctly) that by taking account of the change in weight upon taking logarithms or otherwise altering the form of the relation, only one set of values will be obtained. There is a perfectly straightforward procedure, yielding unique results, regardless of the form used for the relation to be fitted, and it is a pity that it was not included. The authors also forgot their own advice on page 248 when calculating the weights of the logarithms; what they calculate is the weights before taking logarithms. There is no mention of the adjustment of observations in curve fitting; which probably accounts for the absence of connection between curve fitting and other problems to which least squares is applied. Closely related to this apparent lack of appreciation of the principle of least squares is the curious contrivance for fitting a line when both coordinates are subject to error (page 259). The result derived is valid when the x coordinates have the same weight throughout, and the y coordinates likewise, which is the only case they consider. Incidentally, it was published by Kummell in 1876, Karl Pearson in 1901, and Gini in 1921. The more general problem wherein the coordinates have any weights whatever, and the fitted relation is of any form linear or otherwise, is also simple enough as it turns out, and has in fact been published. One must admire the authors for recognizing the importance of this problem (too often neglected), but not their solution nor conclusion that there is no way out in more complicated situations. In this connection it may be of interest to point out that Gauss recognized that the least squares criterion for adjustment must sometimes be applied to the weighted sums of squares of unlike quantities, such as x and y coordinates * In spite of the authors' expressed fondness for determinants, the Gauss reciprocal matrix is not used for expressing or deriving the weights of adjusted constants for a fitted curve. Instead, derivations are made afresh for specific purposes (pages 229 and 249). As for uncritical advice one may turn for example to page 171, where Chauvenet's criterion is outlined. It is something of a shock to see that a "criterion of rejection is necessary." I had thought that this idea had been decently buried long ago, along with other statistical criteria for the rejection of observations. As for irrelevant material, there are two chapters on the normal curve, which is finally dismissed as one of those things that one never encounters anyhow. Why not merely describe it as a useful mathematical device? The question is not what shape of distribution one has, but whether one has *any distribution at all.* One has no distribution of any kind unless his data show *stability,* a practical criterion for which is contained in the Shewhart control chart methods. No word regarding stability is given in the book. The usual $n - 1$ is replaced by n (page 167) when a single unknown is involved, but $n - 2$ is used on page 250 and $n - m$ on page 261. One excuse given on page 167 for using n is convenience, which is acceptable; but another excuse is that the normal curve seldom exists, which is irrelevant. The authors state on page 238 that the method of least squares gives "a best equation of specified type." Again, on page 239, "Granted the type of equation to be used and the weighting of the data, there is no prospect for the obtaining of a more satisfactory equation than that which the least squares method yields." Just what is meant by best or satisfactory? Perhaps the answer is supposed to be on page 216 where one reads "The treatment of adjustments here given assumes that the measurements obey the normal distribution law. It further assumes that the most probable values for the k unknown adjusted means are those which yield a maximum probability of occurrence for the

weighted measured means." Fortunately there are better reasons for using least squares. In the treatment of interpolation there is no mention of the remainder term and the possible dangers of ignoring it. No reference is made to Aitken's simple iterative procedure for interpolating and extrapolating, and consisting of operations somewhat similar to the criss-cross evaluation of a determinant, which would doubtless appeal to the authors. The Aitken scheme is particularly adapted to the requirements of the casual user of interpolation. The zig-zag rule is not given, yet it forms the basis of all polynomial interpolation, and is as easy to write down and remember for divided differences as for natural differences. The Lagrange formula given on page 21 is correct but awkwardly written. Reference is made on page 261 to Gauss' criterion for the goodness of fit of a curve. It would be well to point out that this criterion is equivalent to the calculation of chi-square, and this calculation might well be tied up with the treatment of chi-square on pages 182–5. The treatment of graphical integration and differentiation can not be recommended. Simpson's and Weddle's rules are a part of the discipline of mathematicians, but little comfort to the physicist or engineer because of the subtle differential weighting given to the ordinates, and the requirement of uniform spacing. It seems much better to approach the problems of graphical integration through the Euler-Maclaurin sum. It is uncritically stated on page 92 that "graphical methods....permit the calculation of derivatives ....from the original data." Must one not know something about the wiggles that the curve takes between the tabulated points? Again, one must not neglect consideration of the remainder term. The treatment of Fourier Series propagates an abomination known as Fourier's "half-range" sine and cosine series, which from a pedagogical standpoint is most confusing. The series covers the full period, and to mention a half-range series to the beginner is like telling the children not to put beans up their noses. The greatest fault is lack of purpose. Why does one wish to fit a curve in the first place? What is he going to do with it when he gets through? Why does one adjust the angles of a triangle? What is the purpose of adjustment? Why does one take data? Why does one wish to present data? As a guide in framing a course of action, of course, or for predicting the result of a future experiment, but one can search the book in vain for the answer. Several good points deserve mention. On page 58 the authors give a little known device for straightening a curve and thus discovering whether some particular form seems to fit. On page 198 the discussion of constant errors is excellent. Section 11 on page 200 continues the discussion and is likewise excellent. Numerous interesting problems are given at the ends of the chapters. The summary of each chapter is helpful. In conclusion the reviewer expresses the hope that Messrs. Worthing and Geffner may have the pleasure of writing a review of his book.

J Am Stat Assn 39:252–4 Je '44. A. G. Worthing. [A reply to W. Edwards Deming.] A book reviewer has a responsibility both to the author and the reading public, particularly that public, normally indicated in the preface, for which the book is intended. * The question arises, what should a review include? Without doubt others will differ with the writer, but in his opinion, certain principles will be conceded generally. In addition to the normal introductory matter, a book review should indicate, (1) except where obvious, the fields covered in a somewhat, but not too, detailed way, (2) the public for whom the book is intended, (3) criticisms, favorable and unfavorable, of the need of the book, of procedures followed, of material included or left out, of the precision or lack of precision encountered, of the English used, and of such other material as will enable a busy potential user to conclude that the book is probably worth or not worth his while. The public for whom the book is intended should be continually kept in mind. It is perfectly proper for a reviewer to "pan" an author for lack of purpose, faulty procedures, looseness of thought, failure to include appropriate material, failure to exclude inappropriate material and many other things. Such panning should be done justly, however, for the author ordinarily has but little opportunity for a comeback. In addition to a few commendatory remarks, your reviewer of *Treatment of Experimental Data* has properly called attention to certain failures to include appropriate matter, has pointed out certain inaccuracies of statement, has listed certain original authors that were not mentioned, and has indicated that certain procedures which the authors have followed are unsatisfactory. These criticisms we appreciate and shall make use of them in case the public

for whom the book is intended find the book so useful that a revision is justified. However, there are certain criticisms to which we make objection on the basis that they do not conform to the principles which we believe should govern the writing of a book review. Certain of these I discuss here. The reviewer has not indicated the public for whom the book is intended, though the authors state in the preface, "This book has been written with the physicist, the chemist and the engineer in mind....considerable effort has been made to keep physical situations in mind throughout." Moreover, reading between the lines, it seems to the writer that the reviewer really reviewed from the standpoint of highly trained mathematicians rather than from the standpoint of those who are moderately trained in mathematics. Definitely our public was the latter group. In discussing the section entitled "change of weights implied by a change of variables," Dr. Deming built up the impression that the authors were muddled regarding the effects of such changes of variables on the least-squares determinations of constants. He quotes one sentence from the section which by itself gives the impression that there are several least-squares determinations for a given constant. However, taken with the material which follows immediately that impression is shown to be wrong. Of course, the authors should have added the introductory phrase, "Disregarding weights." The ideal of making each sentence stand by itself is fine. I like it, but, I fear, I fail in living up to it. Incidentally, it is about as heinous to hold up, as expressive of an author's views, a single sentence which apparently differs from its context. Further, the very title to the section under discussion, as quoted above, shows that the authors were not muddled. Incidentally with regard to the alleged failure to take our own advice on page 248, I am of the opinion that the judgment given was too hasty. What we said may be badly worded, but it seems to be correct. We cannot follow the reviewer in his criticism of the section relating to "The least-squares Equation of the Type $y = a + bx$ when Liability of errors occurs with both x and y." We say "Since x and y will generally differ in physical nature, it is necessary to treat certain simple functions of these variables rather than x and y themselves. These functions must be either dimensionless or expressible in the same physical units. Otherwise there seems to be no logical way of properly weighting them." As a physicist who thinks of x and y as representing *physical quantities* and not *numbers,* I feel that the procedure is justifiable and that no other *fundamentally different* procedure is possible. Moreover, we have not indicated nor felt that "There is no way out in more complicated situations." As to procedure here, which is thought not to be straightforward, the reference to an imaginary plot showing $Y' = f(x')$ would possibly not appeal to a true mathematician, but I must say that it helps greatly with the people for whom we write. The reviewer says, "The greatest fault is lack of purpose. Why does one wish to fit a curve in the first place? What is he going to do with it when he gets through? Why does one adjust the angles of a triangle? What is the purpose of adjustment? Why does one take data? Why does one wish to present data? As a guide in framing a course of action, of course, or for predicting the result of a future experiment, but one can search the book in vain for the answer." I think that physicists, chemists, and engineers would all have answered these questions for themselves long before they would open the book. However, we seem actually to have very definitely answered the first four questions asked in the introductions to the various chapters. Although the fifth and sixth questions have not been answered directly, it seems as though the reviwer might have seen, as a purpose throughout, a desire to give to certain groups of scientific workers satisfactory methods for treating their data so that such data may be presented in good form and so that they themselves and those to whom their conclusions may be presented may know to some extent their reliabilities. While this may not seem like the predicting of the result of a future experiment, it is not far from giving thought to the framing of a course of action.

R Scientific Instruments 15:97 Ap '44. Walter A. Shewhart. * The authors' lucid and lively style, the many illustrations drawn from the field of modern physics and chemistry, and the pleasing typography of the book make for a very interesting introduction to a broad range of topics that should be of value to the audience to whom this book is directed. In a book of this size where so many topics are treated, it is necessary to choose between an attempt at more or less complete coverage of available methodology in terse, abstract, and often mathematical

form and an attempt to introduce the student to this broad field by limiting the coverage of methodology and emphasizing the physical significance of the methods considered. The authors have, perhaps wisely, chosen the latter course. For example, the subjects of smoothing, interpolation, and extrapolation are covered in a few pages and the reader is left on his own to look up more advanced methods in the references given in the footnotes and at the end of the book. Three chapters, or nearly a fourth of the book, are devoted to the presentation of data by tables, graphs, and equations. Some excellent advice is given on fitting a curve to plotted points, particularly in the case where a "kink" or discontinuity in the slope of the curve may be overlooked with consequent misinterpretation of the experimental results. A brief discussion of the preparation of graphs for publication that will reproduce well as lantern slides would perhaps have been of value to many readers. At least a reference to the two standards of the American Standards Association on this subject might have been helpful. There is a short chapter on tabular and graphical differentiation and integration. Interesting illustrative examples make clear the need for such methods, and the discussion is enlivened by the description of some of the available instruments that may be used. * The treatment of the normal law....follows along lines of classical error theory and no mention is made of the well-known work of "student" [*sic*] and more recent contributions to the whole subject of setting up confidence intervals, which are of such vital importance in the application of error theory in research work. Likewise, there is no discussion of the important problem in the field of applied science, and particularly in engineering, of establishing valid tolerance ranges; nor is the student warned against the dangers of grouping data together upon the assumption that it follows some law of error. For example, in their discussion of the application of the chi square test to the velocity of light measurements of Michelson, Pease, and Pearson, all of the observations are grouped together and the chi square test is used to test for normality of the underlying law of error, whereas it may easily be shown that these data, when considered in the order in which they were taken, give evidence of not having come from a single universe or "law of error." * A chapter on least squares equations representing observed data considers some of the simpler problems in this field and here again the theory is well illustrated. * Tables useful in solving the excellent lists of problems are provided and the book closes with a useful bibliography. Although the general subject of design of experiment is beyond the scope of the present book, it might have further stimulated the student's interest in the practical importance of statistical error theory to have pointed out, wherever possible, the broad application of such theory in planning an experiment. Only in one instance, namely, on pp. 212 and 213 in discussing the use of the propagation of precision indexes in planning an experiment, do the authors direct the attention of the reader to the important use of probability and statistical theory in designing the most efficient experimental procedure. There are a few places where some may wish that the authors had pursued their critical approach further than they have done. For example, the brief discussion of the use of Chauvenet's criterion for the rejection of observations might lead an unsophisticated student to adopt this as a generally accepted rule without realizing the dangers underlying the use of any such criterion. Likewise, in the discussion of the chi square test, several serious difficulties involved in its use are not considered.

[335]

★YATES, FRANK. **Sampling Methods for Censuses and Surveys.** London: Charles Griffin & Co., Ltd., 1949. Pp. xiv, 318 24*s*. (New York: Hafner Publishing Co., Inc. $6.00.) *

Economica 16:382–4 N '49. R. G. D. Allen. This....important book....brings together, in concise and convenient form, much of the recent developments in sampling methods to which British statisticians have contributed so largely. It deserves to be widely used; a translation into French is already in preparation, and others should be encouraged. It is essential to be clear on what the book sets out to do—or rather on what it does not do. In the first place, though the book will be valuable in teaching, it is not a textbook in mathematical statistics. Practically all proofs are omitted. Secondly, it is confined to only one application of sampling techniques, in the conduct of censuses and surveys. It is limited, therefore, to the estimation of simple totals and the ratios of totals * It is not concerned (for example) with methods of estimating coefficients in linear relations assumed to hold within a set of variables. * Yates....has chosen to proceed from a description of the

different methods of sampling, through the problems arising in planning and executing a survey, to the more theoretical questions of statistical estimation. This treatment will suit many, particularly those willing to take theoretical conclusions on trust. Others will perhaps find it better to read the later chapters first. * The book is essential reading for those interested in social surveys. But the economist (in the narrower sense) will also find much of interest to him. There are good sections on sampling by means of a continuing sample with partial replacement of units on successive occasions, just the kind of sample to produce regular information needed in filling some of the gaps in economic data. Further, the economic theorist cannot fail to be fascinated by the last chapter on efficiency of sampling methods, a matter little discussed hitherto in the literature. * Dr. Yates and the publishers are to be congratulated on a carefully edited and produced text. I have relatively few corrections or suggestions for improvement to offer. The reference to Section 3.17 towards the bottom of p. 77 should be to Section 3.18. I think the correction $(1 - f)$ for finite sampling should have been introduced in the formula for $V(\bar{r})$ towards the top of p. 224. Occasionally, there is a bald and somewhat doubtful assertion, as on p. 3 where Dr. Yates says that "the individuals concerned are more likely to be willing to provide [detailed] information if they know that they represent a small sample of the whole population." Dr. Yates passes over rather lightly the question of terminology and notation (p. 7); personally I doubt whether bold face and Gill Sans type are sufficiently distinct for population values and their estimates respectively. In discussing "frames" for taking samples of industrial undertakings, Dr. Yates seems to ignore the possibility of a current up-to-date register of firms. Finally, on the important matter of compensating for defects which disclose themselves after the taking of a sample, Dr. Yates is content (p. 130) with a brief comment which seems to have been included almost as an afterthought.

J Am Stat Assn 44:580–2 D '49. W. Edwards Deming. Here at last is a real book on sampling. It is a pleasure to review such an outstanding contribution. * The techniques of sampling have advanced rapidly during the past few years, but the requisite knowledge and experience have been largely confined to an inner circle of masters who have trained numerous apprentices by the spoken word. This is an unhealthy state of affairs, because the demand for competent statisticians has been running further and further ahead of the supply. No book can ever replace the privilege of working with a master, but Yates, indeed one of the masters, has put about as much inspiration and guidance into a book as is possible. Unfortunately, there is no royal and easy road to the top, but statistical teaching centres will now have an authoritative book to use for studies in sampling. The book will be useful for instruction in internships, and the private study of innumerable struggling, mathematically-inclined statisticians in government offices throughout the world will now be much more effective. * The very title of the book is a clever statement of the attainment of modern methods of sampling. The title suggests, as is true, that sampling methods are now used not only for occasional or periodic special surveys of various kinds, but actually for replacing, broadening, and calibrating the data heretofore reserved for complete censuses of population, agriculture, commerce, *etc.* * Yates gives a splendid treatment of various methods of computation, along with excellent discussions of the amount of labor that is saved or entailed through the use of constant and variable weighting factors. He gives a well-balanced treatment of ratio-estimates, two-stage sampling, stratified sampling, variable sampling fractions, for some of which he was required to develop new theory to fill in the gaps. * A simple cost-function is treated on pages 283*ff*. In teaching the book, it might be well to make clear to the students that there is a cost-function associated with every sample design, and that sample design in the modern sense means using whatever plan will produce the most information per dollar. The illustrations are mostly drawn from the author's wide experience in surveys of agricultural and wood lands, but this is excellent, because the fundamental principles are the same regardless of the material sampled. The reviewer is in full agreement with the statement on page 59 that where a full census is compulsory, a sample should also be compulsory. The well-chosen bibliography at the back, divided into convenient sections, will be very useful. This review can only conclude with thanks and congratulations to the author: his book heralds a turning-point in statistical history.

J Inst Actuaries 75:265–7 pt 2 '49. N. L. J(ohnson). * the present book *does* fulfil a

long-felt want, it *does* break new ground, it *does* contain an exhaustive treatment of its chosen topic, and it *is* likely to prove of value to a wide circle of readers. A further, and most welcome, feature is the essentially statistical approach to the problems considered. * The absence of formal mathematics is not, however, associated with an absence of logic in the arguments used (as all too often happens in "elementary" text-books). A careful study of this book should result in a clear understanding of the various sampling methods in current use, the types of problem to which they may most profitably be applied, and the most economical and efficient ways of analysing the data collected. In all parts of the book there is awareness of the effect which practical limitations may have on theoretical considerations, and of the necessity to make the best of the conditions actually prevailing. This is the first attempt to provide a systematic and comprehensive description of the general theory and practice of modern sampling, and it is of interest to see the way in which Dr. Yates has chosen to develop the subject. * As the author himself points out, a knowledge of the last three chapters is essential to a complete understanding of the various methods proposed in the earlier chapters. Nevertheless, a study of the earlier chapters alone will provide a most useful knowledge of the methods of sampling which are available to the investigator. * The book contains a useful, though not exhaustive, discussion of practical methods of dealing with [non-response] * Of special interest is the description (in Chapter 5) of methods of recording collected data. The possibilities of the Cope-Chat card system and of the Hollerith mechanical punched card system are discussed in a lucid and thorough manner. Such faults as are to be found in this book seem to arise from the conditions of its production rather than from any shortcomings of the author. First, there was some haste necessary in its preparation as the United Nations Sub-Commission on Statistical Sampling desired it to be completed before the 1950 World Censuses of Agriculture and of Population. Secondly, the book is an attempt to present a consolidated account of a subject which is still developing rapidly and which has not, as yet, the benefit of a universally accepted system of terminology and concepts. In his effort to give a definite form to the subject the author does seem to be a little pedantic, not always consistent in his definitions, and perhaps a little dogmatic in some of his opinions. There is, for example, the rather fine distinction between *census* and *survey,* introduced in Chapter 1. * A further example of an excess degree of detail is the classification of types of defect of sampling frame under five heads (p. 60). These seem to overlap, notably "incompleteness" (which "is often confined to units possessing some special characteristic") and "inadequacy." Exception may be taken to the statement that fiducial probability has "certain logical advantages"; the subsequent description does little to make the concept clear or its logical advantages apparent. The book is expressly intended for persons with "little or no previous training in mathematical statistics." Such persons will probably find Chapters 6-8 rather hard going. This arises from the nature of the subject, and the author cannot be blamed, except in so far as he is, perhaps, rather too sanguine as to the possibility of learning directly from his book, without the necessity of a preliminary general elementary study of statistical theory. In the absence of such previous knowledge these later chapters will not be easily mastered. The various methods described in the book are amply demonstrated by numerical examples * A large bibliography provides examples of the application of sampling methods to a wide variety of problems. * a good index * the book is attractively set up and quite easy to read.

J Royal Stat Soc 112:483-4 pt 4 '49. L. H. C. T(ippett). It has been apparent for some time that the theory and practice of sampling were developing in scope and complication, but only on reading this book does one realize how highly developed they had become. All statisticians will welcome this synoptic treatment of an important branch of their subject—the first of its kind; and those who have to undertake censuses and surveys by sample will find it essential. * the development is systematic and clear * there are two chapters on practical problems arising in planning and executing a survey, and analysing and presenting the results; these chapters, although they do not entirely avoid the platitude, are full of advice and worldly wisdom that is well worth presenting * There are no formulae in the first half of the book. The second half contains the formulae and instructions for estimating population values and sampling errors, and for evaluating

the relative efficiencies and economies of different types of samples in various circumstances. The reader will be unlikely to make much of these chapters unless he is fairly familiar with at least the statistical theory of simple random sampling and with the analysis of variance. The book deals ostensibly with application to agricultural, social and population surveys, but only the chapters on practical problems have this limitation, and the more general parts have a wide application, which, however, remains to be illustrated for other fields. Although the book is comprehensive it has the merit of being relatively short. This is due partly to the wholly admirable disciplined and systematic presentation, and partly to a condensed style of writing. * The book abounds in well described examples, fully worked out, but when essential steps are introduced in general terms, as in the passage quoted, concentrated attention is required in reading. Punched cards and sorting machines, and their use, are described in eleven pages or so; and a statement of the theory of sampling errors occupying only a few pages is a *tour de force* of condensed and yet coherent exposition. These are useful as summaries to the reader who already knows about these matters, but it is doubtful if they will do much to inform the uninstructed reader. Such parts of the book require an entirely different degree of sophistication in the reader from that required in other parts. Dr. Yates states that he had to prepare the book in considerable haste, and he scarcely hopes that perfect balance has been achieved; perhaps he had this kind of thing in mind when making this statement. All this is intended as comment rather than criticism. In practice all readers do not need to understand all parts of the book with equal ease; everyone who has to do with sampling will find in it enough of clear exposition, example and instruction to carry him a very long way; and the statistician with a mathematical turn of mind will find enough of theoretical importance to interest him.

Nature 166:245 Ag 12 '50. J. Wishart. * certainly a notable addition to the growing literature on the theory and practice of statistical methods * the book is of particular value in that it makes available in one work of reference what could previously have been gleaned only by painstaking research over a large number of scattered publications. * A book like this cannot in the nature of things be easy reading right through; but it is at any rate broadly non-mathematical, even where it deals with mathematical concepts. This does not mean that there are not plenty of formulae, but they are not proved, and there is a profusion of arithmetical illustration. The reader who has a general acquaintance with the methods of statistics should be able to follow the author quite well. He will be tempted by the lucid accounts of the practical aspects of sampling procedure to continue reading, when he will find that in spite of himself he is learning quite a lot about the statistical techniques. It is not everyone who will want to master these thoroughly; but they are there for the expert, and it is a good idea that the planner, even if he is not himself the analyst, should see the sound character of the basic methods which are essential to his study.

Sci Progress 37:795 O '49. A. L. Bowley. [Not excerpted because of copyright restrictions.]

[336]

★YULE, G. UDNEY, AND KENDALL, M. G. **An Introduction to the Theory of Statistics, Thirteenth Edition.** London: Charles Griffin & Co., Ltd., 1944. Pp. xiii, 570. For latest edition, see 337. ["The present edition is practically the same as the eleventh" edition. —Preface to the Thirteenth Edition.] *

For reviews of the eleventh edition, see 38:B740 and 2:342.

[337]

★YULE, G. UDNEY, AND KENDALL, M. G. **An Introduction to the Theory of Statistics, Fourteenth Edition.** London: Charles Griffin & Co., Ltd., 1950. Pp. xxiv, 701. 34*s*. (New York: Hafner Publishing Co, Inc. $7 50. *) ["Chapters 21–23 expand the former treatment of small-sample theory and give an introduction to the practical problems of sampling. Chapters 25–27 give an account of index-numbers and the elementary theory of time-series. Chapter 13 on practical problems of correlation has also been rewritten. Additions have been made in the remaining chapters to keep the treatment abreast of new discoveries, some of the examples have been modernised and some further exercises added."—Preface to the Fourteenth Edition]

[338]

★ZARCHIN, MICHAEL M. **Problems and Tables in Statistical Methods.** San Francisco, Calif.: the Author (205 Urbano Drive), 1946 Pp. v, 170. Paper, lithotyped. $1.50. *

[339]

★ZEISEL, HANS **Say It With Figures.** Introduction by Paul F. Lazarsfeld. New York: Harper & Brothers, 1947. Pp. xix, 250. For latest edition, see 341.

Am J Pub Health 38:1289 S '48. Homer N. Calver. While this is primarily a manual for statisticians in the field of consumer and opinion research, it is a valuable text on the science of

assembling and using social statistics of many kinds. * The methods of statistical analysis outlined present nothing new to those skilled in the science of statistics except to illustrate how the principles of that science may be applied to the analysis of certain social situations with which the vital statistician is not usually accustomed to deal. For the imaginative health officer and health educator, it suggests exciting possibilities of a new approach to ancient problems.

Am Sociol R 14:178–9 F '49. Ronald Freedman. * a unique and excellent contribution to the teaching of social statistics * Perhaps the bulk of the work done by professional social statisticians involves tabulations and interpretations of tables for which systematic training in mathematical statistics alone is not adequate preparation. *Say It With Figures* is an excellent introduction to the everyday problems which puzzle beginners in research but which are generally regarded as too simple for extended treatment in conventional textbooks in statistics. These problems center around the logic of the classification of data and the uses to which tables of simple ratios can be put in analyzing and interpreting data. Dr. Zeisel demonstrates in this volume that the logic involved in solving some of these "simple" problems is basic to the understanding of social research procedures. The book is labeled on the jacket as "a manual for statisticians in the field of consumer and opinion research," and most, although not all, of the data used in the book are drawn from this field. However, most of the techniques and principles are relevant to many fields of social science research. * a chapter on the Panel as a research tool....is probably the most complete treatment of this subject in print. Among the specific problems treated in this book which are seldom treated in conventional texts are the following: how to distinguish legitimate "don't know" responses from those which may be regarded as a failure in interview technique, how to determine which way percentages should run in a table, how to reduce three dimensional tables to two dimensions, how to distinguish "true" from "spurious" correlations by the cross-tabulation of additional intermediate factors. Although the chapter on indices has many excellent features, it is the weakest in the book for instructional purposes, not because of any errors, but because it attempts to deal on too simple a level with a difficult subject. For example, after combining three elements into a single index the statement is made (p. 151) that "the indicators may be weighted in any desired manner, if this is felt to be necessary." No attempt is made to explain that any combination of elements into an index involves a weighting process, even if only on an assumed equal weight basis, although Dr. Zeisel does caution that it is necessary to make specific the formula by which data are combined to avoid misunderstanding (p. 163). The style of exposition is lucid and interesting, and the book is well organized. It should be an effective teaching aid for courses in social statistics and research methodology.

J Am Stat Assn 42:666–7 D '47. Albert B. Blankenship. To the technician in consumer and opinion research, this book reads like a novel. * never dull reading. Despite this facile reading, this is not a book for beginners in the field. It assumes knowledge of elementary tabulation on the part of the reader. The book covers classification of replies, numerical summary, and interpretation. It is the only attempt that the reviewer has ever seen to spell out methods and principles of making tabulation decisions which are so necessary before sound statistical treatment can be applied. * What Zeisel has done—and done well—is to cover in detail all of those intermediate tabulation steps which no statistics writer has ever discussed. The steps, as written by Zeisel, seem elementary. Actually this is merely another way of saying that the book is effectively written. * This book has several shortcomings. One is the tendency to oversimplify. * The casual reader, not too well trained in the work, may not get the implications of difficulty and complexity which he should. * the title was selected more for its possible appeal to businessmen than for its description of contents. Another shortcoming is the lack of an introductory section on elementary tabulation techniques. While this was not stated as part of the scope of the book, it is clear that the novice in the field would be lost in attempting to follow the material presented. Several chapters on hand and machine tabulation, along with visual analysis, would add immeasurably to the volume. There would then be available, within one cover, a complete manual on tabulation. Perhaps this is merely another way of expressing the hope that this book is but the first in a series on the various steps in conducting consumer and opinion research. * The advanced student has no intermediate step from the elementary over-all book in the field, to the

postgraduate offerings of the technical journals and the book edited by Cantril. Surely Zeisel's book then marks an important milestone in this intermediate zone. If the other fields are to be similarly covered, Zeisel has set a standard for scope and readability that will be difficult to match. This book should be useful in the classroom, for the undergraduate student who has completed a first course in commercial research. It will also be of some value to the beginner in a practical research situation, though he will have to learn elementary tabulation principles elsewhere. The book should also be useful to "postgraduates" in the field who are honest enough to admit that they have never summarized their thinking on principles of tabulation. This book should enjoy a wide audience. If it does, it should have the effect of completing the transition in commercial research from mere nose-counting to qualitative analysis.

J Appl Psychol 32:326 Je '48. Kenneth E. Clark. * The book is unique, has an excellent selection of topics, and overlaps zero with the usual statistics book. In fact, it isn't statistics at all, but rather is common sense and a little arithmetic. Zeisel demonstrates his points with abundant research findings from the files of the Bureau of Social Research, from advertising, and from public opinion results. It is a most welcome and needed addition to the literature.

Pub Opinion Q 11:468–9 fall '47. Frederick Mosteller. The wrapper on this book describes it as "a manual for statisticians in the field of consumer and opinion research." The inside flap describes it in part as "an introduction to the whole science of assembling and using social statistics." The book's position is probably somewhere between these two descriptions. The book is written by an author who understands how to use short words and short sentences to get his points across. The mathematics required is an ability to compute percentages. * The index is adequate. Part I deals principally with the one variable classification. There is a useful discussion of the "Don't Knows" and "No Answers" from the point of view of polling technique and of analysis of data. Part II deals with percentages and higher dimensional tables. There is also a chapter on indices with an extended example drawn from baseball. The treatment of this example is adequate for the text, but it is so interesting that one wishes the author had still more space for it. Throughout it will be found that the numerous examples have interest in themselves over and above their explanatory value. Part III, *Tools of Casual Analysis,* is bound to be received with mixed feelings. The question of "causes" never fails to make trouble. The author shows how the introduction of a third or fourth variable can help explain associations. But, of course, there is always the question of the stopping point and the choice of the new variable to be introduced. The material is worth reading. The last chapter deals with the panel technique in detail, although it is not "a systematic presentation of the whole panel technique" as advertised. It should be pointed out that the author does not consider sampling variation at all. Since the book can be regarded as a discussion of large samples, this is scarcely a criticism. It seems to the reviewer that the author's intention was to begin to teach the reader the elements of inference from observations in the form of tables and how to construct meaningful tables. With examples so close to everyday life, it might happen that students will be able to think about the main problem even with numbers in front of them. It is well established that students have not been very good at this in the past. If the book can accomplish this it will need no further recommendation. It seems to the reviewer that people in consumer and opinion research will want to examine this book and keep it on their shelves for occasional reference. Introductory courses in quantitative methods could well use this book for a part of the term. For introducing statistical inference in a high school, this is the best book the reviewer has seen. This remark is not to be taken as derogatory. It is made largely because the material is so well written and interesting. On page 151 there is a misprint five lines from the bottom: "often" should be replaced by "of ten." Finally, this is one of the few books the reviewer has seen lately which can be read comfortably without danger of straining a wrist.

Social Forces 27:103 O '48. Daniel O. Price. The jacket of this book characterizes it as "a manual for statisticians in the field of consumer and opinion research." It doubtless will be of interest to people in these fields, but the reviewer hardly feels that it can be classed as a manual. The most important contribution of the book is probably the last chapter on the use of the panel technique. In spite of the value of the last chapter, the omissions and errors in the rest of the book may make it very misleading to students not already familiar with statistical methods. The omission of material on tests of

significance is probably the most dangerous flaw in the book. On page 206 we find the following statement: "It is known that the significance of any difference in percentage in a statistical table depends upon the size of the sample from which these percentages are derived." At no point is the reader given any basis for judging what differences might be significant. In at least one of the examples a conclusion is drawn when the results are not statistically significant. In the example on pages 176–177, the conclusion is drawn that "educated people listen more to classical music when they are older (78% vs. 73%)." In additional samples drawn from a universe in which there is no relationship between age and listening to classical music, differences as great as or greater than those observed in the author's sample would be observed by chance approximately 20 percent of the time. There is, therefore, little if any basis for the conclusion drawn. Such an example is dangerous when not accompanied by some statement of significance because some inexperienced person, following this illustration, might draw erroneous conclusions in a similar manner. Tabular and graphic presentation of some of the results also leaves much to be desired. For example, Graph VIII–8a is the graphic presentation of Table VIII–8a. However, the table is so arranged as to emphasize age differences within educational levels while the figure emphasizes educational differences within age groups. It would have been well had a paragraph been included on the arrangement of tables and figures in order to emphasize particular aspects of the data. Taken as a whole, the book contains many interesting and helpful ideas, but omissions such as the ones mentioned may make it harmful for those using it to learn the application of simple statistical technique.

Sociol & Social Res 32:643 N–D '47. James S. Roberts. For research workers who desire to work with figures, Dr. Zeisel has written an extremely handy if not necessary reference book. * The book's greatest virtue lies in the fact that Dr. Zeisel has attempted to present a practical rather than a theoretical discussion of the problems of statistics. In every section there are simple illustrations which reinforce the material presented in the text. A good background in statistics would be helpful to those who want to understand fully the material presented by Dr. Zeisel, but the book is simple enough to prove very useful to those who have had little or no training in statistics.

[340]

★ZEISEL, HANS. **Say It With Figures, Second Edition.** Introduction by Paul F. Lazarsfeld. New York: Harper & Brothers, 1948. Pp. xxi, 250. * For latest edition, see 341. [Practically the same as the first edition.]

J Am Stat Assn 44:332–3 Je '49. Gregor Sebba. * Zeisel's discussion of "Don't know" answers (which can easily be adapted to "Undecided" answers) is particularly illuminating when applied to political opinion polls. * Among the "Means of Numerical Presentation," Dr. Zeisel singles out percentages and simple indices for a penetrating analysis of their logic. * Of particular interest is Zeisel's subsequent study of the problem of reducing three-and-more-dimensional tables (chap. 6), a problem arising because "only tables containing two variables can be presented in their entirety and still be clearly readable" (p. 127). There follows an [illegible] discussion of simple indices of the type developed in sociometrics * Part III, "Tools of Casual Analysis," contains a superior treatment of cross-tabulation as a tool of research. * Zeisel's study represents a step forward on the road indicated by such classical earlier treatises as Zizek's study of averages (1913), Winkler's monograph on relatives (1923) and Haberler's analysis of index numbers (1927). The book might be termed an essay in the logic of statistics procedures. The teacher of elementary and applied statistics will find in it useful numerical examples and charts of great forcefulness; and while much of the author's discussion is too refined for beginners, there remains enough to enable the teacher to go through the initial chapters of an elementary text without putting the students (and himself) to sleep. Although Professor Lazarsfeld claims that "some of the inevitable errata" have been corrected in the 1948 printing, others seem to have passed unnoticed; among them an ugly blemish: in Table X-19 (pp. 240–2), there occur three questions and answers of the form: "If Hitler offered peace now...., would you favor or oppose such a peace?" Answer: "Yes."

[341]

★ZEISEL, HANS. **Say It With Figures, Third Edition.** Introduction by Paul F. Lazarsfeld. New York: Harper & Brothers, 1950. Pp. xxi, 250. $3.00. * [Except for revision of Chap. 7, "Indices," the third edition is practically the same as the first edition.]

[342]

★ZUBIN, JOSEPH, EDITOR. **Symposium on Statistics for the Clinician.** Journal of Clinical Psychology Monograph Supplement No. 7. Reprinted from the *Journal of Clinical Psychology*, Vol. 6, No. 1, January 1950. Brandon, Vt.: Journal of Clinical Psychology, January 1950. Pp. 76. Paper. $2.00. *

PERIODICAL DIRECTORY AND INDEX

NUMBERS REFER TO THE NUMBERED BOOK ENTRIES

A M A—The A M A: The Journal of the Incorporated Association of Assistant Masters in Secondary Schools 8 issues (combined issues Mr-Ap, Je-Jl, Ag-S, N-D); vol. 45 started Ja '50; 4*s.* 6*d.* per issue; H. L. O'Connor, editor, 31 Hyland Close, Romford, Essex, England: 291

Accounting R—The Accounting Review. Published by the American Accounting Association. 4 issues; vol. 25 started Ja '50; $4 per year; $1 per issue; Frank P. Smith, editor, University of Rochester, Rochester, N.Y.; Arthur M. Cannon, review editor, University of Washington, Seattle, Wash.: 47, 133, 149, 154-5, 203, 210, 225, 277

Adv Mgmt—Advanced Management. Published by the Society for the Advancement of Management, Inc. 12 issues; vol. 15 started Ja '50; $8 per year; $1 per issue; Robert B. Ross, editor, 84 William St., New York 7, N.Y.: 107, 183, 192, 257, 265

Agric—Agriculture: The Journal of the Ministry of Agriculture. 12 issues; vol. 57 started Ap '50; 6*s.* per year; 6*d.* per issue; S. R. O'Hanlon, editor, St. Andrew's Place, Regents Park, London N.W.1, England. 270

Agron J—Agronomy Journal. Title was *Journal of the American Society of Agronomy* (*q.v.*) through vol. 40, no. 12, D '48. Published by the American Society of Agronomy 12 issues; vol. 42 started Ja '50; $10 per year; $1 per issue; M. R. Haag, editor, 2702 Monroe St., Madison 5, Wis.: 6

Am Econ R—The American Economic Review. Published by the American Economic Association. 4 issues (Mr, Je, S, D); vol. 40 started Mr '50; $5 per year; $1.50 per issue; Paul T. Homan, managing editor, Hall of Government, George Washington University, Washington 6, D.C.: 31, 80, 87-8, 108, 143, 225, 233, 278, 310, 330

Am J Physics—American Journal of Physics: Devoted to the Instructional and Cultural Aspects of Physical Science. Published by the American Institute of Physics for the American Association of Physics Teachers. 9 issues (omitting Je, Jl, Ag); vol. 18 started Ja '50; $6 per year; Thomas H. Osgood, editor, Michigan State College, East Lansing, Mich.: 334

Am J Psychol—The American Journal of Psychology. 4 issues; vol 63 started Ja '50; $6.50 per year; $1.75 per issue; Karl M. Dallenbach, editor, University of Texas, Austin, Tex; Madison Bentley, review editor, P.O. Box 446, Palo Alto, Calif.: 31, 51-2, 132, 138, 182, 206, 213, 251, 293, 308

Am J Pub Health—American Journal of Public Health and the Nation's Health. Official monthly publication of the American Public Health Association, Inc. 12 issues; vol. 40 started Ja '50; $7 per year; 70¢ per issue; C. E. A. Winslow, editor, 1790 Broadway, New York 19, N.Y.: 54, 147-8, 161-2, 255, 330, 339

Am J Sci—American Journal of Science. 12 issues; vol. 248 started Ja '50; $8 per year; 75¢ per issue; Chester R. Longwell, editor, 501 Sterling Tower, New Haven, Conn: 334

Am J Sociol—The American Journal of Sociology. Published by the University of Chicago. 6 issues; vol. 56 started Jl '50; $6 per year; $1.25 per issue; Herbert Blumer, editor, 1126 East 59th St., University of Chicago, Chicago 37, Ill.: 49, 62, 93, 102, 108, 144, 168, 179, 187, 212, 242, 251-2, 277

Am Machinist—American Machinist: Magazine of Metal Working Production. 26 issues (semimonthly); vol. 94 started Ja 6 '50; $5 per year; 50¢ per issue; Burnham Finney, editor, 330 West 42nd St., New York 18, N.Y · 107, 192

Am Math Mo—The American Mathematical Monthly. The Official Journal of the Mathematical Association of America, Inc. 10 issues (combined issues Je-Jl, Ag-S); vol. 57 started Ja '50; $5 per year; Carroll V. Newsom, editor, State Education Bldg., Albany 1, N.Y.: 31, 37, 51, 59, 62, 90, 112, 144, 165, 185, 203, 225, 247, 252, 266, 276-7, 293, 308, 313, 325, 330

Am Sociol R—American Sociological Review. The official journal of the American Sociological Society. 6 issues; vol. 15 started F '50; $6 per year; $1 per issue; Maurice R. Davie, editor, Stephen W. Reed, review editor, 133 Hall of Graduate Study, Yale University, New Haven, Conn.: 49, 93, 108, 138, 144, 179, 187, 212, 252, 308, 339

Analyst—The Analyst. The Journal of the Society of Public Analysts and Other Analytical Chemists. 12 issues; vol. 75 started Ja '50; 80*s.* per year; 6*s.* 6*d.* per issue; J. H Lane, editor, 7-8 Idol Lane, London E.C.3, England · 85, 112

Analytical Chem—Analytical Chemistry. Title was *Industrial & Engineering Chemistry, Analytical Edition* (*q.v.*) through vol. 18, no. 12, D '46. Published by the American Chemical Society. 12 issues; vol. 22 started Ja '50; $4 per year; 50¢ per issue; Walter J. Murphy, editor, 1155 16th St, Washington 6, D.C.: 112

Ann Am Acad Pol & Social Sci—The Annals of the

American Academy of Political and Social Science. Published by the American Academy of Political and Social Science. 6 one issue volumes per year; vol. 267 dated Ja '50; $5 per year; $2 per issue; Thorsten Sellin, editor, 3817 Spruce St., Philadelphia 4, Pa.: 51, 75, 87, 144, 212

Ann Appl Biol—The Annals of Applied Biology. Edited for the Association of Applied Biologists. 4 issues; vol. 37 started Mr '50; 50*s.* per volume; R. W. Marsh, editor, Research Station, Long Ashton, Bristol, England: 106, 112

Ann Eug—Annals of Eugenics: A Journal of Human Genetics. 4 issues; vol. 15 started O '49; 50*s.* per volume; 15*s.* per issue; L. S. Penrose, editor, Galton Laboratory, University College, Gower St., London W.C.1, England: 81, 83, 185, 188, 191

Ann Math Stat—The Annals of Mathematical Statistics. The Official Journal of the Institute of Mathematical Statistics. 4 issues; vol. 21 started Mr '50; $10 per year; $3 per issue; S. S Wilks, editor, Mt. Royal & Guilford Aves., Baltimore 2, Md.: 75, 185, 189, 247, 279-80, 306

B Am Math Soc—Bulletin of the American Mathematical Society. Published by the American Mathematical Society. 6 issues; vol. 56 started Ja '50; $11 per year; with the *Proceedings of the American Mathematical Society;* E. B. Stouffer, managing editor, University of Kansas, Strong Hall, Lawrence, Kansas: 75, 87, 108, 188, 227, 305, 332-3

Biometrika—Biometrika. 2 issues (Je (pts 1-2), D (pts 3-4)); vol. 37 started Je '50; 45*s.* per year; E. S. Pearson, managing editor, Department of Statistics, University College, Gower St., London W.C.1, England: 51, 75, 83, 112, 178, 185, 187-8, 191, 249, 313

Brit J Ed Psychol—The British Journal of Educational Psychology. Issued on behalf of the British Psychological Society and the Association of Teachers in Colleges and Departments of Education. 3 issues (F, Je, N); vol. 20 started F '50; £1 per year; 10*s.* per issue; C. W. Valentine, editor, The White House, Wythall near Birmingham, England: 102, 139, 185, 291, 293

Brit J Psychol, Gen Sect—The British Journal of Psychology, General Section. Published by the British Psychological Society. 4 issues; vol. 40 started S '49; 40*s.* per year; 12*s.* 6*d.* per issue; D. W. Harding, editor, Bedford College, Regent's Park, London N.W.1, England: 52, 102, 185

Brit J Psychol, Stat Sect—The British Journal of Psychology, Statistical Section. 3 issues (Mr, Jl, N); vol 3 started Mr '50; 30*s* per year; 15*s.* per issue; edited by Cyril Burt, Psychology Department, University College, London W C.1, England, and Godfrey Thomson, Moray House, Edinburgh 8, Scotland: 112, 185, 191

Brit Med J—British Medical Journal. Journal of the British Medical Association. 52 issues in 2 volumes; vol. 1 for 1950 started Ja 7 '50 (no. 4644); vol. 2 for 1950 started Jl 1 '50 (no. 4669); 2*s.* per issue; Hugh Anthony Clegg, Tavistock Square, London W.C.1, England: 85, 116, 120, 123, 161-2, 187-8

Can J Psychol—Canadian Journal of Psychology. The Journal of the Canadian Psychological Association. 4 issues; vol. 4 started Mr '50; $3 per year; John A. Long, editor, Ontario College of Education, 371 Bloor St. West, Toronto 5, Canada: 203

Cath Ed R—The Catholic Educational Review. Published by the Catholic University of America. 10 issues (omitting Jl, Ag); vol. 48 started Ja '50; $3 per year; 40¢ per issue; Rev. Joseph A. Gorham, editor-in-chief, Catholic University of America, Washington 17, D.C.: 132, 293, 301

Char & Pers—Character and Personality: An International Psychological Quarterly. Title changed to *Journal of Personality* (*q.v.*) beginning with vol. 14, no. 1, S '45: 168

Chem & Eng News—Chemical and Engineering News: The Newsmagazine of the Chemical World. Published by the American Chemical Society. 52 issues; vol. 28 started Ja 2 '50; $4 per year; 15¢ per issue; Walter J. Murphy, editor, 1155 16th St., Washington 6, D.C.: 42, 45, 85-6, 100, 135, 274, 334

Chem & Ind—Chemistry and Industry: Weekly Publication of the Society of Chemical Industry. 52 issues; 70*s.* per year; 2*s.* per issue; no volume numbers; first issue in 1950 started with no. 1; Francis J. Griffin, editor-in-chief, 56 Victoria St., London S.W.1, England: 106 [Reviews in *Chemistry and Industry* are indexed but not excerpted because of copyright restrictions]

Chicago Sch J—Chicago Schools Journal: An Educational Magazine for Chicago Teachers. Published by the Board of Education. 5 issues; vol. 32 started S-O '50; gratis to libraries; Raymond M. Cook, editor; Louise M. Jacobs, managing editor, Ellen M. Olson, review editor, Chicago Teachers College, 6800 Stewart Ave., Chicago 21, Ill.: 54

Child Develop Abstracts—Child Development Abstracts and Bibliography. Published by the Society for Research in Child Development and the Committee on Child Development, Division of Anthropology and Psychology, National Research Council. 6 issues; vol. 24 started F '50; $5 per year; Isidore Altman, editor, 2101 Constitution Ave., Washington 25, D.C.: 276-7, 279

Col & Univ—College and University: The Journal of the American Association of Collegiate Registrars. 4 issues; vol. 26 started O '50; $3 per year; $1 per issue; Wm. Craig Smyser, editor, Miami University, Oxford, Ohio; S. A. Nock, review editor, Briarcliff Junior College, Briarcliffe Manor, N.Y.: 251

Current Sci—Current Science. Published by the Current Science Association. 12 issues; vol. 19 started Ja '50; Rs. 6 per year; M. Sreenivasaya, editor, Malleswaram P.O., Bangalore 3, India: 106

Ecol—Ecology: A Quarterly Journal Devoted to All Forms of Life in Relation to Environment. Published by the Ecological Society of America. 4 issues; vol. 31 started Ja '50; $7.50 per year; $2 per issue; Donald B. Lawrence, editor (botany), University of Minnesota, Minneapolis 14, Minn.; and Edward S. Deerey Jr., editor (zoology), Osborn Zoological Laboratory, Yale University, New Haven 11, Conn.: 269

Econ J—The Economic Journal. The Quarterly Journal of The Royal Economic Society. 4 issues; vol. 60 started Mr '50 (no. 237); 30*s.* per year; 10*s.* per issue; E. A. G. Robinson and R F. Harrod, editors, Royal Economic Society, Marshall Library, Downing St., Cambridge, England: 88, 143, 191, 210

Economica—Economica. Published by the London School of Economics and Political Science 4 issues; vol. 17 started F '50; 21*s.* per year; 6*s.* per issue; T. S. Ashton and F. A. Hayek, acting editors, London School of Economics and Political Science, Houghton St., Aldwych, London, England: 80, 87, 190, 219, 287, 296, 313, 326, 330, 335

Ed Adm & Sup—Educational Administration and Supervision: Including Teacher Training. 8 issues (omitting Je, Jl, Ag, S); vol. 36 started Ja '50; $4.50 per year; $1 per issue; H. E. Buchholz,

editor, 10 East Centre St., Baltimore 2, Md.: 241, 251

Ed Forum—The Educational Forum. Published by Kappa Delta Pi. 4 issues (N, Ja, Mr, My); vol. 14 started N '49; $3 per year; $1 per issue; E. I. F. Williams, editor, 277 East Perry St., Tiffin 4, Ohio: 132

Ed Res B—Educational Research Bulletin. Published by the Bureau of Educational Research, College of Education, Ohio State University. 9 issues (omitting Je, Jl, Ag); vol. 29 started Ja '50; gratis; R. H. Eckelberry, editor, Ohio State University, Columbus 10, Ohio: 308

El Sch J—The Elementary School Journal: Emphasizing Instruction, Administration, Social Change. Published by the University of Chicago. 9 issues (omitting Je, Jl, Ag); vol. 50 started S '49; $4 50 per year; 60¢ per issue; Ralph W. Tyler, chairman of the editorial committee, University of Chicago, Chicago 37, Ill.: 54

Endeavour—Endeavour: A quarterly Review Designed to Record the Progress of the Sciences in the Service of Mankind. 4 issues; vol. 9 started Ja '50 (no. 35); 5*s.* per issue; E. J. Holmyard, editor, 26 Dover St., London W.1, England: 85

Eug R—The Eugenics Review. Published by the Eugenics Society. 4 issues; vol. 42 started Ap '50; 12*s.* per year; 3*s.* per issue; K. Lane and C. P. Blacker, joint editors, 69 Eccleston Square, London S W.1, England: 116-7, 123, 162, 218-9, 252, 290

Gen Elec R—General Electric Review. 12 issues; vol. 53 started Ja '50; $4 per year; 40¢ per issue; E. C. Sanders, executive editor, General Electric Company, Schenectady 5, N Y.: 98, 165, 257, 265, 274, 280, 318

Harvard Ed R—The Harvard Educational Review. Published for the Graduate School of Education, Harvard University. 4 issues; vol. 20 started winter '50; $4 per year; $1 per issue; Julian C. Stanley, Jr., chairman of the editorial board, Palfrey House, 50 Oxford St., Cambridge 38, Mass.: 213

Incorp Statistician—The Incorporated Statistician: Being the Journal of the Association of Incorporated Statisticians. Issued irregularly; vol. 1 started Jl '50; 5*s.* per issue; 54 New Broad St., London E.C.2, England: 15

Ind & Eng Chem, Anal Ed—Industrial and Engineering Chemistry, Analytical Edition. Title changed to *Analytical Chemistry* (*q.v.*) beginning with vol. 19, no. 1, Ja '47: 280, 306

Ind Qual Control—Industrial Quality Control. Published by the American Society for Quality Control. 6 issues; vol. 7 started Jl '50; $6 per year; available only to libraries at $6 per year and to members; Mason E. Wescott, chairman of the editorial board, Lunt Hall, Northwestern University, Evanston, Ill: 55, 135, 183, 192, 244, 257, 274

Iron & Steel—Iron and Steel: Incorporating "Iron and Steel Industry," "The Iron Foundry," and "The British Foundryman." 14 issues; vol. 23 started Ja '50; 40*s.* per year; 2*s.* 6*d.* per issue; W. E. Benbow, editor, Dorset House, Stamford House, London S.E.1, England: 160

J Abn & Social Psychol—The Journal of Abnormal and Social Psychology. Published by the American Psychological Association, Inc. 4 issues; vol. 45 started Ja '50; $6 per year; $1 75 per issue; J. McV. Hunt, editor, Institute of Welfare Research, Community Service Society, 105 East 22nd St., New York 10, N.Y.; Stanley G. Estes, review editor, Harvard University, Cambridge 38, Mass.: 168, 293

J Am Med Assn—The Journal of the American Medical Association. 52 issues in 3 volumes; vol. 142 started Ja 7 '50; vol. 143 started My 6 '50; vol. 144 started S 2 '50; $12 per year; 35¢ per issue; Austin Smith, editor, 535 North Dearborn St., Chicago 10, Ill: 13, 81, 147, 162-3, 255, 279

J Am Soc Agron—Journal of the American Society of Agronomy. Title changed to *Agronomy Journal* (*q.v.*) beginning with vol. 41 no. 1, Ja '49. 208, 269, 279

J Am Stat Assn—Journal of the American Statistical Association. 4 issues; vol. 45 started Mr '50 (no. 249); $8 per year; W. Allen Wallis, editor, 207 Haskell Hall, University of Chicago, Chicago 37, Ill.: 1-2, 8-10, 14-5, 17, 19-23, 28, 31, 38, 41-2, 47-9, 53-5, 59-62, 64, 67, 69-71, 75, 80-1, 83, 85, 87-8, 91, 93, 95-6, 98-100, 102-3, 106-8, 110, 112, 116-7, 119, 128-9, 132-3, 135, 138, 143-4, 146-7, 149, 154-8, 160, 162, 165, 167-8, 178-9, 182-5, 187-8, 190, 192-3, 195, 197, 199, 203-4, 206, 208, 211, 213-4, 219-20, 223, 225, 227, 233, 241, 243-5, 248, 251, 253, 257-60, 266-7, 270-6, 278-80, 284, 287, 289-90, 203, 295-6, 299, 301-3, 305-6, 308-9, 313, 315-9, 325-9, 331, 334-5, 339-40

J Appl Physics—Journal of Applied Physics. Published by the American Institute of Physics. 12 issues; vol. 21 started Ja '50; $9 per year; Elmer Hutchisson, editor, Case Institute of Technology, Cleveland 6, Ohio: 11, 96, 203, 227, 280

J Appl Psychol—Journal of Applied Psychology. Published by the American Psychological Association, Inc. 6 issues; vol. 34 started F '50; $6 per year; $1 25 per issue; Donald G. Paterson, editor, University of Minnesota, Minneapolis 14, Minn.: 102, 339

J Bus—The Journal of Business of the University of Chicago. 4 issues; vol. 23 started Ja '50; $6 per year; $1.50 per issue; Eli Shapiro, editor, The University of Chicago Press, Chicago 37, Ill.: 54, 75, 100, 103, 129, 135, 165, 211, 233, 244, 280

J Consult Psychol—Journal of Consulting Psychology. Published by the American Psychological Association, Inc. 6 issues; vol. 14 started F '50; $5 per year; $1 per issue; Laurance F. Shaffer, editor, 525 West 120th St, New York 27, N.Y.: 141, 213, 250-1

J Ed (London)—The Journal of Education: A Monthly Record and Review With Which is Incorporated *The School World.* 12 issues; vol. 82 started Ja '50 (no 966); 15*s.* per year; 1*s.* 8*d.* per issue; E. Salter Davies, editor, Amen House, Warwick Square, London E.C.4, England: 52, 203, 291

J Ed Psychol—The Journal of Educational Psychology: Devoted Primarily to the Scientific Problems of Learning and Teaching 8 issues (omitting Je, Jl, Ag, S); vol. 41 started Ja '50; $6 per year; $1.10 per issue; H. E. Buchholz, managing editor, 10 East Centre St, Baltimore 2, Md.: 182, 275, 308

J Ed Res—Journal of Educational Research. 9 issues (omitting Je, Jl, Ag); vol. 44 started S '50; $4 per year; 60¢ per issue; A. S. Barr, chairman of the editorial board, University of Wisconsin, Madison 6, Wis.: 182, 185

J Ed Sociol—The Journal of Educational Sociology: A Magazine of Theory and Practice. 9 issues (omitting Je, Jl, Ag); vol. 24 started S '50; $3 per year; 35¢ per issue; E. George Payne, editor-in-chief, 157 West 13th St., New York 11, N.Y.: 203

J Forestry—Journal of Forestry: A Professional Journal Devoted to All Branches of Forestry. Published by the Society of American Foresters. 12 issues; vol. 48 started Ja '50; $6 per year; 60¢ per issue; Albert G. Hall, editor, Henry Clepper, managing editor, 825 Mills Bldg., 17th St. and Pennsylvania Ave, N.W., Washington 6, D.C.: 46, 51, 136, 269

J Franklin Inst—Journal of the Franklin Institute: Devoted to Science and the Mechanic Arts. Published by the Franklin Institute of the State of Pennsylvania. 12 issues in 2 volumes; vol. 249 started Ja '50; vol. 250 started Jl '50; $8 per year; $1 per issue; Henry Butler Allen, editor, Benjamin Franklin Parkway at 20th St., Philadelphia 3, Pa : 51, 83, 322

J Hered—The Journal of Heredity. Published by the American Genetic Association. 12 issues; vol. 41 started Ja '50; $5 per year; 50¢ per issue; Robert C. Cook, managing editor, 1507 M St., N.W., Washington 5, D C.: 43

J Inst Actuaries—Journal of the Institute of Actuaries. Issued irregularly; vol. 76 started Je '50 (no. 342); 15*s.* per issue; Maurice Edward Ogborn and Harold George Jones, joint editors, Staple Inn Bldgs, Holborn, London W.C.1, England: 23, 85, 162, 187-8, 191, 199, 227, 249, 335

J Inst Actuaries Students' Soc—Journal of the Institute of Actuaries Students' Society. 3 issues (Mr, Jl, N); vol. 9 started Jl '49; 3*s.* per issue; K. A. C. Wheeler and Kennedy Williams, joint editors, Staple Inn Bldgs, Holborn, London W.C.1, England· 85, 165, 195, 287

J Marketing—The Journal of Marketing. Published by the American Marketing Association. 5 issues (Ja, Ap, Jl, S, O); vol. 15 started Jl '50; $4 per year; Ralph Cassady, Jr., editor-in-chief, University of California, Los Angeles 24, Calif.; Charles J. Dirksen, review editor, University of Santa Clara, Santa Clara, Calif.: 110, 120, 182, 209, 257, 277

J Personality—Journal of Personality. Title was *Character and Personality* (*q.v.*) through vol. 13, no. 4, Je '45. 4 issues; vol. 18 started S '49; $2 per year; 50¢ per issue; Karl Zener, editor, Box 6877, College Station, Durham, N C.; George F. J. Lehner, review editor, Dept. of Psychology, University of California, Los Angeles 24, Calif.: 213

J Pol Econ—The Journal of Political Economy. 6 issues; vol. 58 started F '50; $6 per year; $1.50 per issue; Earl J Hamilton, editor, 1126 E. 59th St., Chicago 37, Ill.: 75, 80, 87-8, 108, 154, 190, 276, 311, 326

J Royal Stat Soc, Series A—Journal of the Royal Statistical Society, Series A (General). 4 issues; vol. 113 started pt 1 '50; 61*s.* per year; 15*s.* per issue; 4 Portugal St., London, W.C.2, England: 15, 34, 42, 49, 51, 80, 82, 85, 96, 103, 112, 120, 134-5, 154, 162, 165, 181, 185, 187-8, 190, 195, 219, 223, 227, 238, 244, 247, 252, 264, 266, 278-80, 296, 313, 326, 328, 330, 335

J Scientific Instruments—Journal of Scientific Instruments. Published by Institute of Physics With the Cooperation of the National Physical Laboratory. 12 issues; vol. 27 started Ja '50; 60*s* per year; 6*d.* per issue; H. R. Lang, editor, Institute of Physics, 47 Belgrave Square, London S.W.1, England· 85

J Social Psychol—The Journal of Social Psychology: Political, Racial, and Differential Psychology. 4 issues in 2 volumes; vol 31 started F '50; vol 32 started Ag '50; $14 per year; $4 per issue; Carl Murchison, editor, 2 Commercial St., Provincetown, Mass.: 293

Lancet—The Lancet: A Journal of British and Foreign Medicine, Surgery, Obstetrics, Physiology, Pathology, Pharmacology, Public Health, and News. 52 issues in 2 volumes; vol. 258 started Ja 7 '50 (no. 6593); vol. 259 started Jl 1 '50 (no. 6618); 42*s.* per year; 1*s.* per issue; T. F. Fox, editor, 7 Adam St., Adelphi, London W.C.2, England: 123, 218-9

Math Gazette—The Mathematical Gazette. Published by the Mathematical Association. Usually 5 issues; vol. 34 started F '50 (no. 307); 21*s.* per year; 5*s.* per issue; T. A. A. Broadbent, editor, Royal Naval College, Greenwich, London S.E.10, England: 30, 51-2, 78, 85, 135, 178, 186-8, 193-5, 203, 247, 252, 266, 291, 313, 325-6, 330

Math Mag—Mathematics Magazine. Title was *National Mathematics Magazine* (*q.v.*) through vol. 20, no 2, N '45. 5 issues (omitting Jl-Ag); vol. 24 started S-O '50; $3 per year; 65¢ per issue; Glenn James, managing editor. 14068 Van Nuys Blvd., Pacoima, Calif.. 266

Math R—Mathematical Reviews. Published by the American Mathematical Society. 11 issues (omitting Ag); vol. 11 started Ja '50; $20 per year; J. E. Wehausen, executive editor, Brown University, Providence 12, R I.: 59, 67, 75, 81, 83, 87-8, 93, 103, 123, 129, 143, 168, 185, 187-8, 190, 217, 220, 227, 247, 298-9, 313, 326, 330

Math Tables—Mathematical Tables and Other Aids to Computation. Published by the National Research Council. 4 issues; vol. 4 started Ja '50 (no. 29); $5 per year; $1.50 per issue; D. H Lehmer, chairman of the editorial committee, 942 Hilldale Ave, Berkeley, Calif.: 32, 186

Mech Eng—Mechanical Engineering. Published by the American Society of Mechanical Engineers. 12 issues; vol. 72 started Ja '50; $7 per year; 75¢ per issue; George A. Stetson, editor, 29 West 39th St., New York 18, N.Y.: 96, 128, 135, 182-3, 244, 265, 272, 305

Med J Austral—The Medical Journal of Australia. 52 issues in 2 volumes; 37th year, vol. 1 started Ja 7 '50; 37th year, vol. 2 started Jl 1 '50; 60*s.* per year in British Commonwealth, 90*s.* elsewhere; 2*s.* per issue; Mervyn Archdall, editor, The Printing House, Seamer St., Glebe, New South Wales, Australia: 51, 116

Mental Hyg—Mental Hygiene: Quarterly Magazine of the National Committee for Mental Hygiene, Inc 4 issues; vol. 34 started Ja '50; $5 per year; $1.25 per issue; George S. Stevenson, editor, 1790 Broadway, New York 19, N.Y : 52

Mgmt R—The Management Review. Published by the American Management Association. 12 issues; vol. 39 started Ja '50; $6 per year; 60¢ per issue; M. J. Dooher, editor, 330 West 42nd St, New York 18, N.Y.: 128, 183, 192, 263

Mind—Mind: A Quarterly Review of Psychology and Philosophy. Published for the Mind Association. 4 issues; vol. 59 started Ja '50; 16*s.* per year; 4*s.* 6*d.* per issue; Gilbert Ryle, editor, Magdalen College, Oxford, England: 52

Nat Math Mag—National Mathematics Magazine. Title changed to *Mathematics Magazine* (*q.v.*) beginning with vol. 21, no. 1, S-O '47· 154, 308

Nature—Nature. 52 issues in 2 volumes; vol. 165 started Ja 7 '50 (no. 4184); vol. 166 started Jl 1 '50 (no. 4200); 90*s.* per year; 1*s* 6*d.* per issue; A. J. V. Gale and L J. F. Brimble, joint editors, Macmillan & Co., Ltd., St. Martin's St., London W.C.2, England: 42, 51, 55, 62, 75, 87, 96, 103,

117, 119-20, 123, 135-6, 165, 178, 181, 187-8, 190-1, 195, 203, 210, 219, 238, 247, 252, 256, 269, 280, 296, 313, 326, 330, 335

N Y Times Book R—The New York Times Book Review. 52 issues; vol. 55 started Ja 1 '50; $3 per year; John K. Hutchens, editor, New York Times, Times Square, New York 18, N.Y.: 202

Occupational Psychol—Occupational Psychology. Published by the National Institute of Industrial Psychology. 4 issues; vol. 24 started Ja '50; 20*s.* per year; 5*s.* per issue; Alec Rodger, editor, 14 Welbeck St., London W.1, England: 102

Personnel J—Personnel Journal: The Magazine of Labor Relations and Personnel Practices 11 issues (combined issue Jl-Ag); vol. 29 started My '50; $5 per year; 75¢ per issue; Edward N. Hay, editor, Swarthmore, Pa.: 183

Philos Mag—The Philosophical Magazine: A Journal of Theoretical Experimental and Applied Physics 12 issues; vol. 41 started Ja '50 (no. 312); **102*s.* 6*d.* per year; 10*s.* per issue**; N. F Mott, editor, c/o Messrs. Taylor and Francis, Ltd, Red Lion Court, Fleet St., London E.C.4, England: 85

Plant Breeding Abstracts—Plant Breeding Abstracts. Published by the Commonwealth Bureau of Plant Breeding and Genetics. 4 issues; vol. 20 started Ja '50, 35*s.* per year; 10*s* 6*d.* per issue; P. S. Hudson, director, the Bureau, School of Agriculture, Cambridge, England. 75, 85, 116, 123, 127, 187-8, 208, 219-20, 247, 252, 299, 326

Psychiatry—Psychiatry: Journal for the Study of Interpersonal Processes. Published by the William Alanson White Psychiatric Foundation, Inc. 4 issues; vol. 13 started F '50; $8 per year; $2 per issue; Mabel Blake Cohen, editor, 1711 Rhode Island Ave, Washington 6, D C.: 78

Psychol B—Psychological Bulletin. Published by the American Psychological Association, Inc. 6 issues; vol. 47 started Ja '50; $7 per year; $1.25 per issue; Lyle H. Lanier, editor, University of Illinois, Urbana, Ill.: 51, 102, 132, 168, 204, 206, 251-2, 275, 293

Psychometrika—Psychometrika: A Journal Devoted to the Development of Psychology as a Quantitative Science. Official journal of the Psychometric Society. 4 issues; vol. 15 started Mr '50; $10 per year for current subscriptions (2 copies of each issue); $5 per back volume; $1 25 per back issue (current single issues not sold); Dorothy C. Adkins, managing editor, University of North Carolina, Chapel Hill, N.C.; Clyde H. Coombs, review editor, University of Michigan, Ann Arbor, Mich.: 62, 102, 132, 141, 185, 204, 251, 293, 325

Pub Opinion Q—The Public Opinion Quarterly. 4 issues; vol 14 started Sp '50; $5 per year; $1.50 per issue; W. Phillips Davison, editor, Box 486, Princeton, New Jersey: 339

Pub Personnel R—Public Personnel Review: The Quarterly Journal of the Civil Service Assembly of the United States and Canada 4 issues; vol. 11 started Ja '50; $5 per year; $1.50 per issue; Kenneth O. Warner, editor, 1313 East 60th St., Chicago 37, Ill.: 233

Q R Biol—The Quarterly Review of Biology. 4 issues; vol. 25 started Mr '50; $5 per year; $1.50 per issue; B. H. Willier, editor, Department of Biology, Johns Hopkins University, Baltimore 18, Md: 13, 28, 43, 51-2, 93, 103, 112, 116, 119, 124, 147-8, 165, 185-6, 203-4, 213, 217-9, 248, 250-1, 275, 277, 304, 308, 325, 333

Q Appl Math—Quarterly of Applied Mathematics. 4 issues; vol. 8 started Ap '50; $6 per year; $2 per issue; W. Prager, managing editor, Brown University, Providence 12, R.I.: 190, 220

R Econ & Stat—The Review of Economics and Statistics. Title was *Review of Economic Statistics* (*q.v.*) through vol. 29, no. 4, N '47. 4 issues; vol. 32 started F '50; $6 per year; Seymour E. Harris, editor, 322 Littauer Center, Cambridge 38, Mass.: 49

R Econ Stat—The Review of Economic Statistics. Title changed to *The Review of Economics & Statistics* (*q.v.*) beginning with vol. 30, no. 1, F '48: 87, 143

Res—Research: A Journal of Science and Its Applications. 12 issues; vol. 2 started Ja '50; 45*s.* per year, 3*s.* 6*d.* per issue; H. F. Onley, editor, 436 Strand, London W.C.2, England: 36

R Scientific Instruments—The Review of Scientific Instruments. Published by the American Institute of Physics. 12 issues; vol. 21 started Ja '50; $7 per year; Gaylord P. Harnwell, editor, Randal Morgan Laboratory of Physics, University of Pennsylvania, Philadelphia, Pa.: 51, 91, 93, 96, 98, 165, 318, 334

Rural Sociol—Rural Sociology. Official organ of the Rural Sociological Society. 4 issues; vol. 15 started Mr '50; $3 50 per year; $1 per issue; Howard W. Beers, editor, University of Kentucky, Lexington, Ky.; Otis D. Duncan, review editor, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.: 80, 108, 144, 212, 248

Sankhyā—Sankhyā: The Indian Journal of Statistics. 4 issues; vol 10 started Mr '50 (pts 1-2 combined); Rs. 30 per year; Rs. 10 per issue; P. C. Mahalanobis, editor, Indian Statistical Institute, Presidency College, Calcutta, India: 53, 87, 112, 160, 165, 190, 220, 247, 313

Sch R—The School Review: A Journal of Secondary Education. Published by the University of Chicago. 9 issues (omitting Je, Jl, Ag), vol. 58 started Ja '50; $4.50 per year; 60¢ per issue; Ralph W. Tyler, chairman of the editorial committee, University of Chicago, Chicago 37, Ill.: 168

Sci—Science. Published by the American Association for the Advancement of Science. 52 issues in 2 volumes; vol. 111 started Ja 6 '50 (no. 2871); vol. 112 started Jl 7 '50 (no 2897); $7.50 per year; 25¢ per issue; Beth Wilson, executive editor, 1515 Massachusetts Ave., N W., Washington 5, D.C.: 28, 31, 51, 67, 75, 78, 82, 85, 112, 123, 165, 167-8, 185, 187, 219-20, 251, 256, 277, 279-80, 293, 306

Sci Ed—Science Education. The official organ of the National Association for Research in Science Teaching, the National Council on Elementary Science, the Association of Science Teachers of the Middle States 5 issues (F, Mr, Ap, O, D); vol. 34 started F '50; $4 per year; $1 per issue; Clarence M. Pruitt, editor, Oklahoma Agricultural and Mechanical College, Stillwater, Okla.: 241

Sci Progress—Science Progress: A Quarterly Review of Scientific Thought, Work & Affairs. 4 issues; vol. 38 started Ja '50 (no. 149); 31*s.* per year; 7*s.* 10*d* per issue; editors: F. P. Dunn, E. J. Salisbury, and D. O. Wood; 41 Maddox St., London W.1, England: 85, 103, 117, 178, 306, 335 [Reviews in *Science Progress* are indexed but not excerpted because of copyright restrictions.]

Scientific Agric—Scientific Agriculture. Edited by the Agricultural Institute of Canada. 12 issues;

vol. 30 started Ja '50; $3 per year; C. Gordon O'Brien, managing editor, 338 Somerset St., West., Ottawa, Canada: 51

Scottish Ed J—The Scottish Educational Journal. The Official Organ of the Educational Institute of Scotland. 52 issues; vol. 33 started Ja 6 '50; 2*d.* per issue; The Editors, 47 Moray Place, Edinburgh, Scotland: 291

Social Forces—Social Forces: A Scientific Medium of Social Study and Interpretation. 4 issues (O, D, Mr, My); vol. 28 started O '49; $5 per year; $1.50 per issue; Howard W Odum, editor, Katharine Jocher, managing editor, University of North Carolina, Chapel Hill, N.C.: 87, 108, 165, 168, 185, 212, 330, 339

Social Service R—The Social Service Review: A Quarterly Devoted to the Scientific and Professional Interests of Social Work. Published by the University of Chicago. 4 issues; vol. 24 started Mr '50; $6 per year; $1.75 per issue; Edith Abbott, editor, University of Chicago, Chicago 37, Ill.: 47, 54, 147

Sociol & Social Res—Sociology and Social Research: An International Journal. 6 issues; vol. 35 started S-O '50; $3 50 per year; 70¢ per issue; Emory S. Bogardus, editor, 3551 University Ave., Los Angeles 7, Calif.: 212, 339

Sociol R—The Sociological Review. Journal of the Institute of Sociology. 12 or more issues; vol. 42 started with section 1 '50; 21*s.* per year; 1*s.* or more per issue; Le Play House Press, Ledbury, Herefordshire, England: 78

South Econ J—The Southern Economic Journal. A Joint Publication of the Southern Economic Association and the University of North Carolina. 4 issues; vol. 16 started Jl '49; $4 per year; $1.25 per issue; G. T. Schwenning, managing editor, P.O. Box 1289, Chapel Hill, N.C.: 31, 47, 87, 93, 108, 149, 203, 212, 225, 233, 272

Southw Social Sci Q—The Southwestern Social Science Quarterly. Official Organ of the Southwestern Social Science Association. 4 issues; vol. 31 started Je '50; $4 per year; Oliver Benson, editor-in-chief, University of Oklahoma, Norman, Okla.; H. Malcolm Macdonald, review editor, University of Texas, Austin, Tex.: 241

Times Ed Sup—The Times Educational Supplement. 52 issues; 41st year started S 2 '50 (no. 1844); 19*s.* 6*d.* per year; 3*d.* per issue; The Editor, The Times Publishing Co., Ltd., Printing House Square, Parish of St. Ann, Blackfriars, London E.C.4, England: 85, 284

Trans Actuarial Soc Am—Transactions of the Actuarial Society of America. 3 issues (parts 1, 2, sup.); vol. 49 ended O '48 (no. 121); replaced by *Transactions of the Society of Actuaries* (vol. 1 started fall '49; Society of Actuaries, 208 South La Salle St., Chicago 4, Ill.: 24, 93, 154, 165, 195, 247, 287, 326

Trans Faraday Soc—Transactions of the Faraday Society. 12 issues; vol. 46 started Ja '50; 5*s.* per issue; F. C. Tompkins, editor, 6 Gray's Inn Square, London W.C.1, England: 85

PUBLISHERS DIRECTORY AND INDEX

NUMBERS REFER TO THE NUMBERED BOOK ENTRIES

Accountants Publishing Co., Ltd., 37 Queen St., Melbourne Victoria, Australia: 125
Agricultural Chemicals Division, American Cyanamid Co., 30 Rockefeller Plaza, New York 20, N.Y.: 323-4
Agricultural Experiment Station, Iowa State College of Agriculture and Mechanic Arts, Ames, Iowa: 24, 65-6, 74, 169, 171-2, 180, 205
Agricultural Experiment Station, Michigan State College, East Lansing, Mich.: 89
Agricultural Experiment Station, North Carolina State College, Raleigh, N.C.: 111, 159, 261
Agricultural Experiment Station, University of Connecticut, Storrs, Conn.: 33
Agricultural Experiment Station, University of Puerto Rico, Río Piedras, Puerto Rico: 208
Alabama Polytechnic Institute. *See* Statistical Laboratory, Alabama Polytechnic Institute.
Albritton, Errett C., George Washington University, Washington 6, D.C.: 12-4
Allen, George & Unwin Ltd., Ruskin House, 40 Museum St., London W.C.1, England: 82, 167
Almqvist & Wiksells, Box 47, Uppsala, Sweden: 75, 216
American Cyanamid Co. *See* Agricultural Chemicals Division, American Cyanamid Co.
American Management Association, 330 West 42nd St., New York 18, N.Y.: 35
American Museum of Natural History, Columbus Ave. & 77th St., New York 24, N.Y.: 57
American P[illegible] Association, 1515 Massachusetts Ave., N.W., Washington 5, D.C.: 137
American Society for Quality Control, c/o Alfred L. Davis, Treas., 65 Plymouth Ave., South, Rochester 8, N.Y.: 16-7
American Society for Testing Materials, 1916 Race St., Philadelphia 3, Pa.: 18-9, 97
American Society of Mechanical Engineers, 29 West 39th St., New York 18, N.Y.: 20
American Standards Association, Inc, 70 East 45th St., New York 17, N. Y: 21-2, 38-9, 98
American Statistical Association, 1603 K St., N.W., Washington 6, D.C.: 1
Anderson, Paul, Co., 125 Broadway, San Antonio 5, Tex.: 223
Arco Publishing Co., Inc., 480 Lexington Ave., New York 17, N. Y.: 25, 230-1

Barnes & Noble, Inc., 105 Fifth Ave., New York 3, N.Y.: 26
Biometrika Office, University College, Gower St., London W.C.1, England: 113-4, 224, 246, 288-9
Black, A. & C., Ltd., 4-6 Soho Square, London W.1, England: 104
Blackwell, Basil, & Mott, Ltd, 49 Broad St., Oxford, England. 284-5
Bookshop, 114 East Washington St., Iowa City, Iowa: 204
British Book Centre, 122 East 55th St., New York 22 N.Y.: 34
British Information Services, 30 Rockefeller Plaza, New York 20, N.Y.: 130, 271
British Standards Institution, 28 Victoria St., London S.W.1, England: 38-9, 98
Brown, Wm. C, Co., 915 Main St., Dubuque, Iowa: 145
Bruce Publishing Co., 540 North Milwaukee St., Milwaukee 1, Wis. 54
Bureau of Agricultural Economics, United States Department of Agriculture, Washington 25, D.C.: 300
Bureau of Business Research, College of Business Administration, University of Texas, Austin 12, Tex.: 40
Bureau of Business Research, College of Commerce and Administration, Ohio State University, Columbus 10, Ohio: 273
Bureau of Transport Economics and Statistics, Interstate Commerce Commission, Washington 25, D. C.: 170
Burgess Publishing Co., 426 South Sixth St., Minneapolis 15, Minn.: 174, 298-9

California Book Co., Ltd., Berkeley, Calif.: 177
Cambridge University Press, Bentley House, 200 Euston Road, London N.W.1, England: 23, 56, 83, 112, 168, 181, 190, 238, 247, 249, 256, 287, 293, 313-4, 327, 329. Cambridge University Press, 51 Madison Ave., New York 10, N.Y.: 23, 83, 112, 181, 190, 247, 249, 287, 313-4, 329
Catholic University of America Press, 620 Michigan Ave., N.E., Washington 17, D.C.: 29, 239
Chand, S., & Co., Lahore, India: 232
Chanticleer Press, 41 East 50th St., New York 22, N.Y.: 166
Chapman & Hall, Ltd., 37-39 Essex St., Strand, London W.C.2, England: 27-8, 67, 84, 92-3, 96, 105-6, 108-9, 115, 128, 165, 201, 213, 248, 257, 268, 272, 306-7, 322, 334
Chartwell House, Inc., 280 Madison Ave., New York 16, N.Y.: 250
Chelsea Publishing Co., 231 West 29th St., New York 1, N.Y.: 200, 297
Chemical Publishing Co, Inc., 26 Court St., Brooklyn 2, N.Y.: 43-5
Codex Book Co., Inc., 74 Broadway, Norwood, Mass.: 315
College Book Co., 1836 North High St., Columbus 1, Ohio: 316
Collegiate Press, Inc., Ames, Iowa: 279

Columbia University Press, 2960 Broadway, New York 27, N.Y.: 280
Connecticut Agricultural Experiment Station, New Haven, Conn.: 32
Council for Scientific and Industrial Research, Commonwealth of Australia, 314 Albert St., East, East Melbourne C.2, Victoria, Australia: 70-1, 253
Crowell, Thomas Y., Co., 432 Fourth Ave, New York 16, N.Y.: 154-5

Department of Educational Research, Ontario College of Education, University of Toronto, 371 Bloor St., West, Toronto 5, Ontario, Canada: 176
Department of Mathematics, Notre Dame University, Notre Dame, Ind.: 305
Division of Educational Research, Purdue University, Lafayette, Ind.: 131
Dover Publications, Inc., 1780 Broadway, New York 19, N.Y.: 217-8
Duke University. *See* School of Forestry, Duke University.

Econometric Society, University of Chicago, Chicago 37, Ill.: 143
Edwards Brothers, Inc., 300 John St, Ann Arbor, Mich.: 304
Edwards & Broughton Co., Raleigh, N.C.: 244
Emmott & Co. Ltd., 31 King St., W., Manchester 3, England: 283
Explosives Factories, Munitions Division, Department of Supply and Development, Commonwealth of Australia, 339 Swanston St., Melbourne C. 1, Victoria, Australia: 309

Federal Products Corp., 1144 Eddy St, Providence 1, R I.: 2
Forest Research Institute, Dehra Dun, India: 136
Freshwater Biological Association, Wray Castle, Ambleside, Westmorland, England: 48
Funk & Wagnalls Co., 153 East 24th St., New York 10, N.Y.: 209, 263

Gads, G. E. C, Copenhagen, Denmark: 146
Gee & Co. (Publishers) Ltd., 27-28 Basinghall St, London E.C.2, England: 53, 215, 240
General Electric Co., Ltd of England, Magnet House, Kingsway, London W C.2, England: 99
Ginn and Co., Statler Building., Boston 17, Mass.: 266
Ginn & Co., Ltd., 7 Queen Square, Southampton Row, London W.C.1, England · 266
Government Printing Office, Washington 25, D.C : 9, 37, 49, 152, 179, 197, 332-3
Graduate School, United States Department of Agriculture, Washington 25, D.C.: 30, 91
Graduate School of Engineering, c/o Natalie Nicholson, Pierce Hall, Harvard University, Cambridge 38, Mass.: 303
Greenwood, J. Arthur, 25 Winthrop St., Brooklyn 25, N.Y.: 59
Griffin, Charles, & Co. Ltd., 42 Drury Lane, London W.C 2, England: 134, 187-9, 191, 335-7
Gryphon Press, 200 Montgomery St., Highland Park, N.J.: 50-1, 99, 318-9

H. F. L. (Publishers) Ltd., 29 Mincing Lane, London E.C.3, England: 34, 229
Hafner Publishing Co., Inc., 31 East Tenth St., New York 3, N.Y.: 86, 118, 134, 335, 337
Harcourt, Brace and Co., 383 Madison Ave., New York 17, N.Y.: 258
Harper & Brothers, 49 East 33rd St., New York 16, N.Y.: 183, 242, 251, 282, 339-41
Harrap, George G., & Co. Ltd., 182 High Holborn, London W.C 1, England: 206
Harvard University Press, 38 Quincey St., Cambridge 38, Mass · 68-9, 185-6, 327
Heath, D. C., & Co., 285 Columbus Ave., Boston 16, Mass.: 281
His Majesty's Stationery Office, Adastral House, Kingsway, London W.C.2, England: 42-5, 130, 271
Hoeber, Paul B, Inc., 49 East 33rd St., New York 16, N.Y.: 147-8
Henry Holt and Co., Inc., 257 Fourth Ave., New York 10, N.Y.: 31, 90, 144, 236, 308
Houghton Mifflin Co., 2 Park St., Boston 7, Mass.: 206, 290, 292
Hunter Pressed Steel Co., Lansdale, Pa.: 64
Hutchinson's University Library, Hutchinson & Co. (Publishers) Ltd., 11 Stratford Place, London W. 1, England: 15

Indiana University Bookstore, Bloomington, Ind.: 259
Industrial Press, 148 Lafayette St., New York 13, N. Y.: 107
Inter American Statistical Institute, c/o Halbert L. Dunn, Sec. Gen., National Office of Vital Statistics, Washington 25, D.C : 175
Interscience Publishers, Inc, 215 Fourth Ave., New York 3, N.Y.: 11, 81-2, 220
Interscience Publishers Ltd., 2a Southampton Row, London W.C.1, England. 81
Interstate Commerce Commission. *See* Bureau of Transport Economics and Statistics, Interstate Commerce Commission.
Iowa State College of Agriculture and Mechanic Arts. *See* Agricultural Experiment Station, Iowa State College of Agriculture and Mechanic Arts.
Iron and Steel Industrial Research Council, British Iron and Steel Federation, London, England: 295
Irwin, Richard D, Inc., 3201 South Michigan Ave., Chicago 16, Ill.: 47, 150-1

Journal of Clinical Psychology, Brandon, Vt.: 342

Karger, S., Basle, Switzerland: 81
Kerrich, J. E., University of Witwatersrand, Johannesburg, South Africa: 195

Lancet Ltd, 7 Adams St., Adelphi, London W.C.2, England: 161-3
Lifetime Editions, Inc, 425-435 East 24th St., New York 10, N.Y.: 184
Longmans, Green & Co., 55 Fifth Ave., New York 3, N.Y.: 15, 132, 156, 301
Longmans, Green & Co. Ltd., West End, 6-7 Clifford St., London W.1, England: 132, 156

MacDonald & Evans, 8 John St, Bedford Row, London W.C.1, England · 321
McGraw-Hill Book Co., Inc., 333 West 42nd St., New York 18, N Y.: 46, 80, 100, 103, 110, 129, 135, 138-9, 212, 228, 252, 255, 274, 276-8 311-2
McGraw-Hill Publishing Co. Ltd., Aldwych House, London W C.2, England: 46, 80, 100, 103, 110, 129, 135, 138-9, 212, 228, 252, 255, 274, 276-8, 311-2
Machinery Publishing Co., Ltd, National House, West St., Brighton 1, Sussex, England: 107
Macmillan & Co. Ltd., 10 St. Martin's St., Leicester Square, London W.C.2, England: 62, 193-4, 227, 233, 330
Macmillan Co., 60 Fifth Ave., New York 11, N.Y.: 52, 62, 233-5
Macmillan Co. of Canada Ltd., St. Martin's House, 70 Bond St., Toronto 2, Canada: 330
Maverick, Lewis A., Carbondale, Ill.: 222

Mayflower Publishing Co., Ltd., 17 Farringdon St., London E C 4, England: 209
Methuen & Co. Ltd., 36 Essex St., London W.C. 2, England. 218-20
Michigan State College. *See* Agricultural Experiment Station, Michigan State College.
Ministry of Supply, London, England: 41

National Bureau of Economic Research, Inc, 1819 Broadway, New York 23, N.Y.: 310
National Research Council of Canada, Sussex St., Ottawa, Canada · 214
Nelson, Thomas, & Sons Ltd, 3 Henrietta St., London W C 2, England: 160, 203
New York Academy of Sciences, Central Park West & 79th St., New York 24, N.Y : 5
New York State College of Forestry, Syracuse University, Syracuse, N.Y.: 127
Nijhoff, Martinus, Lange Voorhout 9, The Hague, Netherlands: 58
Noordhoff, P., Ltd., 12 Oude Boteringestraat, Groningen, Holland: 302
North Carolina State College. *See* Agricultural Experiment Station, North Carolina State College
Norton, W W., & Co., Inc, 101 Fifth Ave, New York 3, N Y. · 167

Ohio State University. *See* Bureau of Business Research, College of Commerce and Administration, Ohio State University
Ohio Water Resources Board, State of Ohio, Columbus, Ohio: 142
Oliver & Boyd Ltd., Tweeddale Court, Edinburgh 1, Scotland · 11, 85-6, 116-24, 210-1
Oxford University Press, Amen House, Warwick Square, London E.C.4, England: 68-9, 75, 178, 185-6, 199, 280, 296, 325-6, 331. Oxford University Press, 114 Fifth Ave, New York 11, N Y.: 178, 199, 296

Parrish, Max, & Co, Ltd., Adprint House, 51a Rathbone Place, London W 1, England · 166
Philips Lamps Ltd, Century House, Shaftesbury Ave, London W.C 2, England · 318-9
Phillips, L B, Co, Raleigh, N C.: 243
Pictograph Corp, 142 Lexington Ave., New York 16, N.Y.: 3-4
Pitman, Sir Isaac, & Sons Ltd, Pitman House, Parker St., Kingsway, London W.C.2, England: 63, 78, 260, 264-5
Pitman Publishing Corp., 2 West 45th St, New York 19, N Y.: 260, 265
Prakash Brothers, Agra, India: 60
Prentice-Hall, Inc., 70 Fifth Ave., New York 11, N.Y. · 72, 76-9, 182, 192, 225-6, 241
Princeton University Press, Princeton, N J.: 75, 325-6
Principia Press, Inc., Bloomington, Ind.: 87-8
Purdue University. *See* Division of Education Research, Purdue University.

Quality Control Panel, Birmingham Production Committee, Ministry of Production, C. M. L. Buildings, Great Charles St, Birmingham 3, England: 8

Reinhold Publishing Corp., 330 West 42nd St, New York 18, N.Y.. 268
Rinehart & Co., Inc., 232 Madison Ave., New York 16, N.Y.: 101-2, 202, 275
Ronald Press Co., 15 East 26th St., New York 10, N Y : 133, 149, 203

Saunders, W. B., Co., 7 Grape St., Shaftesbury Ave., London W.C.2, England: 245
Saunders, W. B, Co., 218 West Washington Square, Philadelphia 5, Pa.: 245
School of Forestry, Duke University, Durham, N.C.: 269-70
Science Research Associates, Inc., 228 South Wabash Ave., Chicago 4, Ill.: 7, 157
Sheridan Supply Co., P.O. Box 837, Beverly Hills, Calif.: 140-1
Society of Actuaries, 208 South LaSalle St., Chicago 4, Ill.: 330
Stanford University Press, Stanford, Calif.: 331
Statistical Laboratory, Alabama Polytechnic Institute, Auburn, Ala.: 6
Syracuse University. *See* New York State College of Forestry, Syracuse University.

Taraporevala, D. B., Sons & Co., Ltd., 210 Hornby Road, Bombay, India: 286
Time Study Engineer, Great Peter House, Great Peter St., London S W.1, England: 320

United States Department of Agriculture. *See* Bureau of Agricultural Economics, United States Department of Agriculture; and Graduate School, United States Department of Agriculture.
University of California Press, Berkeley, Calif.: 61, 126, 164, 173, 207, 221, 237-8, 254, 256, 262
University of Chicago Press, 5750 Ellis Ave., Chicago 37, Ill.: 56, 168, 293
University of Connecticut. *See* Agricultural Experiment Station, University of Connecticut.
University of London Press Ltd., Little Paul's House, Warwick Square, London E C 4, England: 52, 290-2
University of Oregon Cooperative Store, Eugene, Ore.: 94
University of Puerto Rico. *See* Agricultural Experiment Station, University of Puerto Rico.
University of Texas *See* Bureau of Business Research, College of Business Administration, University of Texas.
University of Texas Press, Austin 12, Tex.: 95
University of Toronto Press, Toronto 5, Ontario, Canada: 317
University of Washington Press, Seattle 5, Wash.: 55
U S. Naval Institute, Annapolis, Md. · 10

Van Nostrand, D., Co., 250 Fourth Ave., New York 3, N.Y. · 193-4, 227
Virginia Agricultural Experiment Station, Blacksburg, Va : 73, 153, 158
Vora & Co., Publishers Ltd, 8 Round Bldg., Kalbedini Road, Bombay 2, India: 196

Wiley, John, & Sons, Inc., 440 Fourth Ave., New York 16, N.Y.: 27-8, 67, 84, 92-3, 96, 105, 108-9, 115, 128, 165, 201, 213, 248, 257, 272, 306-7, 322, 334
Williams and Norgate, Ltd., 36 Great Russell St., London W.C.1, England · 87-8, 294
Wintner, Aurel, Rowland Hall, Charles & 34th Sts., Baltimore, Md.: 328
Wool Industries Research Association, Torridon, Headingley, Leeds, 6, England: 36
World Book Co., 313 Park Hill Ave., Yonkers 5, N. Y.: 267

Zarchin, Michael M., 295 Urbano Drive, San Francisco, Calif.: 338
Zoological Society of San Diego, San Diego, Calif.: 198

INDEX OF TITLES

NUMBERS REFER TO THE NUMBERED BOOK ENTRIES

A.S.T.M. Manual on Presentation of Data: Including Supplement A, Presenting ± Limits of Uncertainty of an Observed Average; Supplement B, "Control Chart" Method of Analysis and Presentation of Data; and Tables of Squares and Square Roots, 19
Abstracts of Papers: Third Annual Convention in Conjunction With the Third New England Quality Control Conference, Copley Plaza Hotel, Boston, Massachusetts, May 5 and 6, 1949, 16
Acceptance Sampling: A Series of Papers and Discussion on the Subject of Acceptance Sampling Delivered at the Annual Meeting of the American Statistical Association at Cleveland, Ohio, on January 27, 1946, 1
Actuarial Statistics: Vol. I, Statistics and Graduation, 287
Actuarial Statistics: Vol. II, Construction of Mortality and Other Tables, 23
Administrative and Statistical Techniques of Quality Control, 35
Advanced Theory of Statistics, Vols. I and II, 187-9
Analysis and Design of Experiments: Analysis of Variance and Analysis of Variance Designs, 217
Analysis of Cubic Lattice Designs in Varietal Trials, 253
Analysis of Economic Time Series, 87
Analysis of Lattice and Triple Lattice Experiments in Corn Varietal Tests, 74
Applied General Statistics, 78
Applied Statistics: A Series of Lectures Given in the Graduate School of the University of Minnesota, 174
Assistant Statistical Clerk, 230

Bibliography of Selected Statistical Sources of the American Nations: A Guide to the Principal Statistical Materials of the 22 American Nations, Including Data, Analyses, Methodology, and Laws and Organization of Statistical Agencies, 175
Bibliography of Statistical Quality Control, 55
Biometrical Genetics: The Study of Continuous Variation, 218
Bureau of the Census Manual of Tabular Presentation: An Outline of Theory and Practice in the Presentation of Statistical Data in Tables for Publication, 179
Business Charts: A Clear Explanation of the Various Types of Charts Used in Business, and of the Principles Governing the Correct Presentation of Facts by Graphical Margins, Fourth Edition, 264
Business Statistics (Brumbaugh-Kellogg), 47
Business Statistics, Second Edition (Davies-Yoder), 84
Business Statistics and Statistical Method, Third Edition, 321

Chance and Choice by Cardpack and Chessboard: An Introduction to Probability in Practice by Visual Aids, Vol. I, 166
Chapter in Population Sampling, 49
Charting the Course of Your Business, 263
Choice of Inspection Stringency in Acceptance Sampling by Attributes, 164
Comparative Study of the Wherry-Doolittle and a Multiple Cutting-Score Method, 137
Concise Manual of Statistics: With Special Reference to the Requirements of Students for Municipal Examinations, Second Edition, 53
Conference Papers: First Annual Convention, American Society for Quality Control and Second Midwest Quality Control Conference, Hotel Sherman, Chicago, Illinois, Thursday-Friday, June 5 and 6, 1947, 17
Construction of Mortality and Other Tables: Actuarial Statistics, Vol. II, 23
Construction of Mortality and Sickness Tables: A Primer, Fourth Edition, 104
Contributions to Mathematical Statistics, 115
Contributions to the Study of Oscillatory Time-Series, 190
Control Chart Method of Controlling Quality During Production, 21
Control Charts: An Introduction to Statistical Quality Control, 274
Control Charts in Factory Management, 257
Correlation Analysis, 298
Culture Element Distributions: XXV, Reliability of Statistical Procedures and Results, 61
Curve Fitting for Students of Economics, 232

Decomposition of a Series of Observations Composed of a Trend, a Periodic Movement, and a Stochastic Variable, 146
Descriptive and Sampling Statistics, 251
Design and Statistical Analysis of Some Confounded Factorial Experiments, 205
Design of Experiments, Third, Fourth, and Fifth Editions, 116-8

Early Statistical Papers, 249
Economic and Social Statistics, 221
Economic Statistics, Revised Edition, 222
Effect of Time of Application and Levels of Nitrogen, Phosphorus and Potash on the Growth of

Sugar Beets With a Detailed Statistical Procedure of Confounding in a 3×3×3 Design, 89
Elementary Social Statistics, 212
Elementary Statistical Analysis, 325
Elementary Statistical Exercises, 140
Elementary Statistical Methods, 308
Elementary Statistical Methods: As Applied to Business and Economic Data, 233
Elementary Statistics, 203
Elementary Statistics and Applications: Fundamentals of the Theory of Statistics, Vol. I, 276, 278
Elementary Statistics for Students of Education and Psychology, 301
Elementary Statistics: With General Applications, 31
Elements of Mathematical Statistics, 59
Elements of Statistical Inference, 177
Elements of Statistical Method, Second Edition, 311
Elements of Statistics, 225
Elimination of the Effects of Accidental Errors of Measurements in Statistical Investigations, 216
Engineering and Scientific Graphs for Publication, 20
Engineering Statistics: Basic Ideas on the Subject as It Is Applied in Production Control and Standardisation, 283
Engineers' Manual of Statistical Methods, 272
Estimation of the Mean and Its Error From Incomplete Poisson Distributions, 32
Estimation of the Variance of the Bivariate Normal Distribution, 173
Exact Formulas in the Sequential Analysis of Attributes, 254
Examination of Industrial Measurements, 100
Examination of the Accuracy of Lattice and Lattice Square Experiments on Corn, 65
Experiment Design and Judgment of Evidence, First, Second, and Third Editions, 12-4
Experimental Design in Psychological Research, 101
Experimental Designs, 67
Experimental Introduction to the Theory of Probability, 195
Experimental Methods in Agricultural Research, 208
Expressing Educational Measures as Percentile Ranks, 50
Extension Course in Statistical Quality Control, 317
Extrapolation, Interpolation, and Smoothing of Stationary Time Series: With Engineering Applications, 322

Facsimiles of Two Papers by Bayes: (i) An Essay Toward Solving a Problem in the Doctrine of Chances, With Richard Price's Foreword and Discussion; Phil. Trans. Royal Soc. pp. 370-418, 1763; With a Commentary by Edward C. Molina; (ii) A Letter on Asymptotic Series from Bayes to John Canton; pp. 269-271 of the Same Volume; With a Commentary by W. Edwards Deming, 30
Factor Analysis: A Synthesis of Factorial Methods, 168
Factorial Analysis of Human Ability, Second, Third, and Fourth Editions, 290-2
Factorial Differentiation by Maximal Differences, 239
Factors of Mind: An Introduction to Factor-Analysis in Psychology, 52
Federal Dimensional Quality Control Primer: A Simplified Method for Applying Quality Control to Dimensions, Revised Edition, 2
First Course in Mathematical Statistics, First and Second Editions, 313-4
First Course in Probability and Statistics, 236
First Course in Statistics: Their Use and Interpretation in Education and Psychology, Revised Edition, 206
First Guide to Quality Control for Engineers, 271
Forest Mensuration, Second Edition, 46
Foundations of the Theory of Probability, 200
Four Papers on the Applications of Statistical Methods to Herpetological Problems, 198
Fourier Transforms of Probability Distributions, 328
Fraction-Defective for Quality Control, 38
Fundamental Principles of Mathematical Statistics: With Special Reference to the Requirements of Actuaries and Vital Statisticians and an Outline of a Course in Graduation, 330
Fundamental Statistics in Psychology and Education, First and Second Editions, 138-9
Fundamentals of Statistics (Kelley), 185
Fundamentals of Statistics (Scarborough-Yoder), 266
Fundamentals of the Theory of Statistics, Vols. 1 and 2, 276-8

Gamma and Beta Functions: Notes and Problems Designed for Use in Mathematical Statistics and Mathematical Physics, 91
Gantt Chart, Revised Edition, 63
Graphic Presentation Simplified, 209
Ground of Induction, 327
Guide for Quality Control and Control Chart Method for Analyzing Data, 22
Guide to Utilization of the Binomial and Poisson Distributions in Industrial Quality Control, 331

Handbook of Tabular Presentation: How to Design and Edit Statistical Tables: A Style Manual and Case Book, 149
Hints on the Study of Elementary Statistics, 240
History of the Mathematical Theory of Probability: From the Time of Pascal to That of Laplace, 297
How to Chart: Facts From Figures With Graphs, 315
How to Read Statistics, 54

Industrial Experimentation, First, Revised, Second, Third, and Fourth Editions, 41-5
Industrial Statistics: Statistical Techniques Applied to Problems in Industrial Research and Quality Control, 128
Introduction to Business Statistics, Second Edition, 281
Introduction to Educational Statistics, 241
Introduction to Index Numbers, 229
Introduction to Industrial Statistics and Quality Control, First and Second Editions, 243-4
Introduction to Managerial Business Statistics, 154
Introduction to Mathematical Genetics, 167
Introduction to Mathematical Statistics (Hoel), 165
Introduction to Mathematical Statistics, Revised Edition (West), 316
Introduction to Medical Biometry and Statistics, Third Edition, 245
Introduction to Probability Theory and Its Applications, Vol. I, 109
Introduction to Quantitative Systematics, 57
Introduction to Statistical Analysis (Dixon-Massey), 94
Introduction to Statistical Analysis, Third Edition (Richardson), 258
Introduction to Statistics, Revised Edition, 304
Introduction to the Theory of Probability and Statistics, 28
Introduction to the Theory of Statistics (Mood), 228
Introduction to the Theory of Statistics, Thirteenth and Fourteenth Editions (Yule-Kendall), 336-7
Investigations in Plot Technique With Peanuts, 261

Junior Statistician (Junior Professional Assistant Examination), 231

Kelley Statistical Tables, Revised 1948, 186

Laboratory Manual and Problems for Elements of Statistical Method, Second Edition, 312
Laboratory Manual for Elementary Statistical Methods, First and Second Editions, 234-5
Lecture Notes on Mathematical Theory of Probability and Statistics, 303
Lectures on Probability and Statistics, 95
Lectures on Statistical Methods of Inspecting and Controlling Quality: Delivered During a Course of Instruction Arranged by the Department of Munitions for Members of the Technical Staff: Held at the University of Melbourne, August, 1944, 309
Logical Foundations of Probability, 56

Machine Computation of Elementary Statistics: With Special Reference to the Friden, Marchant, and Monroe Calculating Machines, 250
Management of Inspection and Quality Control, 183
Manual of Problems in Statistics, 90
Mathematical Bases of Experimental Sampling for Estimation of Size of Certain Biological Populations, 73
Mathematical Methods for Population Genetics, 81
Mathematical Methods of Statistics, 75
Mathematical Statistics (Chaturvedi), 60
Mathematical Statistics (Wilks), 326
Mathematical Treatment of the Results of Agricultural and Other Experiments, Second Edition, 302
Mathematics of Sampling, 158
Mathematics of Statistics, Parts One (Second Edition) and Two, 193-4
Mean Value and Correlation Problems Connected With the Motion of Small Particles Suspended in a Turbulent Fluid, 58
Memorandum on Sampling Clauses in Specifications for Manufactured Articles, 39
Methods in Climatology, First and Second Editions, 68-9
Methods of Biological Assay Depending on a Quantal Response: Reports on Biological Standards, III, 130
Methods of Computing a Regression of Yield on Weather, 171
Methods of Correlation Analysis, Second Edition, 108
Methods of Estimating Farm Employment From Sample Data in North Carolina, 111
Methods of Estimating Vital Statistics of Fish Populations, 259
Methods of Statistics: An Introduction Mainly for Experimentalists, Third Edition, 294
Multiple-Factor Analysis: A Development and Expansion of *The Vectors of Mind*, 293

New Tables of Statistical Variables: (1) The Percentage Points of the Inverted Beta (F) Distribution, (2) The Probability Integral of the "Studentized" Range in Samples From a Normal Population, (3) The Percentage Points of the "Studentized" Range, 224
New Tables of Statistical Variables: (1) The Probability Integral of the Range in Samples From a Normal Population, (2) The Percentage Points of the Range, (3) The Percentage Points of the t Distribution, 246
Note on Exact Sequential Analysis, 262
Notes on Precision of Sample Estimates: Technical Notes on the Formulas Used to Evaluate the Precision of Data, 152

Objective Method of Sampling Wheat Fields to Estimate Production and Quality of Wheat, 197
1000 Pictorial Symbols, 3
On Sets of Probability Laws and Their Limit Elements, 207
On the Principles of Statistical Inference: Four Lectures Delivered at the University of Notre Dame, February 1941, 305
On the Problem of Estimating the Number of Schools of Fish, 237
On the Statistical Treatment of the Results of Parallel Trials With Special Reference to Fishery Research, 48
On the Theory of Stochastic Processes and Their Application to the Theory of Cosmic Radiation, 27
Opportunities for Statistical Workers, Revised Edition, 157
Outline of Statistical Methods for Use in the Textile Industry, 36
Outline of Statistics, Third Edition, 156
Outlook for Women in Mathematics and Statistics, 37

Pictorial Symbols, Second Edition, 4
Place of Statistical Methods in Biological and Chemical Experimentation, 5
Poisson's Exponential Binomial Limit, 227
Power Functions and the Distribution Functions Related to "Student's" Test, 29
Practical Business Statistics, Second Edition, 79
Practical Problems in Business Statistics, 72
Practical Rules for Graphic Presentation of Business Statistics, 273
Practical Statistics, Second Edition, 215
Practical Statistics in Health and Medical Work, 255
Prediction Efficiencies by Deciles for Various Degrees of Relationship, 176
Prediction of Categories From Measurements: With Applications to Personnel Selection and Clinical Prognosis, 141
Pre-Harvest Sampling of Soybeans for Yield and Quality, 172
Prentice-Hall Mathematical Tables Chiefly to Four Significant Figures: To Accompany the Elements of Statistics by Elmer B. Mode, 226
Preparation of Statistical Tables: A Handbook, Slightly Revised, 300
Principles of Biological Assay, 106
Principles of Counting and Probability, 10
Principles of Medical Statistics, Third, Fourth, and Fifth Editions, 161-3
Principles of Punch-Card Machine Operation: How to Operate Punch-Card Tabulating and Alphabetic Accounting Machines, 155
Probability and Induction, 199
Probability and the Weighing of Evidence, 134
Probability Approach in Econometrics, 143
Probability Theory for Statistical Methods, 83
Probit Analysis: A Statistical Treatment of the Sigmoid Response Curve, 112
Problems and Tables in Statistical Methods, 338
Proceedings of the Auburn Conference on Statistics Applied to Research in the Social Sciences, Plant Sciences, and Animal Sciences, September 7-9, 1948, 6
Proceedings of the Berkeley Symposium on Mathematical Statistics and Probability: Held at the Statistical Laboratory, Department of Mathematics, University of California, August 13-18, 1945, January 27-29, 1946, 238
Psychological Statistics, 213
Public Health Statistics, First and Second Editions, 147-8
Punched Card and Calculating Machine Methods for

Analyzing Lattice Experiments Including Lattice Squares and the Cubic Lattice, 169

Quality Control: A Manual of Quality Control Procedure Based Upon Scientific Principles and Simplified for Practical Application in Various Types of Manufacturing Plants, 107
Quality Control and Statistical Methods, 268
Quality Control by Statistical Methods, 160
Quality Control Chart Technique When Manufacturing to a Specification: With Special Reference to Articles Machined to Dimensional Tolerances, 99
Quality Control Charts: Being Part 1 of a Revision of B.S. 600:1935, The Application of Statistical Methods to Industrial Standardisation and Quality Control, 98
Quality Control in Industry: Methods and Systems, 265
Quality Control in Production: A Machine-Shop Manual on the Statistical Method of Controlling Product Quality During Manufacture, 260
Quality Control Methods, 192
Quality Through Statistics, First and Second Editions, 318-9
Quantitative Methods in Psychology, 204

Random Normal Deviates: 25,000 Items Compiled From Tract No. xxiv (M. G. Kendall and B. Babington Smith's Tables of Random Sampling Numbers), 329
Random Sampling Distributions, 299
Rank Correlation Methods, 191
Recovery of Inter-Block Information in Quasi-Factorial Designs With Incomplete Data: 1, Square, Triple, and Cubic Lattices, 70
Recovery of Inter-Block Information in Quasi-Factorial Designs With Incomplete Data: 2, Lattice Squares, 71
Rectangular Lattices, 153
Regression Analysis of Production Costs and Factory Operations, First and Second Editions, 210-1
Rudimentary Mathematics for Economists and Statisticians, 80

Sampling Inspection: Principles, Procedures, and Tables for Single, Double, and Sequential Sampling in Acceptance Inspection and Quality Control Based on Percent Defective, 129
Sampling Inspection Tables: Single and Double Sampling, 96
Sampling Methods for Censuses and Surveys, 335
Sampling Methods in Forestry and Range Management, First and Second Editions, 269-70
Sampling Statistics and Applications: Fundamentals of the Theory of Statistics, Vol. 2, 277-8
Say It With Figures, First, Second, and Third Editions, 339-41
Scaling and Factorial Design in Opinion Poll Analysis, 131
Science of Chance: From Probability to Statistics, 202
Second Yearbook of Research and Statistical Methodology Books and Reviews, 51
Selected and Annotated Bibliography of Literature on Statistical Quality Control, 40
Selected Techniques of Statistical Analysis: For Scientific and Industrial Research and Production and Management Engineering, 103
Sequential Analysis, 306
Sequential Analysis of Statistical Data Applications, 280
Significance Test for Time Series and Other Ordered Series, 310
Silviculture Research Code: Vol. 2, The Statistical Manual: Being the Application of Statistical Methods to Silvicultural Research in India, 136
Simplified Guide to Statistics for Psychology and Education, Revised Edition, 275
Some Additional Lattice Square Designs, 66
Some Rapid Approximate Statistical Procedures, First and Second Editions, 323-4
Some Theory of Sampling, 92
Statistical Adjustment of Data, 93
Statistical Analysis for Students in Psychology and Education, 102
Statistical Analysis in Biology, First and Second Editions, 219-20
Statistical Clerk and Junior Statistician: A Guide and Preparation for Civil Service Statistical Tests: Contains Actual Previous Examinations With Official Answers, Statistical Study Material, and Sections on the Various Other Types of Questions Found on Such Tests, 1949 Edition, 25
Statistical Decision Functions, 307
Statistical Forecast of Floods, 142
Statistical Inference in Dynamic Economic Models, 201
Statistical Investigation of a Sample Survey for Obtaining Farm Facts, 180
Statistical Mathematics, 11
Statistical Methods Applied to Agricultural Economics, 248
Statistical Methods: Applied to Experiments in Agriculture and Biology, Fourth Edition, 279
Statistical Methods as Applied to Accounting Reports, Second Edition, 125
Statistical Methods for Medical and Biological Students, 82
Statistical Methods for Research Workers, Eighth Ninth, Tenth, and Eleventh Editions, 119-22
Statistical Methods in Industry, 295
Statistical Methods in Medical Research: I, Qualitative Statistics (Enumeration Data), 214
Statistical Methods in Quality Control, 64
Statistical Methods in Research, 182
Statistical Methods in Research and Production: With Special Reference to the Chemical Industry, First and Second Editions, 85-6
Statistical Procedures and Their Mathematical Bases, 252
Statistical Quality Control, 135
Statistical Quality Control Procedure, 320
Statistical Tables for Biological, Agricultural, and Medical Research, Second and Third Editions, 123-4
Statistical Techniques in Market Research, 110
Statistical Workers, 7
Statistics (Keskar), 196
Statistics (Tippett), 296
Statistics: An Intermediate Text Book, Vol. I, 181
Statistics and Graduation: Actuarial Statistics, Vol. I, 287
Statistics and Their Application to Commerce, Ninth Edition, 34
Statistics: Collecting, Organizing, and Interpreting Data, 267
Statistics for Economists, 15
Statistics for Foresters, Revised Edition, 127
Statistics for Sociologists, 144
Statistics: How to Handle Them: A Practical Handbook for Students and Businessmen With a Special Chapter on Business Forecasting, 286
Statistics in Psychology and Education, Third Edition, 132
Statistics in School, First and Second Editions, 284-5
Statistics Without Numbers: A Visual Explanation, 184

"Student's" Collected Papers, 247
Surveys, Polls, and Samples: Practical Procedures, 242
Symposium of Papers on Statistical Quality Control, 8
Symposium on Statistical Quality Control, 18
Symposium on Statistics for the Clinician, 342
Symposium on Usefulness and Limitations of Samples, 97

Table for the Calculation of Working Probits and Weights in Probit Analysis, 114
Table of 105,000 Random Decimal Digits, 170
Table of Significance Levels for the Fisher-Yates Test of Significance in 2 × 2 Contingency Tables, 113
Tables for Statisticians, 26
Tables for Testing the Homogeneity of a Set of Estimated Variances, 289
Tables of Noncentral χ^2, 126
Tables of Orthogonal Polynomial Values Extended to $N = 104$, 24
Tables of Percentage Points of the Incomplete Beta-Function and of the χ^2 Distribution, 288
Tables of Probability Functions, Vol. I, 332
Tables of Probability Functions, Vol. II, 333
Tables of the Binomial Probability Distribution, 9
Technique for Testing Consumer Preferences, With Special Reference to the Constituents of Ice Cream, 33
Techniques in Measuring Joint Relationships: The Joint Effects of Temperature and Precipitation on Corn Yields, 159
Theory of Econometrics, 88
Theory of Experimental Inference, 62
Theory of Probability, Second Edition, 178
Theory of Probability: An Inquiry Into the Logical and Mathematical Foundations of the Calculus of Probability, Second Edition, 256
Time Series Analysis: Smoothing by Stages, 223
Treatment of Experimental Data, 334

What the Figures Mean, 133
Work Units in Educational Statistics: A Text and Workbook, 282
Workbook for Business and Economic Statistics, 145
Workbook for Business Statistics, 105
Workbook in Applied General Statistics, Second and Third Editions, 76-7
Workbook in Business Statistics, First and Second Editions, 150-1

INDEX OF NAMES

NUMBERS REFER TO THE NUMBERED BOOK ENTRIES

The abbreviations and numbers following names may be interpreted thus: "*bk*, 15" indicates authorship of book 15; "*rev*, 80" indicates authorship of a review of or a reply to a review of book 80; "*misc*, 74" indicates that the name is listed in the entry for book 74 for other reasons.

Abbott, J. C.: *bk*, 10
Aitken, A. C.: *bk*, 11
Albritton, Errett C.: *bk*, 12-4
Allen, R. G. D.: *bk*, 15; *rev*, 80, 143, 335
American Society for Quality Control: *bk*, 16-7
American Society for Testing Materials: *bk*, 18-9
American Society of Mechanical Engineers: *bk*, 20
American Standards Association: *bk*, 21-2
Anastasi, Anne: *rev*, 52
Anderson, E. O.: *bk*, 33
Anderson, J. L.: *bk*, 23
Anderson, Montgomery D.: *rev*, 47
Anderson, R. L.: *bk*, 24; *rev*, 93, 143
Anderson, T. W.: *rev*, 190
Andrews, T. G.: *rev*, 62, 185
Anscombe, F. J.: *rev*, 55, 190, 280
Arco Editorial Board: *bk*, 25
Arkin, Herbert: *bk*, 26; *rev*, 233
Arley, Niels: *bk*, 27-8
Arnold, Kenneth J.: *rev*, 96, 135
Arnold, Sam: *bk*, 273
Aroian, Leo A.: *rev*, 185, 266
Arrow, Kenneth J.: *rev*, 90
Atwater, Franklin S.: *rev*, 183
Awbery, J. H.: *rev*, 85

Bacon, Annette L.: *bk*, 57
Bailey, N. T. J.: *rev*, 75, 85, 208
Baker, G. A.: *rev*, 289, 302
Ball, *Sister* Saint Augustine: *bk*, 29
Bancroft, T. A.: *rev*, 91, 158, 325
Barley, Ronald G.: *rev*, 162
Barna, T.: *rev*, 210
Barnard, G. A.: *rev*, 306
Bartlett, M. S.: *rev*, 103, 189, 326
Baten, W. D.: *bk*, 89; *rev*, 154, 208
Baumol, W. J.: *rev*, 80
Bayes, Thomas: *bk*, 30
Beall, Geoffrey: *rev*, 211
Bell, Reginald: *rev*, 132
Benac, T. J.: *bk*, 10
Bennett, Kenneth R.: *bk*, 248
Berkson, Joseph: *rev*, 112, 245
Berrettoni, J. N.: *rev*, 203
Bhattacharyya, A.: *rev*, 112
Blackburn, Raymond F.: *rev*, 31
Blair, Morris Myers: *bk*, 31
Blankenship, Albert B.: *rev*, 209, 339
Bliss, C. I: *bk*, 32-3; *rev*, 123, 219
Bliss, Charles A.: *rev*, 31, 278
Blommers, Paul J.: *rev*, 241
Blythe, Richard H., Jr.: *rev*, 269
Boddington, A. Lester: *bk*, 34; *misc*, 229
Booker, H. S : *rev*, 190
Bose, Purnendu Kumar: *rev*, 220
Bowker, Albert H.: *rev*, 38, 244
Bowley, A. L.: *rev*, 87, 335
Bowman, R. T.: *rev*, 80
Boyan, Edwin A.: *bk*, 35
Brandt, A. E.: *rev*, 117
Brearley, A.: *bk*, 36
Brilla, Mary H.: *bk*, 37
British Standards Institution: *bk*, 38-9
Brogden, Hubert E.: *rev*, 141
Broom, H. N.: *bk*, 40
Brown, George W.: *rev*, 42
Brown, R. M.: *rev*, 51
Brownlee, K. A.: *bk*, 41-5
Brožek, Josef: *rev*, 182, 213
Bruce, Donald: *bk*, 46; *rev*, 269
Brumbaugh, Martin A.: *bk*, 47; *rev*, 138, 183, 244
Buch, K. Rander: *bk*, 28
Buchanan-Wollaston, H. J.: *bk*, 48
Bureau of Agricultural Economics, United States Department of Agriculture: *bk*, 300
Bureau of the Census, Sampling Staff: *bk*, 49
Burke, Laverne K.: *rev*, 308
Buros, Francis C.: *bk*, 50
Buros, Oscar Krisen: *bk*, 50-1
Burr, Irving W.: *rev*, 8, 100
Burt, Cyril: *bk*, 52; *rev*, 185, 191, 290, 293
Burton, Clement: *bk*, 53
Butsch, R. L. C.: *bk*, 54
Butterbaugh, Grant I.: *bk*, 55
Butz, E. L.: *rev*, 248
Byers, Roscoe: *rev*, 100

C., E. A.: *rev*, 185
Calver, Homer N.: *rev*, 339
Camp, Burton H.: *rev*, 59, 187
Campbell, Norman R.: *rev*, 62
Carnap, Rudolf: *bk*, 56
Carter, G. K.: *rev*, 280
Carter, Hugh: *rev*, 144, 212
Cattell, Raymond B.: *rev*, 293
Cazier, Mont A.: *bk*, 57
Chambers, E. G.: *rev*, 185
Champernowne, D. G.: *rev*, 15, 223
Chan-Mou, Tchen: *bk*, 58
Chapanis, A.: *rev*, 13, 28, 43, 103, 124, 185-6, 204, 218, 250, 275, 304, 325
Chapman, R. A.: *bk*, 269-70
Charlier, C. V. L.: *bk*, 59
Chaturvedi, J. C.: *bk*, 60
Cheriyan, K. C.: *rev*, 190
Choudhury, T.: *rev*, 53, 165
Chrétien, C. Douglas: *bk*, 61
Christofferson, H. C.: *rev*, 132
Churchill, Edmund: *rev*, 213, 275
Churchman, C. West: *bk*, 62; *rev*, 100, 327
Clark, John R.: *bk*, 267
Clark, Kenneth E.: *rev*, 102, 339
Clark, Wallace: *bk*, 63
Clarke, P. C.: *bk*, 64
Clarkson, J. M.: *rev*, 272
Clem, Mary A.: *bk*, 169
Clifford, Paul C.: *rev*, 55, 244
Cochran, William G.: *bk*, 65-7, 74; *rev*, 119, 123, 219, 247

Cockett, R.: *rev*, 102
Cohen, A. C., Jr.: *rev*, 317
Collings, S. N.: *rev*, 127, 326
Colton, Raymond R.: *bk*, 26
Columbia University, Statistical Research Group: *bk*, 280; *misc*, 103
Comrie, L. J.: *misc*, 288
Condon, E. U.: *rev*, 129
Conrad, Victor: *bk*, 68-9
Cook, R. L.: *bk*, 89
Cooper, William: *rev*, 155
Copeland, A. H.: *rev*, 308
Cornell, F. G.: *rev*, 284
Cornish, E. A.: *bk*, 70-1, 253
Cotterman, C. W.: *rev*, 167
Cowan, Donald R. G.: *rev*, 154
Cowden, Dudley J.: *bk*, 72, 78-9; *rev*, 20, 87, 149, 203; *misc*, 72
Cowden, Mercedes S.: *bk*, 72
Cox, D. R.: *bk*, 36
Cox, E. L.: *bk*, 73
Cox, Gertrude M.: *bk*, 67, 74; *rev*, 253
Craig, A. T.: *rev*, 59
Craig, C. C.: *rev*, 61, 165, 168, 313
Cramér, Harald: *bk*, 75; *rev*, 103, 129
Croxton, Frederick E.: *bk*, 76-9; *misc*, 72
Crum, W. L.: *bk*, 80
Crump, S. Lee: *rev*, 49, 112
Cunningham, Graham: *misc*, 264
Curtiss, J. H.: *rev*, 51, 102, 107, 165, 243, 258

Dahlberg, Gunnar: *bk*, 81-2
Daly, Joseph F.: *rev*, 132
David, F. N.: *bk*, 83; *rev*, 75, 178, 185, 191, 313
Davidson, J. H.: *rev*, 280
Davies, George R.: *bk*, 84, 105; *rev*, 154
Davies, Owen L.: *bk*, 85-6
Davis, Harold T.: *bk*, 87-8; *rev*, 308
Davis, J. F.: *bk*, 89
Dayton, Scott: *bk*, 90
De, N. N.: *rev*, 106
DeLury, D. B.: *rev*, 85, 146
Deming, W. Edwards: *bk*, 91-3; *rev*, 31, 251, 271, 278, 334-5; *misc*, 30
Densen, Paul M.: *rev*, 148, 161
Derrick, L.: *rev*, 233
Desind, Philip: *rev*, 204
Dixon, Wilfrid J.: *bk*, 94; *rev*, 165
Dodd, Edward L.: *bk*, 95
Dodge, Harold F.: *bk*, 96-7; *rev*, 135, 318
Doob, J. L.: *rev*, 75, 190
Doppelt, Jerome E.: *rev*, 182
Dow, J. B.: *bk*, 23
Dudding, Bernard P.: *bk*, 98-9; *rev*, 244
Dudley, John W., Jr.: *bk*, 100
Dugan, James E.: *rev*, 277
Duncan, Acheson J.: *bk*, 276-8
Duncan, Kenneth: *rev*, 47
Dunlap, Jack W.: *rev*, 51
Dwyer, Paul S.: *rev*, 301

Eastwood, R. Parker: *rev*, 47, 225
Eckhardt, Robert C.: *bk*, 74
Edwards, A. S.: *rev*, 241, 251
Edwards, Allen L.: *bk*, 101-2
Eisenhart, Churchill: *bk*, 103; *rev*, 51, 165; *misc*, 9
Elderton, William Palin: *bk*, 104; *rev*, 249, 330
Ellis, R. K.: *bk*, 105
Emmens, C. W.: *bk*, 106
Enrick, Norbert L.: *bk*, 107
Epstein, Benjamin: *rev*, 303, 319
Ethe, Solomon: *rev*, 257
Eudey, Mark: *rev*, 305
Eyring, Henry: *rev*, 45, 86
Eysenck, H. J.: *rev*, 293
Ezekiel, Mordecai: *bk*, 108

F., F. A.: *rev*, 34
Fales, W. Thurber: *rev*, 147
Fay, Ernest L.: *bk*, 35
Federal Works Agency, Work Projects Administration: *bk*, 332-3
Federer, Walter T.: *bk*, 169, 172
Feigenbaum, A. V.: *rev*, 98, 165, 257, 265
Feller, William: *bk*, 109; *rev*, 32, 75, 81, 87, 186, 227
Ferber, Robert: *bk*, 110; *rev*, 306
Ferris, Charles D.: *rev*, 257
Fertig, John W.: *rev*, 54, 112, 214, 220, 330
Festinger, Leon: *rev*, 251
Finkner, A. L.: *bk*, 111
Finney, D. J.: *bk*, 112-4; *rev*, 42, 85, 106, 218-9, 279
Fippard, Richard C.: *bk*, 104
Fisher, Ronald A.: *bk*, 115-24, *rev*, 51, 187, 269, 326, 330; *misc*, 219-20
Fitzgerald, A. A.: *bk*, 125
Fix, Evelyn: *bk*, 126
Fleege, Urban H.: *rev*, 301
Fleming, C. M.: *rev*, 291
Forsaith, Carl C.: *bk*, 127
Franzen, Raymond: *rev*, 277
Freedman, Ronald: *rev*, 339
Freeman, Harold A.: *bk*, 128-9; *rev*, 1, 17, 98-9, 128, 135, 211, 260, 305
Freeman, Harry: *misc*, 23, 287
Freund, John E.: *rev*, 24
Friedman, Milton: *bk*, 129
Furfey, Paul Hanley: *rev*, 293
Fuson, William M.: *rev*, 144

G., G.: *rev*, 23
Gaddum, J. H.: *bk*, 130
Gage, N. L.: *bk*, 131
Gaillard, John: *rev*, 183
Garner, W. R.: *rev*, 213, 251
Garrett, Henry E.: *bk*, 132; *rev*, 206
Gause, G. R.: *bk*, 97; *rev*, 64
Geary, R. C.: *rev*, 191
Geffner, Joseph: *bk*, 334
Gehman, H. M.: *rev*, 37
Geiringer, Hilda P.: *rev*, 225
Gengerelli, Joseph A.: *rev*, 213
George, C Oswald: *rev*, 15
Georges, Joel S.: *bk*, 282
Geyer, Denton L.: *rev*, 54
Ghosh, Birendranath: *rev*, 313
Gill, Frank: *misc*, 260
Gilman, Stephen: *bk*, 133
Girshick, M. A.: *rev*, 168, 306
Goffman, Casper: *rev*, 2
Good, I. J.: *bk*, 134
Goulden, G. H.: *rev*, 70-1
Graham, C. H.: *rev*, 204
Graham, Irene J.: *bk*, 47
Grant, David A.: *rev*, 102, 132, 275
Grant, Eugene L.: *bk*, 135; *rev*, 17, 19, 96, 272
Graves, Clyde H.: *bk*, 304
Grebenik, E.: *rev*, 78, 219, 287, 296, 313, 326, 330
Green, Earl L.: *rev*, 218, 220
Greenwood, J. Arthur: *misc*, 59
Greenwood, Major: *rev*, 162, 187-8, 296
Greville, Thomas N. E.: *rev*, 23, 28, 95
Griffith, A. L.: *bk*, 136
Grimsley, Glen: *bk*, 137
Grosenbaugh, Lewis R.: *rev*, 136
Gruneberg, H.: *rev*, 219
Guilford, J. P.: *bk*, 138-41; *rev*, 31, 168, 185
Gumbel, E. J.: *bk*, 142; *rev*, 188
Guttman, Louis: *rev*, 54, 93, 293

H., H. W.: *rev*, 195
H., K.: *rev*, 117
Haavelmo, Trygve: *bk*, 143
Haemer, Kenneth W.: *rev*, 315
Hagen, Beatrice L.: *bk*, 304
Hagood, Margaret Jarman: *bk*, 144; *rev*, 87, 108, 168, 330
Haines, George H.: *bk*, 145
Hald, A.: *bk*, 146
Haldane, J. B. S.: *rev*, 83, 185, 219
Hall, Marguerite F.: *bk*, 147-8
Hall, Ray Ovid: *bk*, 149; *rev*, 179
Hamilton, C. Horace: *rev*, 108, 144, 212, 248
Hampel, Louis F.: *bk*, 150-1
Hannah, M.: *rev*, 36
Hansen, Morris H.: *bk*, 152; *rev*, 277
Hanson, A. A.: *rev*, 6
Harman, Harry H.: *bk*, 168
Harris, Chester W.: *rev*, 275
Harsh, Charles M.: *rev*, 168, 293
Harshbarger, Boyd: *bk*, 153; *rev*, 146
Hartkemeier, Harry Pelle: *bk*, 154-5; *rev*, 53, 108, 133, 225, 311
Hartley, H. O: *bk*, 246; *rev*, 82, 103, 154, 306; *misc*, 224, 288-9
Hartley, Percival: *misc*, 106
Hartzell, F. Z.: *rev*, 208, 279
Harvey, P. H.: *bk*, 261
Haskell, Allan C: *misc*, 315
Hastay, Millard W.: *bk*, 103
Haworth, Floyd B.: *bk*, 234-5
Hayes, H. K.: *misc*, 174
Hays, Samuel: *bk*, 156
Heidingsfield, Myron S.: *rev*, 252
Henderson, Donald E. V.: *bk*, 157
Hendricks, Walter A.; *bk*, 158-9
Henry, John A.: *rev*, 274
Herdan, G.: *bk*, 160

Hestenes, A. D.: *rev*, 322
Heyel, Carl: *misc*, 263
Hicks, J. R.: *rev*, 88
Hill, A. Bradford: *bk*, 161-3; *rev*, 85, 214
Hinshaw, V. G., Jr.: *rev*, 62
Hockley, S. R.: *bk*, 253
Hodges, J. L., Jr.: *bk*, 164
Hoel, Paul G.: *bk*, 165; *rev*, 75
Hogben, Lancelot: *bk*, 166-7
Holmes, Irving: *bk*, 152
Holzinger, Karl J.: *bk*, 168
Homeyer, Paul G.: *bk*, 169
Hopper, W. C.: *rev*, 51
Hornseth, Richard A.: *rev*, 179
Horst, Paul: *rev*, 168, 293
Horton, H. Burke: *bk*, 170; *rev*, 329
Hotelling, Harold: *rev*, 75, 87, 168, 188
Houseman, Earl E.: *bk*, 24, 171-2
Hughes, Harry M.: *bk*, 173
Humphreys, Lloyd G.: *rev*, 204, 251
Hurwicz, Leonid: *rev*, 87, 223, 310
Hurwitz, William N.: *bk*, 152
Hutchinson, E. P.: *rev*, 212
Hutten, Ernest H.: *misc*, 256

Immer, Forrest R.: *bk*, 174
Innes, F. R.: *rev*, 83
Inter American Statistical Institute: *bk*, 175
Irwin, J. O.: ***rev*, 112, 123, 165, 247**
Isserlis, Leon: *rev*, 247

J., E.: *rev*, 165
Jackson, Robert W. B : *bk*, 176
James, William C : *rev*, 184
Jastram, Roy W.: *bk*, 177
Jeffreys, Harold. *bk*, 178; *rev*, 256
Jenkinson, Bruce L : *bk*, 179
Jennet, W. J.: *bk*, 98-9
Jessen, Raymond J.: *bk*, 180
Johnson, Evan, Jr.: *bk*, 304
Johnson, H. M.: *rev*, 275
Johnson, N. Lloyd: *bk*, 181; *rev*, 85, 112, 191, 257, 335
Johnson, Palmer O.: *bk*, 182; *rev*, 67
Jones, Howard L.: *rev*, 154
Jones, Lyle V.: *rev*, 204
Juran, Joseph M.: *bk*, 183; *rev*, 107, 192, 265, 274

Kac, M.: *rev*, 75
Kafka, F : *bk*, 184
Kelley, Truman Lee: *bk*, 185-6; *rev*, 168
Kellogg, Chester E.: *rev*, 108, 168, 293
Kellogg, Lester S.: *bk*, 47; *rev*, 157
Kempthorne, Oscar: *rev*, 42, 116, 219, 299
Kendall, David G.: *rev*, 165, 178, 190
Kendall, Maurice G.: *bk*, 187-91, 336-7; *rev*, 51, 96, 119, 135, 178, 203, 210, 227, 238, 252, 280, 296; *misc*, 329
Kennedy, Clifford W.: *bk*, 192
Kenney, John F.: *bk*, 193-4; *rev*, 195, 247
Kerrich, J. E.: *bk*, 195
Keskar, Y. D.: *bk*, 196
Keyfitz, Nathan: *rev*, 62, 242
King, Arnold: *bk*, 197
Kiser, Clyde V.: *rev*, 147
Kish, Leslie: *rev*, 49
Klauber, L. M.: *bk*, 198
Klein, Lawrence R.: *rev*, 80
Kneale, William: *bk*, 199
Knowler, Lloyd A.: *rev*, 2
Knudsen, Lila F.: *rev*, 106
Kolmogorov, A. N.: *bk*, 200
Koopmans, Tjalling C.: *bk*, 201; *rev*, 326
Kossack, Carl F.: *rev*, 60
Krumhansl, J.: *rev*, 190

Labadie, Margaret A.: *rev*, 9
Lankford, Francis G., Jr.: *bk*, 267
Lardner, Rex: *rev*, 202
Larsen, H. D : *rev*, 31
Lawley, D. N.: *rev*, 185, 293
Lazarfeld, Paul F.: *misc*, 339-41
Leavitt, William L.: *bk*, 235
Lehmann, E. L.: *rev*, 85
Leighton, Walter: *rev*, 313
Lengyel, B. A.: *rev*, 330
Leontief, Wassily W.: *rev*, 88
Leser, C E. V.: *rev*, 87
Levene, Howard: ***rev*, 81, 193**
Levinson, Horace C.: *bk*, 202
Levy, Hyman: *bk*, 203
Lewis, Don: *bk*, 204
Lewis, Edward E.: *rev*, 276
Li, Jerome C. R.: *bk*, 205; *rev*, 233
Lidstone, G. J.: *rev*, 30
Lindley, D. V.: *rev*, 181
Lindquist, E. F.: *bk*, 206
Line, W.: *rev*, 52
Littauer, Sebastian B.: *rev*, 135, 192
Loève, Michel: *bk*, 207
Loevinger, Jane: *rev*, 251-2
Lonseth, A. T.: *rev*, 266
Louden, J. K.: *rev*, 183
Love, Harry H.: *bk*, 208
Lovell, Constance: *bk*, 140
Lowan, Arnold N.: *misc*, 332-3
Lukacs, Eugene: *rev*, 287
Lutz, R. R : *bk*, 209
Lyle, Philip: *bk*, 210-1

McCarty, Dale E.: *bk*, 197
McCormick, Thomas Carson: *bk*, 212; *rev*, 93, 108, 138, 308
McIntyre, Francis: *rev*, 155
McMillen, Wayne: *rev*, 47, 54, 147
McMullen, Launce: *misc*, 247
McNemar, Quinn: *bk*, 213; *rev*, 206, 251, 293, 308
MacNiece, E. H.: *rev*, 107
McPeek, Miles: *bk*, 197
Mainland, Donald: *bk*, 214
Makin, F. Bradshaw: *bk*, 215
Malmquist, Karl J.: *bk*, 216
Mandel, John: *rev*, 85
Mangold, George B.: *rev*, 212
Mann, Henry B.: *bk*, 217; *rev*, 203
Manuele, Joseph: *rev*, 100, 128
Marans, Frances A.: *rev*, 276
Margenau, Henry: *rev*, 334
Marland, R. E.: *bk*, 33
Marschak, Jacob: *misc*, 201
Marsh, Charles J.: *rev*, 110
Martin, Margaret: *rev*, 162
Massey, F. J.: *bk*, 94
Mather, Kenneth: *bk*, 218-20; *rev*, 112, 117, 120, 167, 247
Matthai, Abraham: *rev*, 160
Maverick, Lewis A.: *bk*, 221-3
Merrell, Margaret: *rev*, 14, 112, 148, 165, 203, 277, 299
Merrill, A. A.: *rev*, 274
Merrington, Maxine: *bk*, 224, 246, 289
Merry, Robert W.: *rev*, 257
Metzner, Charles A.: *rev*, 49
Meyer, Walter H.: *rev*, 270
Michael, William B.: *bk*, 141; *rev*, 102, 132
Miller, Lloyd C.: *rev*, 112
Miller, P. F.: *rev*, 252
Mode, Elmer B.: *bk*, 225-6
Modley, Rudolf: *rev*, 273
Molina, Edward C.: *bk*, 227; *rev*, 11; *misc*, 30
Monroe, Robert J.: *bk*, 111; *rev*, 225
Montagu, M. F. Ashley: *rev*, 78
Mood, Alexander M.: *bk*, 228; *rev*, 48, 59, 67, 185, 217, 266
Moore, Geoffrey H. *bk*, 310
Moran, P. A.: *rev*, 134, 238
Morgan, J. J.: *bk*, 111
Morgenstern, Oskar: *rev*, 190
Morrell, A. J. H.: *bk*, 229; *misc*, 34
Morrison, Nathan: *misc*, 200
Morton, J. E.: *rev*, 80, 233
Moskowitz, David R.: *bk*, 230-1
Mosteller, Frederick: *bk*, 129; *rev*, 21-2, 165, 182, 279, 325, 339
Mottley, Charles M.: *rev*, 259
Mudgett, Bruce D.: *rev*, 75
Mueller, C G.: *rev*, 204
Muench, Hugo: *rev*, 162; *misc*, 255
Mukherjee, M : *rev*, 87
Munch, Ralph H.: *rev*, 274

N., D.: *rev*, 244
N., D. M.: *rev*, 85
Nadler, Marcus: *rev*, 263
Nagel, Ernest: *rev*, 296
Nair, K. R.: *rev*, 247
Narain, Brij: *bk*, 232
Neiswanger, William Addison: *bk*, 233-5
Neyman, Jerzy: *bk*, 236-8; *rev*, 227, 305, 326
Nisselson, Harold: *rev*, 156
Noble, Mary Alfred: *bk*, 239
Norton, Horace W.: *rev*, 43, 185, 220
Norton, Paul T., Jr.: *rev*, 135

O., P. D.: *rev*, 162
"Occam": *bk*, 240
Odell, C. W.: *bk*, 241

Olds, Edwin G.: *rev*, 129, 309
Olmstead, Paul S.: *rev*, 100, 129, 295
Oppermann, R. H.: *rev*, 51
Ottman, Frederick R.: *rev*, 225

P., H.: *rev*, 279
P., J. F.: *rev*, 269
Palmer, Edgar Z.: *rev*, 31, 80, 108, 156, 212, 233
Paradiso, Louis J.: *rev*, 87
Parkhurst, Elizabeth: *rev*, 255
Parsons, G. L.: *rev*, 203
Parten, Mildred: *bk*, 242
Peach, Paul: *bk*, 243-4; *rev*, 103, 160, 211, 317
Pearl, Raymond: *bk*, 245
Pearson, E. S.: *bk*, 246-7; *rev*, 51, 178, 187-8; *misc*, 224, 288-9, 295
Pearson, Frank A.: *bk*, 248
Pearson, Karl: *bk*, 249
Pease, Katharine: *bk*, 250
Peatman, John Gray: *bk*, 251; *rev*, 251
Pechanec, Joseph F.: *rev*, 269
Pekeris, Chaim L.: *rev*, 227
Peters, Charles C.: *bk*, 252
Peterson, Andrew I.: *rev*, 183, 272
Phillips, Alexander J.: *bk*, 176
Phipps, I. F.: *bk*, 253
Piaggio, H. T. H.: *rev*, 52
Pollak, L. W.: *bk*, 69
Polya, George: *bk*, 254
Power, Francis W.: *rev*, 334
Preidel, E. E.: *bk*, 203
Price, Daniel O.: *rev*, 165, 185, 339
Price, Richard: *misc*, 30
Puffer, Ruth Rice: *bk*, 255
Pugsley, A. T.: *bk*, 253
Purcell, Warren R.: *bk*, 35; *rev*, 257

Quenouille, M. H.: *rev*, 328

Ram, Bakshi Sant: *bk*, 136
Raymont, T.: *rev*, 52
Reed, Lowell J.: *rev*, 116
Rees, Mina: *rev*, 91
Reichenbach, Hans: *bk*, 256
Reichenbach, Maria: *misc*, 256
Rice, William B.: *bk*, 257
Richardson, C. H.: *bk*, 258
Ricker, William E.: *bk*, 259
Rider, P. R.: *rev*, 203
Riggleman, John R.: *rev*, 128
Rigney, J. A.: *bk*, 261
Riopelle, Arthur J.: *rev*, 182
Rissek, H.: *bk*, 260
Robbins, Herbert: *rev*, 178
Roberts, Harry V.: *rev*, 182
Roberts, James S.: *rev*, 339
Robinson, H. F.: *bk*, 261
Robinson, Julia: *bk*, 262
Romig, Harry G.: *bk*, 96; *rev*, 331
Roos, Charles F.: *bk*, 263
Rose, T. G.: *bk*, 264
Rosenquist, Carl M.: *rev*, 212
Rutherford, John G.: *bk*, 265

Sammi, John C.: *rev*, 46
Sampling Staff, Bureau of the Census: *bk*, 49
Samuelson, Paul A.: *rev*, 87
Sandon, Frank: *rev*, 51, 78, 85, 135, 187-8, 193-5, 203, 247, 252, 313, 325-6, 330
Satterthwaite, Franklin E.: *rev*, 192, 316
Savage, L. J.: *rev*, 75
Scarborough, J. B.: *bk*, 266
Schaefer, Milner B.: *rev*, 48
Scheffé, Henry: *rev*, 75, 103, 187, 247, 280
Schipper, Lowell: *rev*, 182
Scholl, John C.: *bk*, 159
Schorling, Raleigh: *bk*, 267
Schrock, Edward M.: *bk*, 268
Schumacher, F. X.: *bk*, 46, 269-70; *rev*, 197
Schumpeter, Joseph A.: *bk*, 80
Scott, Charles R., Jr.: *rev*, 192
Seal, H. L.: *rev*, 187-8, 199, 227
Sealy, E. H.: *bk*, 271
Sebba, Gregor: *rev*, 340
Shaffer, Laurance F.: *rev*, 141
Shanas, Ethel: *rev*, 49, 179, 187, 251
Shaulis, Lloyd L.: *rev*, 257
Shephard, Ronald W.: *rev*, 193
Shewhart, Walter A.: *rev*, 11, 42, 98, 318, 334; *misc*, 115
Sibley, Elbridge: *rev*, 144
Simon, Leslie E.: *bk*, 97, 272; *rev*, 96
Simpson, F. R.: *rev*, 123
Sletto, Raymond F.: *rev*, 187
Smart, L. Edwin: *bk*, 273
Smith, B. Babington: *misc*, 329
Smith, Cedric A. B.: *rev*, 81, 83, 188, 191
Smith, Edward S.: *bk*, 274
Smith, G. Milton: *bk*, 275
Smith, James G.: *bk*, 276-8, 280
Smith, John H.: *rev*, 93, 108, 199, 276, 296
Smith, R. Tynes, III: *bk*, 170
Smithies, A.: *rev*, 88
Snedecor, George W.: *bk*, 279
Snyder, Virgil: *rev*, 332-3
Solomon, Herbert: *rev*, 10
Solomon, L.: *rev*, 85
Somers, O. H.: *bk*, 35
Spiegelman, Mortimer: *rev*, 287
Sprott, W. J. H.: *rev*, 52
Spurr, William A.: *rev*, 280
Stafford, John W.: *rev*, 132
Statistical Research Group, Columbia University: *bk*, 280; *misc*, 103
Stephan, Frederick F.: *rev*, 251-2
Stephenson, Charles A.: *rev*, 108
Sterne, T. E.: *rev*, 93
Stevens, W. L.: *bk*, 114
Stockton, John R.: *bk*, 281
Stoltz, M. P.: *rev*, 210
Stone, Charles A.: *bk*, 282
Stone, Richard: *rev*, 143
Stubbings, G. W.: *bk*, 283
Stuit, Dewey B.: *rev*, 51
Sumner, W. L.: *bk*, 284-5
Sur, A. K.: *bk*, 286
Swalm, R. O.: *rev*, 318
Swan, A. W.: *rev*, 96
Swineford, Frances: *rev*, 54

Tate, Merle W.: *rev*, 213
Tetley, H.: *bk*, 181, 287
Thom, H. C. S.: *rev*, 68
Thompson, Catherine M.: *bk*, 224, 288-9
Thomson, Godfrey H.: *bk*, 290-2; *rev*, 75, 112, 188, 313
Thouless, Robert H.: *rev*, 52
Thurstone, L. L.: *bk*, 293
Tibbitts, Clark, *rev*, 144, 212
Tinker, Miles A.: *rev*, 308
Tintner, Gerhard: *rev*, 80, 87-8, 108, 190
Tippett, L. H. C.: *bk*, 294-6; *rev*, 85, 135, 335
Todhunter, I.: *bk*, 297
Tomlinson, Helen: *rev*, 241
Treloar, Alan E.: *bk*, 298-9; *rev*, 42
Truesdell, Leon E.: *rev*, 149
Tukey, John W.: *rev*, 41, 62, 83, 93, 128, 220, 280, 290, 293, 306; *misc*, 115

Ulmer, Melville J.: *rev*, 110
United States Department of Agriculture: *bk*, 300

v. Bortkiewicz, L.: *misc*, 59
Vajda, Stefan: *rev*, 85, 103, 135, 181, 195, 278
Vanderslice, J. L.: *rev*, 276-7
Van Every, Everett: *rev*, 183
van Ormer, Edward B.: *bk*, 301
van Uven, M. J.: *bk*, 302
Van Voorhis, Walter R.: *bk*, 252
Vernon, P. E.: *rev*, 241
von Mises, Richard: *bk*, 303; *rev*, 256

W., D. R.: *rev*, 266
W., E. C.: *rev*, 106
W., L.: *rev*, 49
Wadley, F. M.: *rev*, 67, 112, 279
Wadsworth, George P.: *rev*, 128
Wagner, Charles C.: *bk*, 304
Wagner, R. W.: *bk*, 266
Wald, Abraham: *bk*, 305-7; *rev*, 51, 88, 143-4, 188, 298-9, 326, 330
Walker, Helen M.: *bk*, 308; *rev*, 54, 267, 290
Wall, W. D.: *rev*, 102
Wallace, W. N. W.: *bk*, 309
Wallis, W. Allen: *bk*, 103, 129, 310
Warren, L. A. H.: *rev*, 330
Watkins, Ralph K.: *rev*, 241
Waugh, Albert E.: *bk*, 311-2
Weatherburn, C. E.: *bk*, 313-4
Weber, Charles R.: *bk*, 172
Weida, Frank M.: *rev*, 185, 306
Welch, B. L.: *rev*, 187-8, 280
Weld, Walter E.: *bk*, 315
Welker, E. L.: *rev*, 108
Wert, James E.: *rev*, 308
Wescott, Mason E.: *rev*, 274
West, Carl J.: *bk*, 316
West, James R.: *rev*, 85
West, Paul V.: *rev*, 203, 206
Westman, A. E. R.: *bk*, 317; *rev*, 85

Wharton, A. S.: *bk*, 318-20
Wheldon, H. J.: *bk*, 321
Wherry, Robert J.: *rev*, 293
Wiener, Norbert: *bk*, 322
Wilcoxon, Frank: *bk*, 323-4
Wilks, S. S.: *bk*, 97, 325-6; *rev*, 51, 78, 82, 96, 165, 227
Williams, Clarence O.: *bk*, 301
Williams, Donald: *bk*, 327
Williams, Josephine J.: *rev*, 102
Wilsden, B. H.: *misc*, 36
Wilson, Edwin B.: *rev*, 49, 87, 143, 187
Winch, Robert F.: *rev*, 252
Winsor, Charles P.: *rev*, 128, 220, 313
Wintner, Aurel: *bk*, 328
Wishart, John: *bk*, 247; *rev*, 117, 123, 136, 186-8, 191, 266, 278-9, 291, 313, 335
Wittenborn, J. R.: *rev*, 251
Wold, Herman: *bk*, 329
Wolfe, H. D.: *rev*, 129
Wolfenden, Hugh H.: *bk*, 330; *rev*, 93, 195
Wolfowitz, J.: *rev*, 41, 59, 75, 83, 185, 188, 280, 313, 328
Wood, Eric C.: *rev*, 85
Working, Holbrook: *bk*, 331
Work Projects Administration, Federal Works Agency: *bk*, 332-3
Worthing, Archie G.: *bk*, 334; *rev*, 334
Wright, D. K., Jr.: *rev*, 203, 280

Yates, F.: *bk*, 123-4, 335; *rev*, 116
Yerushalmy, J.: *rev*, 162
Yoder, Dale: *bk*, 84, 105; *rev*, 149
Youden, W. J.: *rev*, 279
Young, Louis C.: *rev*, 182, 244, 265
Youngs, Nina L.: *rev*, 133
Yule, G. Udny: *bk*, 336-7; *rev*, 249

Zarchin, Michael: *bk*, 338
Zeisel, Hans: *bk*, 339-41
Zubin, Joseph: *bk*, 342; *rev*, 102, 138

CLASSIFIED INDEX TO BOOKS

NUMBERS REFER TO THE NUMBERED BOOK ENTRIES

Accounting
Burton, C. ('46), 53
Fitzgerald, A. A. ('41), 125
Gilman, S. ('44), 133
Makin, F. B. ('50), 215
Actuarial statistics
Anderson, J. L., and Dow, J. B. ('48), 23
Elderton, W. P., and Fippard, R. C. ('47), 104
Johnson, N. L., and Tetley, H. ('49-50), 181
Tetley, H. ('46), 287
Wolfenden, H. H. ('42-43), 330
Agriculture
Auburn Conference on Statistics ('48), 6
Immer, F. R. ('50), 174
Love, H. H. ('43), 208
Pearson, F. A., and Bennett, K. R. ('42), 248
Snedecor, G. W. ('46), 279
van Uven, M. J. ('46), 302
Analysis of variance
Mann, H. B. ('50), 217

Bibliographies
Broom, H. M. ('49), 40
Buros, O. K. ('41), 51
Butterbaugh, G. I. ('46), 55
Inter American Statistical Institute ('47), 175
Biological assay
Anonymous ('50), 5
Emmens, C. W. ('48), 106
Finney, D. J. ('47), 112
Finney, D. J., and Stevens, W. L. ('48), 114
Gaddum, J. H. ('49 reprint), 130
Wilcoxon, F. ('47-49), 323-4
Biology
Anonymous ('50), 5
Dahlberg, G. ('40), 82
Fisher, R. A. ('41-50), 119-22
Mather, K. ('43-49), 219-20
Snedecor, G. W. ('46), 279
Tippett, L. H. C. ('41), 294
Books for lay persons
Butsch, R. L. C. ('46), 54
Kafka, F. ('50), 184
Tippett, L. H. C. ('43), 296
Business and economics
Allen, R. G. D. ('49-50), 15
Boddington, A. L. ('49), 34
Brumbaugh, M. A.; Kellogg, L. S.; Graham, I. J. ('41), 47
Croxton, F. E., and Cowden, D. J. ('48), 79
Crum, W. L., and Schumpeter, J. A. ('46), 80
Davies, G. R., and Yoder, D. ('41), 84
Hartkemeier, H. P. ('43), 154
Hays, S. ('47), 156
Keskar, Y. D. ('48), 196
Maverick, L. A. ('41-49), 221-2
Narain, B. ('44), 232
Neiswanger, W. A. ('43), 233
Pearson, F. A., and Bennett, K. R. ('42), 248
Stockton, J. R. ('47), 281
Sur, A. K. ('45), 286
Wheldon, H. J. ('48), 321

Chemistry
Anonymous ('50), 5
Brownlee, K. A. ('45-49), 41-5
Davies, O. L. ('47-49), 85-6
Chi square
Finney, D. J. ('48), 113
Fix, E. ('49), 126
Thompson, C. M. ('41), 288
Climatology
Conrad, V. ('44), 68
Conrad, V., and Pollak, L. W. ('50), 69
Collected papers
Fisher, R. A. ('50), 115
Pearson, E. S., and Wishart, J. ('43), 247
Pearson, K. ('48), 249
Conference proceedings
American Society for Quality Control ('47-49), 16-7
American Statistical Association ('50), 1
Auburn Conference on Statistics ('48), 6
Neyman, J. ('49), 238
Correlation
Ezekiel, M. ('41), 108
Kendall, M. G. ('48), 191
Treloar, A. E. ('42), 298
Curve fitting
Deming, W. E. ('43-44), 93
Malmquist, K. J. ('41), 216
Narain, B. ('44), 232
Worthing, A. G., and Geffner, J. ('43), 334

Distribution, binomial
Anonymous ('50), 9
Buchanan-Wollaston, H. J. ('45), 48
Mainland, D. ('48), 214
Working, H. ('43), 331
Distribution, normal
Hughes, H. M. ('49), 173
Work Projects Administration, Federal Works Agency ('41-42), 332-3
Distribution, Poisson
Bliss, C. I. ('48), 32
Molina, E. C. ('42), 227
v. Bortkiewicz, L. ('47 translation), 59
Working, H. ('43), 331

Econometrics
Davis, H. T. ('41), 88
Haavelmo, T. ('44), 143
Koopmans, T. C. ('50), 201
Education and psychology
Buros, F. C., and Buros, O. K. ('49 reprint), 50
Edwards, A. L. ('46-47), 101-2
Garrett, H. E. ('47), 132

Guilford, J. P. ('42-50), 138-9
Guilford, J. P., and Michael, W. B. ('49), 141
Johnson, P. O. ('49), 182
Kelley, T. L. ('47), 185
Lewis, D. ('48), 204
Lindquist, E. F. ('42), 206
McNemar, Q. ('49), 213
Odell, C. W. ('46), 241
Peatman, J. G. ('47), 251
Peters, C. C., and Van Voorhis, W. R. ('40), 252
Smith, G. M. ('46), 275
Sumner, W. L. ('48-50), 284-5
van Ormer, E. B., and Williams, C. O. ('45), 301
Walker, H. M. ('43), 308
Zubin, J. ('50), 340

Examination study guides
Arco Editorial Board ('49), 25
Moskowitz, D. R. ('40-42), 230-1
"Occam" ('46), 240

Experimental design
Cochran, W. G. ('41-43), 65-6
Cochran, W. G., and Cox, G. M. ('50), 67
Cornish, E. A. ('43-44), 70-1
Cox, G. M.; Eckhardt, R. C.; and Cochran, W. G. ('40), 74
Davis, J. F.; Baten, W. D.; and Cook, R. L. ('46), 89
Edwards, A. L. ('50), 101
Fisher, R. A. ('42-49), 116-8
Hald, A. ('48), 146
Harshbarger, B. ('47), 153
Homeyer, P. G.; Clem, M. A.; and Federer, W. T. ('47), 169
Li, J. C. R. ('44), 205
Mann, H. B ('50), 217
Phipps, I. F.; Pugsley, A. T.; Hockley, S. R.; and Cornish, E. A. ('44), 253
Robinson, H. F.; Rigney, J. A.; and Harvey, P. H. ('48), 261

Factor analysis
Burt, C. ('40-41), 52
Holzinger, K. J., and Harman, H. H. ('41-43), 168
Noble, M. A. ('40), 239
Thomson, G. H. ('46-50), 290-2
Thurstone, L. L. ('47), 293

Fishery research
Buchanan-Wollaston, H. J. ('45), 48
Neyman, J. ('49), 237
Ricker, W. E. ('48), 259

Flood forecasting
Gumbel, E. J. ('48), 142

Forestry
Bruce, D., and Schumacher, F. X. ('42), 46
Forsaith, C. C. ('46), 127
Griffith, A. L., and Ram, B. S. ('47), 136
Schumacher, F. X., and Chapman, R. A. ('42-48), 269-70

General textbooks
Blair, M. M. ('44), 31
Croxton, F. E., and Cowden, D. J. ('39-40), 78
Dixon, W. J., and Massey, F. J. ('49), 94
Fisher, R. A. ('41-50), 119-22
Johnson, P. O. ('49), 182
Kelley, T. L. ('47), 185
Keskar, Y. D. ('48), 196
Levy, H., and Preidel, E. E. ('44-45), 203
Smith, J. G., and Duncan, A. J. ('44-46), 276-8
Tippett, L. H. C. ('41), 294
Wagner, C. C.; Johnson, E., Jr.; Hagen, B. L.; and Graves, C. H. ('45), 304
Waugh, A. E. ('43), 311
Yule, G. U., and Kendall, M. G. ('44-50), 336-7

Genetics
Dahlberg, G. ('47-48), 81
Hogben, L. ('46), 167
Mather, K. ('49), 218

Graphic methods
Anonymous ('42-43), 3-4
American Society of Mechanical Engineers ('43), 20
Clark, W. ('48), 63
Lutz, R. R. ('49-50), 209
Roos, C. F. ('48), 263
Rose, T. G. ('49), 264
Smart, L. E., and Arnold, S. ('47), 273
Weld, W. E. ('47), 315

Herpetology
Klauber, L. M. ('41), 198

High school textbook
Schorling, R.; Clark, J. R.; and Lankford, F. G., Jr. ('43), 267

Industrial statistics
Brearley, A., and Cox, D. R. ('49), 36
Brownlee, K. A. ('45-49), 41-5
Davies, O. L. ('47-49), 85-6
Freeman, H. A. ('42), 128
Lyle, P. ('44-46), 210-1
Tippett, L. H. C. ('43), 295

Least squares
Deming, W. E. ('43), 93

Linguistics
Chrétien, C. D. ('45), 61

Machine calculation and tabulation
Hartkemeier, H. P. ('42), 155
Homeyer, P. G.; Clem, M. A.; and Federer, W. T. ('47), 169
Pease, K. ('49), 250

Marketing and opinion research
Bliss, C. I.; Anderson, E. O.; and Marland, R. E. ('43), 33
Ferber, R. ('49), 110
Gage, N. L. ('47), 131
Parten, M. ('50), 242
Zeisel, H. ('47-50), 339-41

Mathematical background
Crum, W. L., and Schumpeter, J. A. ('46), 80
Deming, W. E. ('44), 91
Lewis, D. ('48), 204

Mathematical statistics
Aitken, A. C. ('39-42), 11
Arley, N., and Buch, K. R. ('50), 28
Charlier, C. V. L. ('47 translation), 59
Chaturvedi, J. C. ('48), 60
Cramér, H. ('45), 75
Dodd, E. L. ('45), 95
Fisher, R. A. ('50), 115
Hoel, P. G. ('47), 165
Hogben, L. ('50), 166
Kelley, T. L. ('47-48), 185
Kendall, M. G. ('44-46), 187-8
Kenney, J. F. ('39-49), 193-4
Mode, E. B. ('41), 225
Mood, A. M. ('50), 228
Neyman, J. ('49-50), 236, 238
Peters, C. C., and Van Voorhis, W. R. ('40), 252
Richardson, C. H. ('44), 258
Scarborough, J. B., and Wagner, R. W. ('48), 266
Smith, J. G., and Duncan, A. J. ('44-46), 276-8
van Uven, M. J. ('46), 302
von Mises, R. ('47), 303
Weatherburn, C. E. ('46-49), 313-4
West, C. J. ('41), 316
Wilks, S. S. ('43-48), 325-6
Wolfenden, H. H. ('42-43), 330

Medicine and public health
Albritton, E. C. ('46-49), 12-4
Dahlberg, G. ('40), 82
Hall, M. F. ('42-49), 147-8
Hill, A. B. ('42-50), 161-3
Mainland, D. ('48), 214
Pearl, R, ('40), 245
Puffer, R. R. ('50), 255

Physics
Arley, N. ('49), 27
Chan-Mou, T. ('47), 58
Worthing, A. G., and Geffner, J. ('43), 334

Prediction
Grimsley, G. ('50), 137
Guilford, J. P., and Michael, W. B. ('49), 141
Hendricks, W. A., and Scholl, J. C. ('43), 159
Jackson, R. W. B., and Phillips, A. J. ('45), 176

Probability
Abbott, J. C., and Benac, T. J. ('47), 10
Arley, N. ('49), 27
Arley, N., and Buch, K. R. ('50), 28
Bayes, T. ('40 reprint), 30
Carnap, R. ('50), 56
Churchman, C. W. ('48), 62
Cramér, H. ('45-46), 75
David, F. N. ('49), 83
Dodd, E. L. ('45), 95
Feller, W. ('50), 109
Good, I. J. ('50), 134
Haavelmo, T. ('44), 143
Hogben, L. ('50), 166
Jeffreys, H. ('48), 178
Kerrich, J. E. ('46), 195
Kneale, W. ('49), 199
Kolmogorov, A. N. ('50 translation), 200
Levinson, H. C. ('50), 202
Loève, M. ('50), 207
Neyman, J. ('46-50), 236, 238
Reichenbach, H. ('49-50), 256
von Mises, R. ('47), 303
Williams, D. ('47), 327
Wintner, A. ('47), 328

Quality control
Anonymous ('46-48), 1-2
American Society for Quality Control ('47-49), 16-7
American Society for Testing Materials ('45-46), 18-9
American Standards Association ('41-42), 21-2
Boyan, E. A.; Purcell, W. R.; Somers, O. H.; and Fay, E. L. ('48), 35
British Standards Institution ('46-47), 38-9
Broom, H. M. ('49), 40
Butterbaugh, G. I. ('46), 55
Clarke, P. C. ('45), 64
Dodge, H. F., and Romig, H. G. ('44-5), 96
Dodge, H. F.; Wilks, S. S.; Simon, L. E.; Gause, G. R. ('48), 97
Dudding, B. P., and Jennett, W. J. ('42-45), 98-9
Dudley, J. W., Jr. ('46-47), 100
Eisenhart, C.; Hastay, M. W.; and Wallis, W. A. ('47-48), 103
Enrick, N. L. ('48), 107
Freeman, H. A. ('42), 128
Freeman, H. A.; Friedman, M.; Mosteller, F.; and Wallis, W. A. ('48), 129
Grant, E. L. ('46), 135
Herdan, G. ('48), 160
Hodges, J. L., Jr. ('49), 164
Juran, J. M. ('45), 183
Kennedy, C. W. ('48), 192
Peach, P. ('45-47), 243-4
Rice, W. B. ('47), 257
Rissek, H. ('47), 260
Rutherford, J. G. ('48), 265
Schrock, E. M. ('50), 268
Sealy, E. H. ('43-45), 271
Simon, L. E. ('41), 272
Smith, E. S. ('47), 274
Statistical Research Group, Columbia University ('45-46), 280
Stubbings, G. W. ('47), 283
Tippett, L. H. C. ('43), 295
Wald, A. ('47), 306
Wallace, W. N. W. ('44), 309
Westman, A. E. R. ('47), 317
Wharton, A. S. ('45-50), 318-20
Working, H. ('43), 331

Random numbers
Horton, H. B., and Smith, R. T., III ('49), 170
Wold, H. ('48), 329
Regression
Ezekiel, M. ('41), 108
Houseman, E. E. ('42), 171
Lyle, P. ('44-46), 210-1

Sampling, acceptance
American Statistical Association ('50), 1
British Standards Institution ('46), 39
Dodge, H. F., and Romig, H. G. ('44-45), 96
Freeman, H. A.; Friedman, M.; Mosteller, F.; and Wallis, W. A. ('48), 129
Hodges, J. L., Jr. ('49), 164
Sampling, general
Bureau of the Census, Sampling Staff ('47), 49
Cox, E. L. ('49), 73
Deming, W. E. ('50), 92
Dodge, H. F.; Wilks, S. S.; Simon, L. E.; and Gause, G. R. ('48), 97
Finkner, A. L.; Morgan, J. J.; Monroe, R. J. ('43), 111
Hansen, M. H.; Hurwitz, W. N.; and Holmes, I. ('45), 152
Hendricks, W. A. ('48), 158
Houseman, E. E.; Weber, C. R.; and Federer, W. T. ('46), 172
Jessen, R. J. ('42), 180
King, A. J.; McCarty, D. E.; and McPeek, M. ('42), 197
Schumacher, F. X.; and Chapman, R. A. ('42), 269
Treloar, A. E. ('42), 299
Yates, F. ('49), 335
Sequential analysis
Pólya, G. ('48), 254
Robinson, J. ('48), 262
Statistical Research Group, Columbia University ('45-46), 280
Wald, A. ('47), 306
Significance and inference
Ball, S. A. ('42), 29
Buchanan-Wollaston, H. J. ('45), 48
Finney, D. J. ('48), 113
Fix, E. ('49), 126
Jastram, R. W. ('47), 177
Koopmans, T. C. ('50), 201
Mainland, D. ('48), 214
Merrington, M., and Thompson, C. M. ('43), 224
Pearson, E. S.; Hartley, H. O.; and Merrington, M. ('42), 246
Thompson, C. M. ('41), 288
Thompson, C. M., and Merrington, M. ('46), 289
Wald, A. ('42-50), 305, 307
Wallis, W. A., and Moore, G. H. ('41), 310
Sociology
Hagood, M. J. ('41), 144
McCormick, T. C. ('41), 212
Statistical decision functions
Wald, A. ('50), 307
Statistical tables, general
Arkin, H., and Colton, R. R. ('50), 26
Fisher, R. A., and Yates, F. ('43-48), 123-4
Kelley, T. L. ('48), 186
Mode, E. B. ('41), 226
Statistical tables, specific
Anonymous ('50), 9
Anderson, R. L., and Houseman, E. E. ('42), 24
Buros, F. C., and Buros, O. K. ('49 reprint), 50
Finney, D. J. ('48), 113
Finney, D. J., and Stevens, W. L. ('48), 114
Fix, E. ('49), 126
Horton, H. B., and Smith, R. T., III ('49), 170
Jackson, R. W. B.; and Phillips, A. J. ('45), 176
Merrington, M., and Thompson, C. M. ('43), 224
Molina, E. C. ('42-43), 227
Pearson, E. S.; Hartley, H. O.; and Merrington, M. ('42), 246
Wold, H. ('48), 329
Work Projects Administration, Federal Works Agency ('41-42), 332-3
Statistics as a profession
Anonymous ('47), 7
Brilla, M. H. ('48), 37
Henderson, D. E. V. ('44), 157
Symposia
Anonymous ('45-50), 5, 8
American Society for Testing Materials ('46), 18
Zubin, J. ('50), 342

Tabular methods
Hall, R. O. ('43), 149
Jenkinson, B. L. ('49), 179
United States Department of Agriculture ('42), 300
Textile industry
Brearley, A., and Cox, D. R. ('49), 36
Time series
Davis, H. T. ('41), 87
Hald, A. ('48), 146
Kendall, M. G. ('46), 190
Koopmans, T. C. ('50), 201
Maverick, L. A. ('45), 223
Morrell, A. J. H. ('48), 229
Wallis, W. A., and Moore, G. H. ('41), 310
Wiener, N. ('49), 322

Workbooks, business and economics
Cowden, D. J., and Cowden, M. S. ('48), 72
Dayton, S. ('41), 90
Ellis, R. K.; Davies, G. R.; and Yoder, D. ('41), 105
Haines, G. H. ('49), 145
Hampel, L. F. ('42-47), 150-1
Neiswanger, W. A.; and Haworth, F. B. ('44-50), 234-5
Zarchin, M. M. ('46), 338
Workbooks, education and psychology
Gilford, J. P., and Lovell, C. ('46), 140
Stone, C. A., and Georges, J. S. ('42), 282
Workbooks, general
Croxton, F. E. ('41-50), 76-7
Waugh, A. E. ('44), 312

Zoology
Cazier, M. A., and Bacon, A. L. ('49), 57
Klauber, L. M. ('41), 198