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ORGANISATION AND METHODS

ORGANISATION AND METHODS

A Service to Management

EDITED BY

G. E. MILWARD

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FOREWORD BY SIR THOMAS HUTTON

THE review of organisation and the simplification and improvement of office methods have attracted increasing interest in recent years, so that representatives of some larger firms active in this field, have been in the habit of meeting informally from time to time to exchange ideas and experience. In view of a widespread demand for information on these subjects and for training facilities, these firms reached the conclusion early in 1957 that in the national interest their experience ought to be made available to industry generally and to the members of the various institutions such as the British Institute of Management, the Office Management Association, the British Productivity Council, and the Institute of Chartered Accountants, who have an interest in the subject. They decided therefore to cooperate for a limited period with one or two other like-minded firms to form an Organisation and Methods Training Council for which they have provided the finance. This decision in itself represents something unique in British industry, and is an example that might be imitated in other fields.

The objects of the Council are strictly limited, the first being to record and disseminate the best practice of the participating firms. The results of this work, which has been directed by Mr. G. E. Milward, formerly of the Organisation and Methods Department of the Treasury, are recorded in this book. The substance of this text has been tried out, criticised and amended as a result of two four-week 'proving courses' organised by the Council, in which persons with wide experience and also novices have taken their respective parts.

The second object of the Council is to help in promoting in the main industrial centres courses of training in this subject sponsored by local firms which have had some experience of the work. Although this textbook should be of considerable help in the running of such courses, the member firms feel very strongly that the subject is not one that lends itself to purely academic teaching. Their own experience in running courses has con-

vinced them that the teaching should be on very practical lines and be based largely on syndicate work and discussion, and on studies of practical problems presented by the sponsoring firms. All those who attend such courses should have already had a period of experience in business, factory or office, and a proportion should, if possible, have had some experience in dealing with reviews of organisation or the simplification of methods, or both.

Each firm must, of course, develop its own method of approach to the work and set up a department appropriate to its needs. The emphasis on its various aspects and the methods used will vary from firm to firm and the material in this book does not necessarily represent the current practice of all the firms on the Council. Each chapter is based, however, on the practice of one or two firms which have developed, with considerable success, the methods to which it refers and it has been subjected to searching criticism and amendment by the other participants.

As a first textbook this volume leaves room for improvement, but the need is such that we feel that publication should not be further delayed. Many firms that have already studied the subject will, we think, be able to benefit from it and we hope that it will induce many others to recognise the significance of O and M work. We are convinced that every company should set aside some time for the examination and improvement of existing organisation and methods, and that this will make an important contribution to both efficiency and economy.

The firms that have participated in establishing the Council and the development of its work are as follows and I should like to record my gratitude for the contribution that they have made both in finance and in 'know-how' to the development of this programme:

Dunlop Rubber Co. Ltd.
The English Electric Co. Ltd.
Imperial Chemical Industries Ltd.
The Metal Box Co. Ltd.
The United Steel Companies Ltd.
Rolls-Royce Ltd.
Shell-Mex and B.P. Ltd.

Stewarts and Lloyds Ltd.
Unilever Ltd.

I should also like to record the Council's thanks to the General Managers of the Midland Bank for lending their Training College for the first 'proving course'.

T. J. HUTTON
Chairman of the Council

24 September, 1958

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SUGGESTIONS FOR TEACHING THIS SUBJECT

The publication of this book may stimulate a demand on the part of employers for the teaching of O and M work in universities and technical colleges, either as part of an existing course of training, or as a separate subject. In each case certain considerations apply:

O and M is a practical subject and lends itself more readily to demonstration by experienced staff than to theoretical discussion, or the lecture method.

There is no exact body of principle that can be taught.

This book has been designed to bring together the practical experience of nine large organisations, and has been tested on various other large and medium-sized companies.

The O and M Training Council (OMTC) is satisfied that the book can be used as background reading for illustration and demonstration of the practical considerations that arise under each chapter heading.

Any educational body considering the setting up of facilities for O and M training is therefore recommended to approach local employers with existing O and M or systems and procedures departments, in order to secure their cooperation and to introduce the practical element into their teaching. It would prove especially valuable if a group of these employers could be invited to assist by each taking one or more chapters of this book, which they are prepared to illustrate from their experience.

If courses can be arranged to include both experienced O and M staff and novices, the syndicate method may be employed. Each syndicate discusses the experience of one or more of its members, and follows this up at a later session with a joint discussion of all syndicates, guided by an experienced visitor. This method of exchanging experience through syndicates is most desirable if it can be arranged.

If no experienced staff are available as students, the co-operating employers must be asked to lend a man or men to help with a particular session by supplying details of actual

experience through problems, exercises and examples. It has been the experience of the Council that this threefold distinction is necessary in teaching, thus:

Problems are drawn from actual assignments carried out by O and M teams, to which several answers are possible. The value of the problem in teaching lies in the encouragement given to members of syndicates to learn from one another in discussion, together with the opportunity given at a concluding session of questioning the methods actually adopted or the decision taken.

Exercises should be short and practical, and should result in all members of the course coming to substantially the same answer, which should be confirmed and demonstrated by the man who personally carried out the exercise.

Examples are short factual statements of minor problems and the solutions adopted, designed to illustrate without the members being required to produce any answer themselves.

Some subjects lend themselves to treatment by example, some by exercise, and some by the problem approach.

The spreading of the load of teaching over a number of companies should mean that the demands made on any one for assistance should not be considerable. About eight employers will be needed to form a local group or council; some of these will require their own staff to be trained, in addition to being available to help in the training.

The OMTC will, on demand, provide specimen programmes of training courses that they have conducted. These may be used to divide up the subject between companies, according to their particular experience. As has been mentioned above, the chapters of this book may also provide a convenient method of separating the work so that graphic illustrations are obtained from companies on each part of the course.

The OMTC will also supply specimen problems, although each educational body is recommended to obtain and use actual problems from its local panel of employers. The importance of this is to create a situation where the man who dealt with the work in reality is available to answer supplementary questions on how and why he arrived at his recommendations.

To accompany the book an agenda or 'crib' has been prepared in pamphlet form and this can be obtained free of charge on application to the Catalogue Department of Messrs. Macmillan & Co. Ltd., 10-15 St. Martin's Street, London, W.C.2. This agenda suggests the places where examples are needed to illustrate the main points in each chapter, so that on a training course discussion is maintained on the level of actual experience of different companies. The value of the 'crib' is both to the demonstrator, as a reminder of the examples he needs to demonstrate, and to the student on the training course, who can by this means make sure that he understands the practical implications of what he has read. It has been designed as a separate pamphlet instead of as an appendix to avoid constant reference by the reader to the back of the book; it is not, however, a summary of the main points of the book and it has little value other than on an organised training course.

Finally, the OMTC has already made one film, and has others in preparation. These will be available on hire or for purchase.

The OMTC does not intend to run public national training courses, but is handing over this responsibility to regional groups of companies and/or educational bodies. It will, however, provide any help within its power to suggest ways of presenting the various subjects in a practical manner, and may, on occasion, be able to provide a demonstrator until such time as a local employer feels able to take over the subject.

With regard to the method of conducting courses, experience has indicated to the OMTC that there is greater value in residential courses than can be expected to be obtained from part-time training. It is realised, however, that the former may not be feasible for some companies or teaching bodies. The decision as to how long the training should last and the form it should take must be taken in consultation between the employers' group and the teaching authority involved. Nevertheless, the OMTC strongly believes that the close association between individuals and acclimatisation to a new subject are greatly assisted by a residential qualification.

Who should attend the courses? This decision may well lie more with the employer than the teaching body. Very large companies may take on staff with the express purpose of training

them in O and M work. The smaller company may detail a manager, or an accountant, to set up O and M and see that existing staff are trained locally. The form that the training is to take may well depend upon the seniority and experience of those selected by local employers. But it is to be borne in mind that:

Several years of business experience are desirable before taking O and M training.

Several months of actual O and M assignment work will prove a very valuable background for training.

Apprenticeship to an experienced man before, and after, training will give excellent results.

Those who teach this commonsense subject may, sooner or later, be embarrassed to discover that quite important practical points they wish to communicate appear obvious in print, even though they are often overlooked in practice. These points, in interviewing, for instance, or on the simplification of office work, are best covered by inference from practical examples or by teaching from the obverse, in which a course is invited to point out the mistakes made by a demonstrator. By this method, they will often teach themselves, and the demonstrator, to accept rules or principles that might have been resented and certainly would have been labelled obvious if mentioned in a lecture.

The machinery and techniques described in this book will be developed over the passage of time. Nevertheless the approach used in this book will continue to provide an invaluable starting point for teaching through the exchange of experience. The Council hopes that further editions of this book will be published to bring up to date the chapters dealing with practice and machinery.

Scope of the Book

The contents of this book have been divided into main headings distinguishing between:

the simplification of the work;
measurement, layout of the work, and sampling;
instruction on how to carry out an assignment;
managing O and M staff and their work;
understanding and simplifying organisation; and finally,
certain background subjects which can be applied at different stages of the work.

No two companies do O and M work in exactly the same way. The emphasis will be different according to the immediate needs of the company and the particular work upon which it is engaged. Sometimes the approach is heavily conditioned by the history of the unit concerned, however short that may be. For instance, in one company O and M was first carried out by the accounts branch with an emphasis upon economy and office machines. In another, the origin was in a factory efficiency service with an emphasis upon work measurement and standardisation. In a third, the service reported direct to the managing director and was concerned largely with improving management and organisation. Despite these differences, all O and M branches seem to be engaged upon some part or parts of the work included in the contents page of this book, with varied emphasis and particular expertise.

Wherever the detailed work of office, sales, accounting, or stores procedure is extremely complicated (in factory paper work for instance), procedure studies and detailed charts will be needed to record the exact operations carried out at the time. At a later stage the investigator will have to simplify what is being done by thinking out alternative ways of getting the same or better results with a lower expenditure of time and material. The object is not necessarily to reduce overhead expenditure; increases in income are also a worthy objective. An increase in overhead expenditure may be justified if sales are thereby increased with a worthwhile surplus in net income. Similarly, reductions in capital employed may also justify an increase in overheads. To do all this, he has to build up an extensive knowledge of the equipment and office machinery which is

available, and know whether either will do the work quicker or more accurately than the best hand method. He must realise that forms design is not work to be looked down upon. The layout of the form should be one that is easy for staff to fill in; that avoids errors by keeping close together columns of figures which have to be added; that is easy of reference when completed, by highlighting totals or significant figures; that is designed to tie-in with other forms or records based upon it. So described, designing a form will be seen as responsible work; not a self-contained job, but a large part of the main business of simplifying procedures so as to save unnecessary paper, unnecessary copying and summarising, possibly to save also a complete further procedure by providing information in a shape that will serve some additional purpose of the business.

The Place of Equipment

In the same way, office equipment is not a subject in itself. Some excellent office equipment can be made to serve purposes which were not thought of by those who design or those who sell. 'Glossiness' is not of importance by itself. A simplified procedure may be made to look nice in addition to being simple, but all simplifiers of office work are warned against 'glossy' records whose main purpose is to impress. Often the most simple method is extremely humble and the best equipment may well be something cheap to buy and maintain.

The ordinary man working in O and M will not himself have to be an expert in office equipment, office machinery, or electronic computers. Life is not long enough and his service in O and M much too short for him to learn all that he ought to know of these three very big subjects. He must, however, learn to know what the equipment, machinery, or computer can do economically and what it cannot do. He must know and recognise the particular fields of work in which particular appliances are of the greatest value, and also the name of some specialist, who is also an honest broker, on whom he can call for a technical opinion. This subject of machines may be difficult, but the presentation in this book should ease some of the difficulty, for office machines are shown as alternative means of carrying out certain office procedures. No one is yet ready to make the parallel approach for computers, for experience of

their use is as yet insufficient, and some years will have to elapse before the use of a particular computer for a particular management job, or a group of management jobs, can be justified on strict grounds of economy. At the moment the novice is recommended to read the sections on computers very carefully, but to keep an open mind upon their applications, other than on research work where speed and thoroughness may justify installation.

The measurement of office work has importance in the company with large offices. The techniques of work study or time and motion study are not immediately transferable from the factory floor to the office desk. The reason is, perhaps, the element of decision involved in most office work. The first approach of work study is often to typing pools and machine rooms because of some similarity to the work of the factory. Few engineers would, however, permit raw material to reach a skilled operator in a workshop in the mess in which it reaches a typing pool. Dictation and writing are often so poor as to slow down times of operation and seriously reduce the value of any standards based upon good material and highly trained operators.

Optimum Standards

This absence of precise measurements of output does not mean, however, that O and M can get away with guesses. The experienced investigator must have in his mind or his notebook a series of acceptable optimum standards for any clerical operation which he is studying. He should know what can be done under good conditions, with good material and good staff, if he is to raise the level of output. This is a second field where experience and knowledge is of great value and some companies have therefore measured and timed office work in some detail so as to form a basis for better training, better supervision, and better O and M standards. The ordinary office investigator will seldom be called upon to use the techniques of work study, but he will need a good knowledge of motion economy (or the common sense of saving unnecessary work) in the design of workplace, desks, counters, etc., and the layout of working points within the floor space available. These subjects and others are dealt with in the last part of the book.

In conducting an assignment, apart from knowledge of

office procedures, equipment, etc., the investigator must learn to manage himself. He must plan his own work intelligently, interview extremely tactfully, and be able to prepare his findings in the form of a report which is readable. There is no magic in all this and the logical approach suggested in Chapter V should be a very great help to the man new to this work in warning him of those things he must not forget and encouraging him to do certain things that his superiors will appreciate.

The remaining sections of the book will need little introduction for the day-to-day work of management and the understanding of organisation are more familiar as subjects than is the practice of O and M.

What qualities and abilities does the investigator himself need for this work? He will need an analytical approach, a discipline of investigation, detailed knowledge of modern office methods and machinery and an understanding of organisation. These four requirements are essential. The first we all claim to possess. The second is most necessary in order to be able to prove any recommendations made. The third may take years to acquire, for very few people have all this knowledge. The last is perhaps the most difficult to develop for the understanding of organisation involves considerations more abstract than practical; yet this understanding must in addition be based on a practical knowledge of the different ways in which different companies divide up their duties and activities, and of the different considerations that underlie these divisions.

Office Work

In many companies O and M is largely concerned with paper work carried out in offices. An office can be any room in the factory, the warehouse, despatch office, or the administrative buildings where clerical work takes place, but in the O and M context 'the office' is primarily the administrative headquarters of the business which provides management with:

A service of communication.

A record of past transactions and operations.

To conduct its business a company must be able to communicate with suppliers and customers — actual or potential; with shareholders, bankers, insurers and others whose interest is largely financial; with trade unions and trade associations; with

the central government and local government. The executive needs to communicate with the management and *vice versa*. For this information is needed about products and prices, customers and competitors, money, men and machines. Not only information is needed but provision of channels of communication. The purpose of the office is to provide information and services.

Similarly, and to provide for continuity, a business must be able to relate current to past conditions. A business must have a 'memory', and thus be able to refer to and recall information. Records have, therefore, to be kept of business activities in such a way that all the information relating to a particular transaction can be speedily obtained. The office provides the 'memory' of recorded information.

The office collects and processes raw material or data and turns this into managerial information of various kinds. Parts of this processing can be mechanised where desired, but the decision to mechanise should follow the sort of careful investigation discussed in later chapters.

Office Processes

In studying office work, five processing stages can be distinguished through which any piece of information may have to pass. These are assembly, rearrangement, recording, transmission, and interpretation. Not all information passes through all stages and the operations at one stage may be repeated. For example, information may be set out in one way for one particular purpose, and transmitted and rearranged for another purpose. Again, two processing stages may be completed simultaneously, as when a piece of information is transmitted and a record is automatically made of it.

Assembly is a phrase used for the receipt and collection of information. Some information, letters, orders, enquiries, invoices, etc. flow in daily. Other information has to be found.

The information as it arrives is seldom in a usable form and needs rearrangement to suit the recipients. Quantitative information may need summarising, recalculating, and checking. Factual information may need collating, restating, amending, or bringing up to date before suitable for presentation. Statistical tables, charts, or graphs may have to be prepared as well as financial statements and reports.

Records of information are kept for statutory and other purposes, as well as for day-to-day management. These records include sales and purchases, debts settled and outstanding, stocks and capital assets, and buildings and plant. Information about employees, hours worked, wages and salaries paid, income tax and other deductions from pay must all be recorded and brought into account.

The offices arrange the transmission of information to those responsible for planning and seeing that action is taken, whether this is routine or to meet a special request. The 'office' must see that data or instructions are in a form suited for transmission by a means which does not distort or otherwise risk misunderstanding. Quotations, orders for supplies, invoices, statements of account, balance sheets, progress reports, works instructions, and receipts are examples of this work.

Finally, the 'office' must at all times subject the information being handled to a process of interpretation. The operating conditions of the business are reflected in the records maintained and the office has the duty of observing these records intelligently, and taking appropriate action. Overdue accounts must be pursued, stock levels adjusted, assets protected, cash properly accounted for, salaries reviewed, and any significant changes reported without delay to responsible management.

These five clerical processing stages — assembly, rearrangement, recording, interpretation, and transmission — will be found in any commercial organisation. In a small business, they may all be the responsibility of one clerk or even the proprietor himself. There is no 'office' in the conventional sense. As the business grows, it becomes more and more difficult for one man to remember or to record, and to deal in person with all the transactions and details of the business. The office therefore exists to fulfil these functions on behalf of the management and to provide a service to the rest of the business.

Problem Solving

Whether engaged in the study of purpose, or in tidying up methods or organisation, the investigator will be faced by 'problems' concerned with how to obtain a desired result, or how to produce certain information in a given time and at a low cost. One of the queer aspects of efficiency work, in the factory

or the office, is the preoccupation of the investigators with problems. These they are taught to formalise and to write down before attempting a solution. The fact that there are two aspects to a problem is often overlooked; the method (HOW) provides an obvious field for simplification or mechanisation, but the change is of little profit unless the purpose (WHAT) is first determined and validated. At some stage in most O and M assignments the investigator and his team leader will come together to crystallise in words the problem involved in the job. Then they must solve it. Is there a guide to this work?

The analysis that follows may help. The steps it suggests (based on heuristic) are familiar in science and mathematics and may also serve an O and M investigation.

Understanding the Problem

Can I write down what I think the problem is?
Why has this assignment arisen? Does that give a clue to the question?
What are the facts available?
What special considerations influence the assignment? (company practice, market requirements, personalities involved, etc.)
Will a chart, map or figure help to interrelate the parts of the problem or the organisation affected?
What is the main purpose that has to be served? What are the subsidiary purposes?
What special requirements have to be met? — accuracy, time, etc.?
What output is required of the system?
If I owned the business, what would I require in the way of information and control?
Are there any other outputs or by-products? Are they necessary?
Where does the original information come from?
Who else uses it? What do they use it for?
Can I now rewrite what I understand the problem to be?

Devising a Plan

How would I do this sort of test at home?
What are the simple components of this problem?

What are the normal techniques of dealing with such components?
Can I see how to apply them to this problem?
Have I seen this problem before? Or a similar one? What characteristics are different?
Do I know a solution to a similar problem that could be useful and economic?
Would this solution work? If not, why not? Could it be adapted?
What other part of the company has a similar problem?
What other companies have similar problems?
What do they do? Would it work here?
Is there any authority on problems of this sort?
Who knows more about it than I do? Do I know him? Can I get an introduction?
Is there anything in the literature that would help?
Could I do with help from an expert in another field, e.g. operational research, work study, statistics?
Is the problem perhaps better suited to solution by someone in another field?
With whom can I discuss my ideas for a solution?
Who would make useful suggestions? Who would be a good sounding-board?
Shall I sleep on this, i.e. go on to another task and give my mind reasonable time to work out a solution without any forcing process?
Can I improvise a method of doing this myself? (before looking at standard practice or merely copying others)

Testing a Solution

Does it meet all the requirements — of accuracy, time, etc.?
Would it properly serve all the purposes?
Have I eliminated all that can be eliminated? Combined all that can be combined?
Have I taken everything into account? Would it work in exceptional cases?
Should there be discriminatory treatment for different classes of items?
Would the people who would work this way like it?

What are its advantages over present practice?
Am I sure it is the best way I could devise?
Will it make sense to the operating staff?
Will it be difficult to sell?
Will it be difficult to install? Could it be tried on a pilot basis?
Prepare a chart or map of the new way. How does it compare with the old?
Are the improvements conspicuous?
Could any change in circumstance disrupt it?
Could the result be applied to any other problem?
Have I made a detailed breakdown of the steps which will be understandable to others?
Have I obtained good constructive criticisms which have sufficiently tested my ideas?
Have I made a balance sheet of pros and cons and also tested cost?
Is there a sufficiency of saving from improvements to make this worth recommending to management?

So much for an introduction to a book designed mainly for men and women who are working on efficiency audits, organisation and methods, office administration, office management, systems and procedures, or any of the other trade names for simplification of organisation and operations. Any director, executive, or manager could benefit from following the thinking of the nine companies whose joint experience this book represents, for some of their practice will suggest methods by which he can increase productivity or efficiency and decrease paper work.

VERIFICATION OF PURPOSE

Before setting out to simplify an existing job of work, the investigator must satisfy himself that what is being done is really necessary, that the purpose is useful, and the work worth doing. Considerable time may otherwise be spent in studying an office procedure which is found later to be unnecessary. Industry consists essentially of purposeful enterprise — the making of a product or the selling of goods, the search for profit, or the development of a research project, and in these examples the purpose may be pin-pointed and committed to paper. Most departments or branches of a business are assigned duties or tasks which together add up to their purpose.

Purpose itself is of three different orders of importance: firstly overall purpose, also known as policy; secondly departmental purpose; thirdly 'the end' or object of any office procedure. These degrees of purpose are respectively concerned with organisation, management, and the method. Most alterations in purpose at any level involve a change in the organisation, and this represents a first association of method with organisation. An overall purpose, for instance, to sell goods may be broken down into management objectives to sell x tons of this and y tons of that. Objectives, often used as synonyms for purpose, are the physical interpretations of purpose in the form of targets.

In O and M work a pilot survey is needed of the purposes of the organisation and management before a procedure study is begun. The pilot survey must discover the answers to 'WHY' and 'WHAT', that is to say 'Why is this work being done? What does the department hope to achieve by it?' In this way it may be shown that some activities will become unnecessary when, for example, a gradual change in purpose is carried fully into effect by the redesign of methods and procedures.

Purpose of a Procedure

All clerical work may be assumed to have had a useful object or purpose when originally designed. Any office activity may be justified if it is a stage or step in the collection and recording of

information needed for the management of the business. When business was on a small scale, the manager could carry much of this in his head. As the business grew, he gradually delegated some part of the information service or 'office work' to assistants or clerks. Today, this office work has grown to very great proportions, due partly to specialisation in management, partly to the insatiable demands of government departments for information, and partly to demands by the executive for complicated data for planning.

The first requirement in the study of any office activity is to separate the various degrees of purpose involved. The usual way to start this exercise is to find satisfactory answers to WHY and WHAT.

Consider WHY any particular office procedure exists. For example:

For meeting some statutory requirement. For instance, as a means of producing the company's accounts. (Overall purpose)

To enable the company to meet its normal trading obligations. (Overall purpose)

As a control on efficiency. (Overall and departmental purpose)

As a control on expenditure. (Overall and departmental purpose)

As a control of assets. (Overall purpose)

To enable the company to meet its obligations as an employer. (Overall purpose)

As part of the duty of the watch dog against fraud or embezzlement. (Departmental purpose)

To provide the data for a management decision. (Departmental purpose)

The association of a procedure with one or more of these questions involves a high level of management. Often those who carry out the activity and those supervising it may not know why they are doing what they do. On occasion the investigator will have to determine the departmental purpose and find out from management whether or not this is correct. The manager himself may not necessarily know or say precisely what information he wants, what picture he is looking for from his figures, or why he wants them. The figures may give him a trend or a

comparison between present and past performance or estimates.

The Challenge of Purpose

Sometimes a quantity of data, which at the time of preparation appeared to have some value, later turns out to be useless. Yet sometimes the production of information in the wrong form may help the manager to decide the right form of presentation. In many cases the fact that the manager wants information may have to be accepted as the justification for its preparation. In cases of the control of expenditure, the actual controls may be investigated to see whether or not they achieve their object. In the verification of the value of records and other data — 'statistical information' — the challenge of purpose will often afford an opportunity for savings.

A group of considerations, at the management level, may also need review and may include the need:

To provide a service for management. (Departmental purpose)
To pay suppliers' accounts. (Departmental purpose)
To control cash. (Departmental purpose)
To balance stocks. (Departmental purpose)
To provide a record of staff. (Departmental purpose)
To establish a control total for main ledgers, etc. (Object or purpose of procedure)

The challenge, apart from the questioning during the pilot survey, may not provide a correct answer because of the difficulty of distinguishing between why it is done and what object or purpose it really serves. As an example, a machine operator engaged on listing a batch of documents said that the object of the work was to provide a reconciliation with the general ledger control balance. Now the object of listing the totals was clearly the provision of a total figure and no more, since listing by itself would not reconcile any balance. Looking at the object showed that a total figure had to be produced and was, therefore, purposeful. The listing operation did not help the reconciliation and was purposeless. If no other object could be established for listing all the items in the batch of documents, then the procedure itself would be reviewed to see how much could be eliminated or simplified.

Controls That Do Not Control

Experience has shown that many so-called controls do not in fact fulfil their object, which is to compare and control a varying condition of the business. Often the control is really little more than a check on the accuracy of the arithmetic of the compiler of the information. Many examples could be given of this, but two which provide a good illustration are as follows:

A sales return gave a summary of sales and had attached to it one copy of each sales invoice. The invoices were checked against the summary as a control on the sales summary. There was, however, no means of knowing whether all invoices had been included, so in effect the checking assured the accuracy of the arithmetic only.

Two returns were sent to a control office — one for use in stock control, showing sales and other details, and one showing sales only. The sales return was checked against the stock return, and if it agreed was accepted as correct and controlled. But the sales return was, in fact, an extract from the stock return, so that any disagreement was accidental and no control existed at all.

These examples suggest that there is a real need to take considerable care in establishing 'the object of the exercise, or the purpose'. Where, for example, this is to follow-through or progress some routine or other, then the investigator is often free to develop another method provided that the object is attained. The difficulty of understanding purpose becomes greater when the reports and returns are not of a routine nature, but are supplied to managements who do not say why they want them.

Inside the Manager's Mind

For example, let us consider a statement showing staff at locations on a certain date in comparison with staff at the same locations at some previous date. What is the object or purpose of this statement? Is it purposeful or purposeless? To examine the return and form an opinion is of little value because the O and M man will not necessarily have the experience to place the same interpretation on the figures as would the actual manager. Different managers may read different meanings into

the same report. There would therefore seem to be more than one purpose possible.

In this example the purpose might be one of showing a trend in staff establishments; it could, however, be merely one of showing the total staff by locations. Why should a manager wish to have the current totals at each centre of employment if not for some purpose or comparison? To make any worthwhile contribution to a case like this, an estimate of the use and value placed on this record by the manager is necessary. What goes on in his mind when he reads these particular figures? He could find them just interesting; he might get from them a sense of relative proportions between different centres; he could want to see which centres are increasing by more than a certain percentage. Put in another way, he might be looking for significant trends. If that is the object of the return, then much of what has been described has no purpose at all because whatever trend is shown may not warrant a change of policy.

Only by getting the manager to explain what he is thinking and requiring as he reads the return will the investigator be able to discover the object or purpose of it. To make matters worse, the same return may be used for different purposes by different managers, so that discovering the 'ends' of any particular piece of paper work is not a simple matter, and demands understanding of what managers want and need in order to control the activities for which they are responsible.

Some work may be found purposeless, yet a company might gain some value from the creation of a useful purpose and the maintenance or redesign of the work to suit a need that was not previously met.

Work Elimination

Possibly the most satisfying assignment to work upon is one in which the study of departmental purpose leads to agreement with management that the work or part of the work being surveyed is no longer necessary. Great emphasis must be placed on securing agreement to dispense with any records in question because, as already suggested, there may be a number of reasons for the continuation of a record or control although by ordinary standards of efficiency it purposeless. Indeed, on occasion, deliberate duplication of some part of the work may

be used for security reasons, or, for a different reason when a number of departments all need access to the same records. Risks of fraud or embezzlement, information that may be needed for a future tax claim, information that serves to give a pointer in policy matters — these three and others may be among the considerations that will need verification. Conversely, the purpose of certain records may be tested and found to be valuable, yet not all the operations that lead to that purpose are warranted. For instance, the checking of suppliers' invoices may be justified in principle, but below a certain value this checking may not be worth while.

All possible leads of uses to which the records are put should be followed up in studying work which may possibly be discontinued. These leads are not only of the uses claimed for them, but include reference to all the managers who like to see the records; each line of defence of the existence of the records should be tested very carefully before agreeing to the necessity of keeping them.

Any experienced head of O and M will be able to give a number of examples where a complete procedure was found to be unnecessary and was dispensed with. The survey that led to this conclusion was invariably a study of the object which the procedure was supposed to serve.

Testing the purpose of work demands experience and ability and involves organisation, management and methods. Because of the complexity of subject it ought perhaps to come towards the end of a text-book, yet because of its overriding importance it has been placed with the introductory chapter, and we shall need to return to it in a number of later chapters.

CHAPTER I

THE SIMPLIFICATION OF OFFICE WORK

The Study of Procedures

In a very straightforward office job consisting of only two or three steps, like that involved in receiving a remittance, acknowledging on demand, and posting the credit to the correct account, the details of the work may easily be retained in the memory of the investigator. As soon as work becomes complicated by the number of branches involved, or the variety of products or materials to be handled, memory by itself cannot be trusted and a record may have to be made for future reference and as a working paper for the investigator to use in simplifying the whole of an existing procedure. Various forms of record may be used and two detailed records are illustrated in this chapter.

Not all companies use detailed records when studying office work and the second half of this chapter (page 23) illustrates an alternative and interesting approach which avoids recording or measuring the detailed steps followed in a procedure. This method concentrates upon developing a new and improved method designed to suit the particular requirements of the job and trains the staff to carry it out without a detailed analysis of the old method.

The question as to when to use a detailed study is controversial. One obvious value is in the preliminary training of an investigator to ensure that he works to the requisite degree of detail and makes a careful record of what has been found. In some companies, procedure charts are used on every occasion; in others, where the work is highly complicated, or, when actual evidence is needed of the details of the present procedure in order to clinch an argument for a new procedure. No generalisation is possible. Knowing how to use a procedure chart is part of the equipment of an investigator. The head of O and M will require the use of these charts whenever he thinks necessary.

Any job, large or small, consists of a number of smaller jobs.

Before considering what ought to be done and how many smaller jobs are required, a process of analysis is necessary to divide the main job into its several parts or steps. Every step in a procedure study, and all the actions that take place must be recorded separately on each document that enters the procedure. Each step so recorded should be complete in itself, having a definite beginning and end.

The tools of procedure studies are method analysis sheets, procedure charts, activity lists, and movement diagrams. The systematic study of office work demands that charts and method-analysis sheets should be standardised on some conventions. These are mainly useful to the investigator who will adapt or modify them in any way he likes to suit his own or his company's local requirements.

Method Analysis Sheets

In teaching a systematic way of recording the details of clerical procedures the Method Analysis Sheet — Unit Document can be of help.

The rough notes made on the spot during a survey may be systematically assembled by the use of these forms. A separate sheet is used for each document. Each separate step in the procedure must be recorded on the sheet so that full particulars of every clerical step the document follows will be recorded in accurate and concise form and in the order the steps were taken. The 'boxes' on the Method Analysis Sheet (See p. 3) are now explained.

Entries Identifying the Job and the Document

System — e.g. Sales, Supply, Wages.

Procedure for — These entries describe the job briefly, but accurately, e.g. Originating Stock Checking Lists.

Form Title / *Form Ref.* — Identifications extracted from the documents concerned.

Entries Detailing the Procedure

Operation No. — Operations, or steps, are entered in strict sequence of occurence in the procedure. Because separate sheets may be used

METHOD ANALYSIS — UNIT DOCUMENT

SHEET No.....

SYSTEM	PROCEDURE FOR
FORM TITLE	FORM REF

OPERATION SYMBOLS

- C — CLERICAL OPERATION
- T — TYPEWRITER OPERATION
- M — MACHINE OPERATION
- ○ — TRANSPORT OPERATION
- ◇ — INSPECTING (FOR QUALITY) OPERATION
- ▽ — PERMANENT STORAGE OPERATION
- ▽ (inverted) — TEMPORARY STORAGE OPERATION

Elimination — WHAT?

Combination — HOW? / WHO?

Change of Sequence — WHERE? / WHEN?

IS / COULD / SHOULD — WHY?

OPERATION No (1)	SYMBOL (2)	DESCRIPTION OF OPERATION (OR STEP) (3)

LC.1/3274/1 7 56 KP Date..... Prepared by.....

See over for Notes.

FIG. 1A

Legend to procedure charting symbols and conventions.

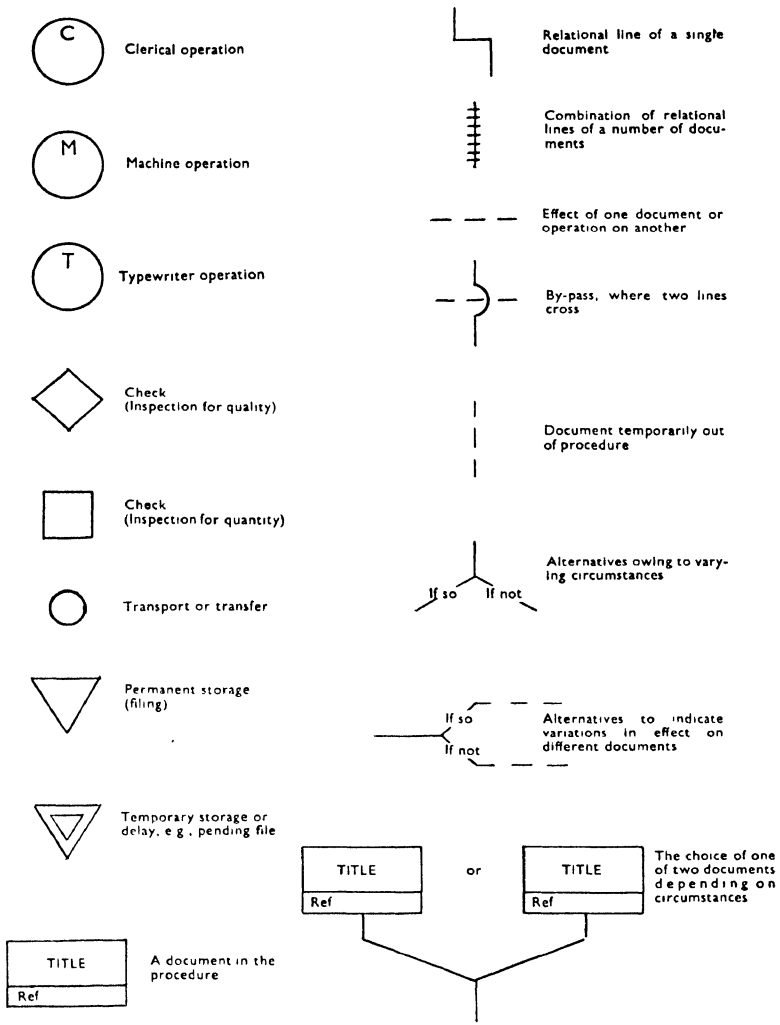


FIG. 1B

there may therefore be gaps in the sequence of numbers on any *individual* method analysis sheet, if more than one document is involved.

Operation Symbol The appropriate charting symbol should be inserted.

Description The description column contains concise details of activity and, in addition, where appropriate:

Number of operators.
Time taken (minutes).
Distance moved (approximate).

Finally, the date and signature should be added.

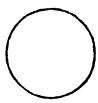
Space is provided on the reverse for notes about a particular step described on the front, or for Basic Information relevant to the investigation regarding the overall system or procedure, but not part of the procedure under observation.

As each step is observed, its importance should be estimated in order to decide the most convenient method of recording. This will depend on how much detail is required to achieve a sufficiently accurate record. As already mentioned, each step recorded should be complete in itself and have a definite and definable beginning and end.

Procedure Charts

Symbols (used in activity lists and procedure charts)

A variety of different symbols is used in different countries, and different industries have developed their own. Five basic symbols are connected according to the following conventions.



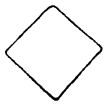
Operation is represented by a circle.

An operation is said to take place whenever an object is intentionally changed in any characteristic; when assembled, stripped, arranged or prepared for further operations; when information is given or received or recorded; when planning or calculating takes place.

The symbol may represent a complete activity or

operation such as 'Staple paper together' or 'Calculate and enter prices and amounts'. For clerical work, this has been sub-divided to cover:





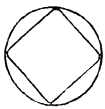
Inspection (*Check*) is represented by a diamond.

An inspection for quality occurs whenever the characteristics of an object are examined. A document may have to be checked both for the quality of reproduction and the correctness of information.



Inspection for Quantity is represented by a square.

An inspection for quantity takes the form of a count. This symbol is used whenever the accurate check of quantity is the predominant objective. Quality inspection is the usual form of inspection in the office.



Combination of Symbols is permissable e.g. a diamond within a circle.

Two symbols may be combined when activities are performed at the same work place, or when they are performed concurrently as an activity. For example, operation and inspection.

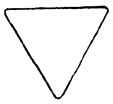


Transport is represented by a small circle.



— ASME alternative (American Society of Mechanical Engineers).

A 'transport' or transfer occurs whenever any object is moved from one place or position to another. The distance travelled should be indicated. When a procedure, as distinct from an operation, is under investigation, this symbol should only be used when the object or form moves outside the immediate *working area* of the clerk or operator. Notes should be made of the mode employed, i.e. man, trolley, lift, conveyor, mail, etc.



Permanent Storage is represented by a single inverted triangle.

A permanent storage occurs whenever an article or object is kept and protected against unauthorised removal.

The use of this symbol indicates that the object is static at the time and in clerical procedures the final filing of the document concerned.



Temporary Storage or Delay is represented by a double inverted triangle.



— ASME alternative.

A temporary storage delay occurs when conditions do not require or permit the immediate performance of the next planned action or operation.

This symbol has many uses, such as to indicate material or papers, deposited or filed, awaiting posting by a clerk.

Construction of the Chart

Before a chart is started the fineness of detail needed for effective investigation needs to be decided; as far as possible, the individual steps should be kept to the same degree of detail.

Five operation symbols are used and these are connected according to certain conventions.

The amount of detail recorded on a procedure chart will depend upon the use to be made of the chart. An operation, such as posting an entry on a card, may be shown by one symbol unless a very close study of this operation is required; then it will be split into its elements or steps, each of which will be represented by a separate symbol.

A procedure chart designed to demonstrate the value of a new method, or to be used for teaching, may leave out the more obvious symbols. For example, when recording the operation involved in duplicating a paper, there may be no need to show that the master has been placed on the duplicating machine. This would, however, be needed if a close comparison was attempted with an alternative method of copying information.

Example of use of procedure charting symbols and conventions.

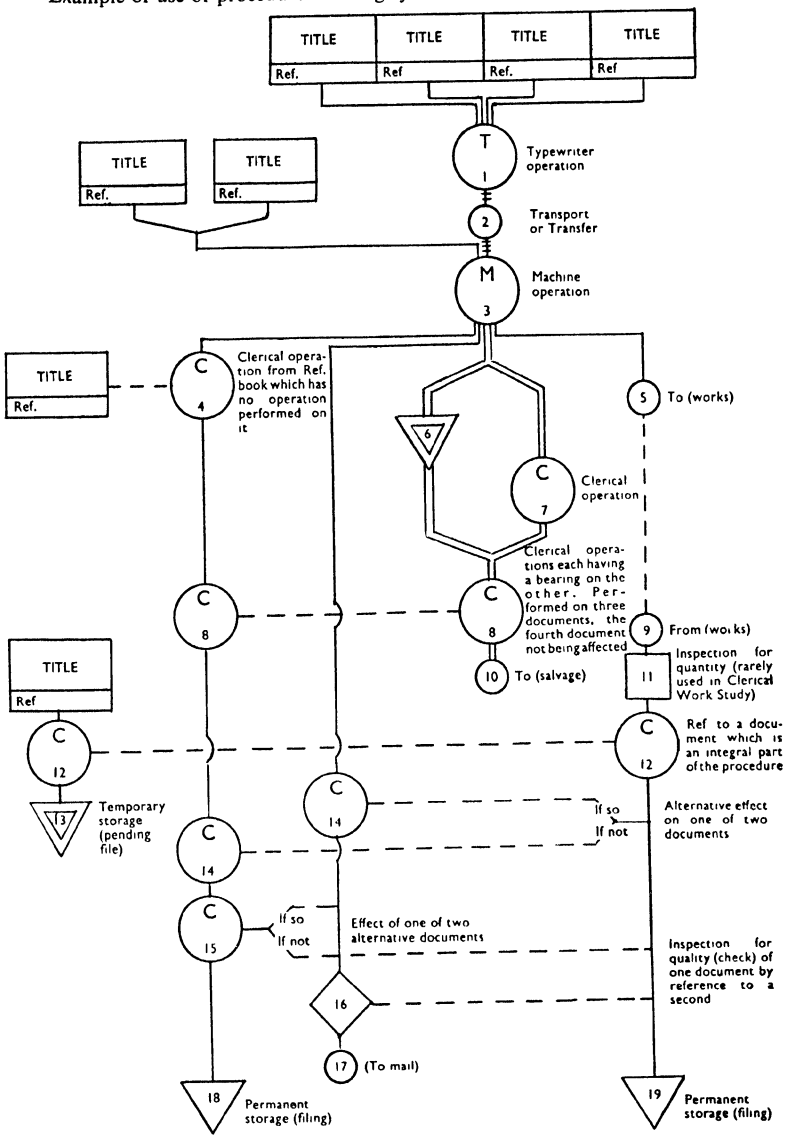


FIG. 1C

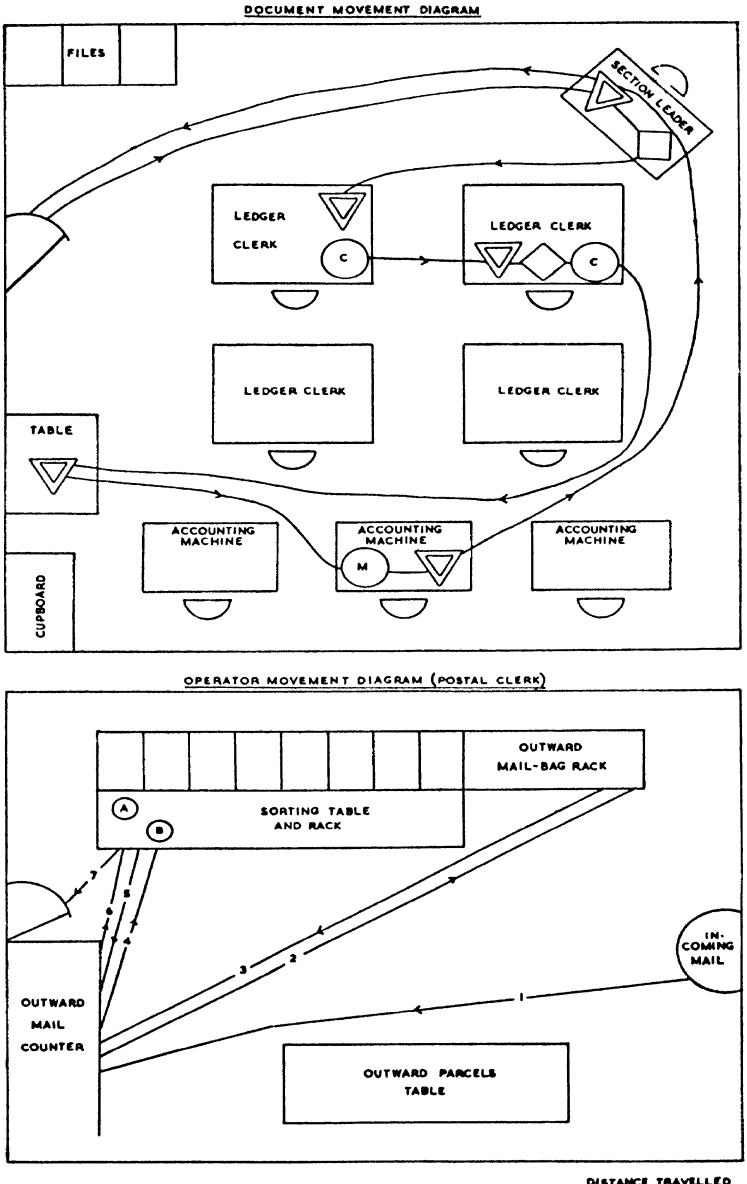

DOCUMENT MOVEMENT DIAGRAM
FILES
SECTION LEADER
LEDGER CLERK
C
LEDGER CLERK
C
LEDGER CLERK
LEDGER CLERK
TABLE
ACCOUNTING MACHINE
ACCOUNTING MACHINE
M
ACCOUNTING MACHINE
CUPBOARD
OPERATOR MOVEMENT DIAGRAM (POSTAL CLERK)
OUTWARD MAIL-BAG RACK
A
B
SORTING TABLE AND RACK
7
6
5
4
3
2
1
IN-COMING MAIL
OUTWARD MAIL COUNTER
OUTWARD PARCELS TABLE
A LETTER OPENER
B DATE STAMP
DISTANCE TRAVELLED 187 FEET
NOT TO SCALE

FIG. ID

Procedure charts are drawn vertically or horizontally. The horizontal has some advantages particularly for very simple procedures. The document lines run from left to right, a convenience to the eye, but in a complicated procedure the vertical chart is preferable.

Each document in the procedure is identified by its name and form reference, which are placed in a rectangular box above the first operation that takes place on the document.

A procedure chart therefore consists of:

document boxes
the five symbols and
relational lines showing:
relations between operations, and
relations between operations and documents.

Sufficient words in the form of a caption are used to amplify the symbol. These descriptive words are inserted on the immediate right of the appropriate symbol.

The operation number, indicating the position of the step in a strict sequence of occurence, is inserted in each symbol on the procedure chart. Where method analysis sheets are used the numbers will correspond. The relational lines are vertical, horizontal and diagonal, broken or unbroken.

The general layout should be decided before drawing a chart and, in particular, how it is to be set out on a piece of paper. If there is one main document which runs throughout the procedure, this main line is best fixed towards the right of the chart. Layout is, however, settled to suit individual requirements.

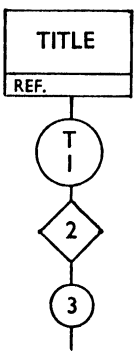


FIG. 2

A working chart for the analysis and examination of the procedure need not be elaborate. One used for selling the new method, or for instructional purposes, requires a better standard of drawing. Various ways of showing the procedure are as follows:

(*a*) *Vertical Trunk.* A solid line running vertically, joining the bottom of a document box with the top of a symbol, or the bottom of a symbol with the top of another symbol, denotes the sequence of operations on a document, the sequence running from the top of the page to the bottom.

(*b*) *Document Boxes.* As far as possible, operations performed on documents are shown vertically under the relevant document box at the top of the page. One symbol covering several vertical relational lines means that one operation is performed producing results on several documents, e.g. by use of carbon paper. This is illustrated in the following diagram.

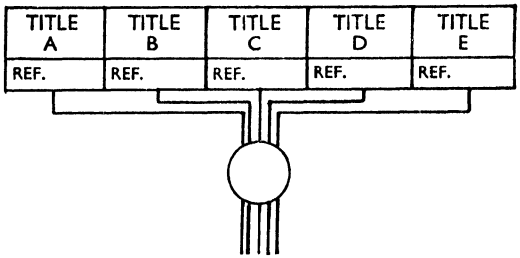


FIG. 3

(*c*) *Railway Line.* When the number of these lines to be drawn together is so numerous that they cannot be easily shown individually they may be merged into a single 'railway' line as follows:

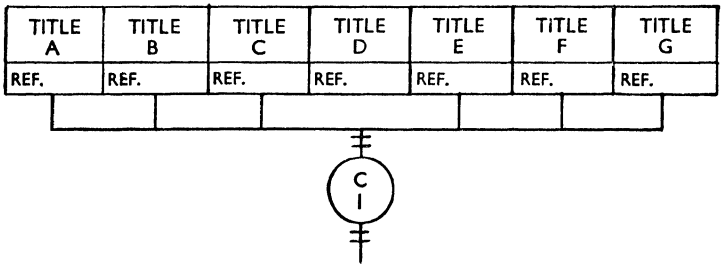


FIG. 4

(*d*) *Railway Line and Other Documents.* A further use of this convention is shown below where a set of documents has been

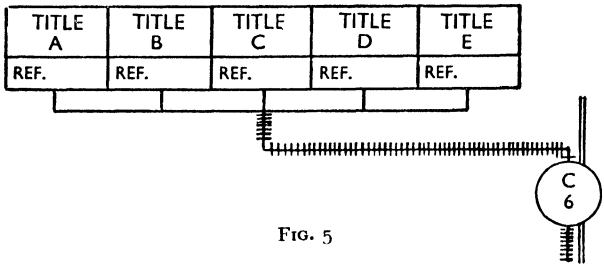


FIG. 5

combined with two independent documents for the performance of one operation on all of them.

(*e*) *Railway Line Parting from other Documents.* When operations are again performed on the documents individually the relational lines are brought back to positions under the original documents at the head of the chart as shown below:

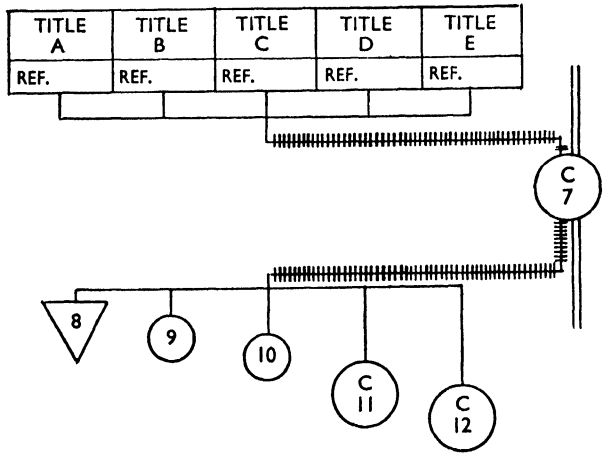


FIG. 6

(*f*) *Horizontal Effects.* A broken horizontal line between a symbol on a relational line and another relational line means that an operation is performed on the first document as a result

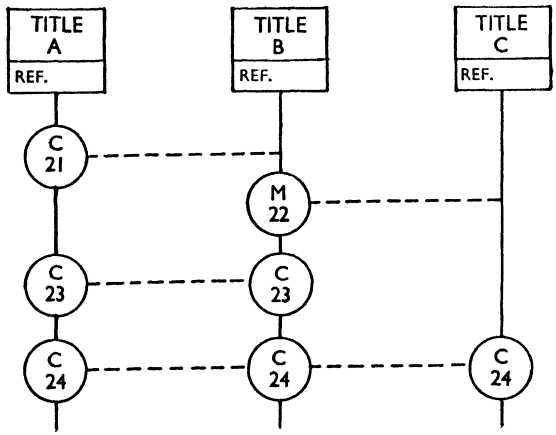


FIG. 7

of the effect made on it by the second document. Similarly, a broken horizontal line may connect two symbols on different relational lines, meaning that significant operations are carried out on both documents, each having some bearing on the other. The same convention may be extended to cover related operations performed on several documents.

(*g*) *Incidental Documents.* If a document in the procedure has an operation performed on it as a result of reference to another document which is not otherwise part of the procedure, it is left to the discretion of the person preparing the chart as to whether the reference document is included or not. As a general rule if such a document or book is an integral part of the system it should be shown:

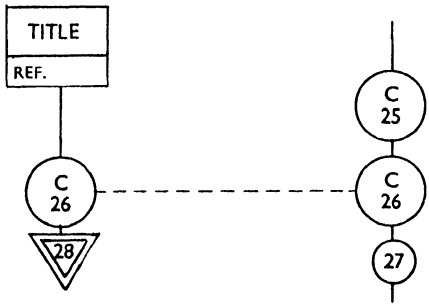


FIG. 8

If the document or book of reference has no operation performed on it, only the title box need be shown, as follows:

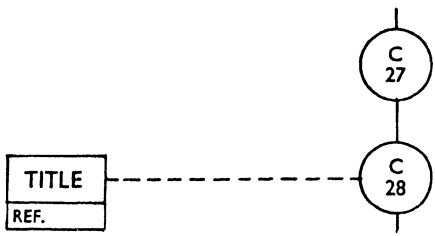


FIG. 9

(*h*) *Documents Temporarily Leaving a Procedure.* If a document leaves the procedure and returns to it later, its normal unbroken

relational line is replaced by a broken line to the point at which it rejoins the procedure. This convention implies that other operations are performed on this document in the meantime but these operations are not part of the procedure which is being charted.

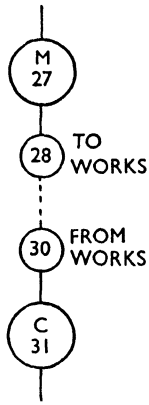


FIG. 10

(*i*) *By-Passing.* If horizontal lines cross vertical lines the by-pass convention will be used on the vertical lines to show which documents remain unaffected.

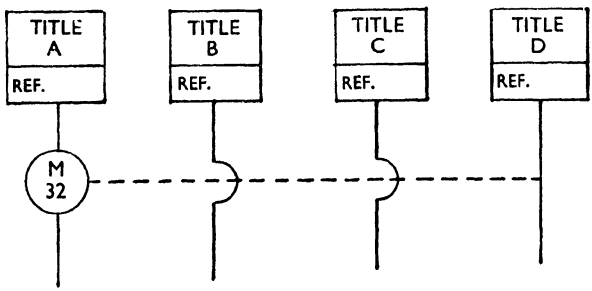
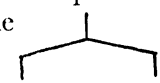


FIG. 11

(*j*) *Alternative Procedures.* A diagonal line implies an alternative. The division of the relational line  expresses the logical notion 'either — or —'.

Notation concerning the alternatives is written preferably along the diagonal lines; if this is not practicable the lines are broken and a notation written in the breaks.

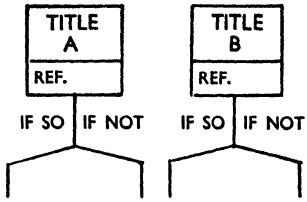


FIG. 12

This convention may be used to cover more than one alternative by drawing diagonal relational lines for each of the alternatives to be charted.

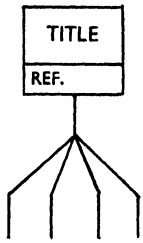


FIG. 13

If a document is subject to alternatives and in one of these alternatives no operations are performed on the document, the diagonal line convention may be omitted and the procedure shown by the inclusion of if clause in the narrative of the next symbol.

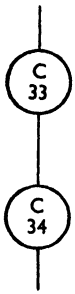
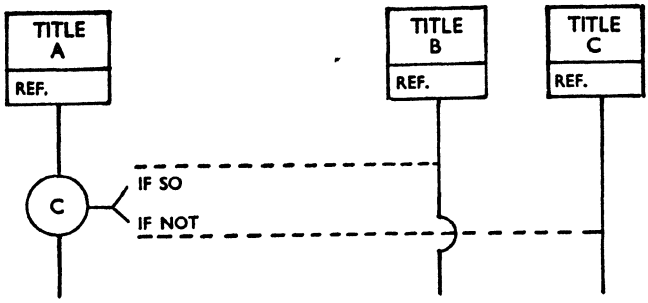


FIG. 14

The following conventions show how the 'either — or —' notion can be used to indicate variations in effect on different documents.



or

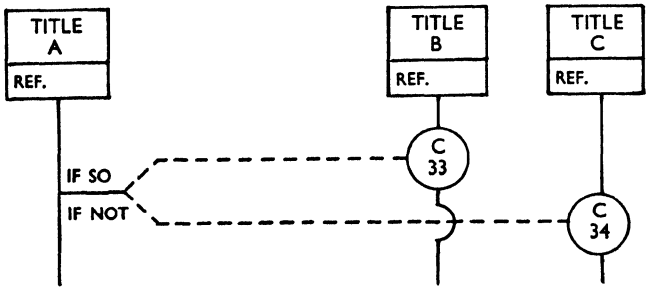


FIG. 15

When it is necessary to show in a procedure that either of two documents may be used this can be done by placing the box titles of the forms side by side and writing the word 'OR' between them; diagonal relational lines converge into one relational line which will then be charted for either of the two documents.

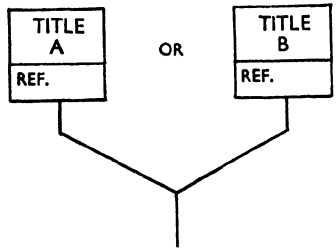


FIG. 16

(*k*) *Starting a New Sheet.* Complicated or alternative procedures may have to be continued on separate sheets. When this is done, lines should be drawn across the page as shown below:

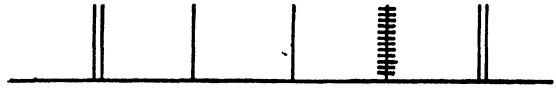


FIG. 17

When a procedure chart is continued from one sheet of paper to another, a document being carried forward is shown by a vertical line from the last operation, finishing just above the bottom of the sheet. In the succeeding sheet, a document box including the title and reference of each document brought forward is shown with a short vertical line from the top of the sheet to each document box.

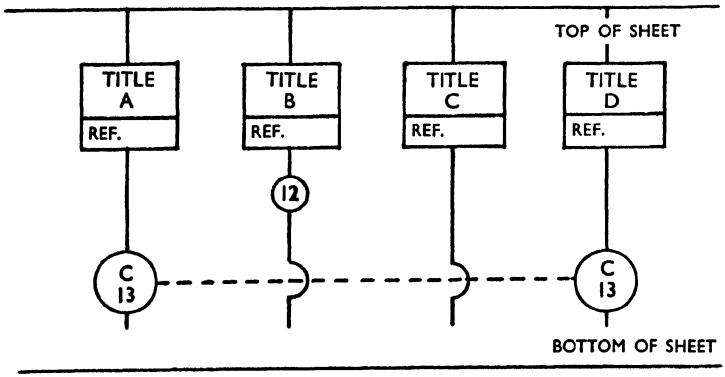


FIG. 18

Legend Key

A legend is placed in front of, or on the first sheet of, any chart or batch of charts to permit interpretation of the procedure by those not familiar with the symbols.

Alternative Charting Symbols

Overleaf is an example of an alternative method of recording a procedure, with notes on the conventions employed.

Analysis

The information obtained by use of procedure charts has next to be analysed, and throughout this process the investigator must question and critically appraise what he has found out. A fruitful first division is into work that is immediately productive, in the sense that it achieves some concrete object, and into work that is unproductive, as for instance the work entailed in preparing or putting away.

PROCEDURE FOR VERIFICATION OF PURCHASE

INVOICES AND STATEMENTS OF ACCOUNT

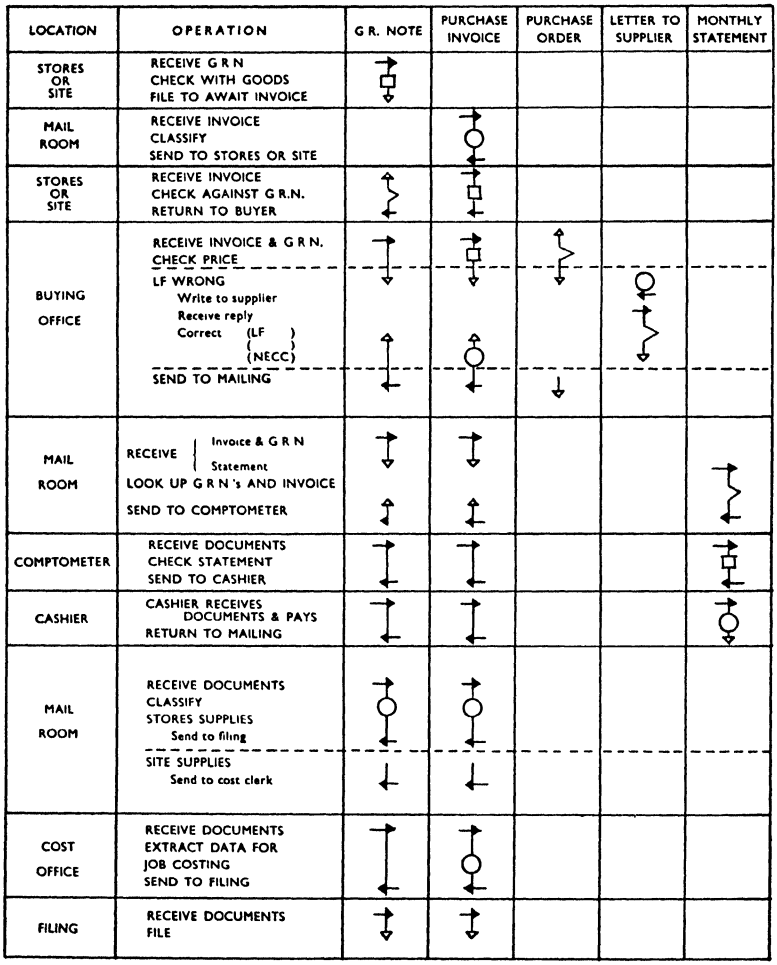


FIG. 19

Work can thus be classified broadly in terms of 'Do' (productive), and 'Make-Ready' or 'Put-Away' (non-productive) operations. As an example, 'Do' operations are those concerned with making an entry on a document, either manually or mechanically.

Examples of 'Make-ready' are:

Obtaining instructions or information.

Getting materials ready.
Setting up and adjusting machine.

Examples of 'Put-away' are:
Removing a stencil from a duplicator.
Replacing a file in a cabinet.
Putting away registers or reference books.

This classification applies also to information provided by activity lists, movement diagrams or string diagrams, and to answers to the questions listed in the sections dealing with these three methods of recording.

ALTERNATIVE PROCEDURE CHARTING CONVENTIONS



Document or material in.

Document or material out.

Operation.

Inspection.

Refer to.

To File.

From File.

Dotted line across page indicates alternative action.

Length of delay approximates to length of line between other conventional signs.

A double line drawn across the page represents a time delay.

FIG. 20

Activity Lists

Before making a survey and to aid in its planning, outline the work done by sections within a department, by individual operators, or by machines.

The term used to describe such outlines is 'Activity List', qualified by the terms 'Section', 'Operator' or 'Machine'.

Lists may summarise the activities carried out in a day, week, month or year. Times, whether estimated or derived from time study, may be filled in against each item.

In addition to the identity of the section, operator, or machine involved, lists should include the name of the person responsible for preparation, the date of preparation, the period covered and, if times are included, the degree of their accuracy.

Section Activity List

The section head should prepare this but he will need adequate notice before doing so. The list should contain the jobs for which his section is responsible and the total hours spent on each job if figures are available. During a survey this list will serve as a check-list to ensure that every job performed by the section has been covered.

Operator Activity List

The operator should prepare this list because the section head may not have accurate and complete information available. If the investigator attempts it, he may miss jobs that only occur infrequently. Each operator should be asked to estimate the amount of time he spends on each of his jobs. These estimates will vary in accuracy, but may be useful to draw attention to time-consuming parts of the procedure.

Machine Activity Lists

These lists show the jobs for which any machine is used. With times included, they show loading details useful for comparing methods and costs and give evidence of machine breakdowns and maintenance needs.

Work Distribution Lists

These lists are not often used because of the variety in most clerical jobs. In a work distribution list, operator or section activity lists are consolidated to show the total amount of time spent on each job and provide a handy way of summarising the amount of time spent on broad activities.

Progressive Activity Lists

Progressive activity lists show the activities of an operator or machine arranged in time sequence, instead of being summarised as in the preceding lists. A general list is in the nature of a programme and rarely deals in times of less than a quarter of an hour. A detailed list may show times in minutes, or even seconds. The latter is particularly important where documents have to flow to a time schedule to ensure a programme being carried

out; it is usually prepared as the result of a time study, though on occasion it may be feasible for the operator himself to prepare it.

In preparing a machine activity list, machine time often needs to be analysed as follows:

Machine Availability Time	- Equivalent to staff working hours.
Machine Operating Time	- Total of make-ready time, machine productivity time and put-away time.
Machine Productive Time	- Time during which machine is actually operating.
Machine Idle Time	- Includes time for maintenance and cleaning, tea breaks, etc.

Reference should be made to the Section on Statistical Sampling in Chapter IX.

Some questions to ask when examining such a list are:

Does the machine programme fit in with the flow of work?

Is full use made of machine time?

Can the machine programme be altered to provide greater effectiveness?

Can greater effectiveness be obtained by altering the flow of work to the machine?

Is full use being made of the operator?

Can output be increased by altering the method of servicing the machine?

Movement Diagrams

Document movement diagrams and operator movement diagrams have their uses during surveys in the study of possible changes in layout designed to shorten distances travelled.

The movements can be recorded on paper, or illustrated by making a string diagram, and the choice will depend on the complexity of the job. In either case a scale plan has to be drawn first, but the string diagram has the advantage of being easily altered, and therefore affords a means of improving on a solution before it is finally recorded.

Squared paper is useful, and a scale of $\frac{1}{4}$ inch to 1 foot is usual. All doors, windows, pillars, and fixed furniture and equipment should be shown in the chart. Movable templets for furniture and equipment will help in designing a layout for an office

because they can be used to record existing movements or to establish proposed movements. On this aspect, reference should be made to Chapter IX.

A string diagram is very simply made by running string or cotton round pins placed at the various work stations. This clearly shows distances travelled, number of journeys and complexity or possible bottle-necks where these exist.

The movement diagram employs lines drawn on a plan to show the path of movement of document or operation. Procedure-charting symbols can be used with or without lettering to indicate what takes place at any stage in the flow of work. The total distances travelled can be usefully recorded to compare new methods or layout with those previously in force.

There is a possible conflict between the interest of the department and those of the operators. New methods should be chosen and illustrated by a diagram which combine the requirements of both.

Diagrams should contain details of subject, author, date and scale and, where desired, should be included with the report of recommendations.

The following questions are useful in studying a movement diagram:

What is the object of the movements shown? (This will probably be asked and answered prior to the drawing of the diagram.)

What is the total distance covered by the main documents in the procedure?

Can this distance be reduced by altering the method?

Can this distance be reduced by altering the lay-out?

Is the flow progressive or is there back-tracking?

How are the documents moved from one operator to another?

Is there a case for a messenger service or a mechanical conveyor?

How important is the cycle time, i.e. the speed of throughput of individual documents?

Are too many operators handling the documents? Is there too much work awaiting attention?

What control methods should there be to ensure a smooth and rapid flow?

Simplification of Process

In what is called a procedure study the actual operations involved in any process are listed, reduced in number, and then simplified. An alternative approach mentioned in the introduction to this book looks at the purpose of the whole procedure, simplifying this if possible; after clarification, the form the essential office process should take is determined, and the simplest way of carrying out that process is devised, without necessarily studying any of the operations or motions involved. Both approaches should be mastered and used with discretion. If the 'simplification by itself' approach fails or shows no further prospect of progress, a detailed procedure study and/or measurement study may be required.

In the section on Verification of Purpose, it was recommended that the purpose of any job be studied before any detailed study is made of how the work is done. In the earlier part of this chapter various charting methods have been suggested to assist in the analysis of the detailed steps or stages through which the work passes. In either approach the next stage is one of synthesis — the constructive stage in which a new procedure is built up to serve an essential purpose, or to save labour, time, and money.

Work simplification consists of making the purpose clear and the process easy. This demands knowledge and experience of the alternative ways of doing any office job, together with a detailed knowledge of various office aids and equipment which can help to translate a complicated process into an easy one. This section concentrates upon these O and M aids to manual methods, leaving office machinery to a later chapter.

Making the purpose clear

To find a better method we must keep clearly in mind what the job is required to do and match that with the essential process required to carry it out. For convenience, these essential processes may often be reduced to the three — sorting, summarising, and copying — on occasion with some combination of the three. For example, some work involves sorting (of mail before issue), or summarising (of comparable data for a number of representatives), or copying (ledger entries on to a statement

of account). These are obvious examples, but much office work has become so complicated that thinking out and recognising what the basic process really is may be difficult. The investigator has to learn to see the carrying out of a purpose in terms of one or other of these three basic processes. An example may be taken from stores control where analysis showed that requisitions for sundry stores were designed to provide the office with summaries of throughput:

By commodity for bulk posting stores records.
By commodity and department for charging out.
By job costing for reference.

This stores control involved rewriting in summary form, thereby creating opportunities for mistakes. Assuming that the control had a purpose and was therefore necessary, the essential process needs to be determined before one attempts to simplify the work. In the example this essential looks like copying but this itself may not be necessary. The rewriting actually used seems a roundabout way of sorting and summarising items of sundry stores and may have been used because each requisition carried more than one item. If the forms for these multi-item requisitions were designed to take single items only they would not need to be copied but could be sorted and re-sorted into any desired sequence; a single listing machine would provide any summaries required without the liability to error in copying. This example should illustrate that rethinking this particular job demanded no special knowledge, apart from the ability to recognise exactly what the control and its records were intended to do in terms of the essential office process, which in this case was sorting.

Whenever storeskeeping records have to be studied, the object of keeping them should be confirmed. This may be:

Keeping an accurate statement of assets.
Maintaining a check against pilferage.
Providing a reminder for reordering stores.
Providing information for charging out issues.

When agreement has been secured as to which of these objects is intended, thought must be given as to whether the purpose named is being fulfilled and is justified. For example, in the engineer's stores there may be a considerable number of small items such as nuts, bolts, and washers, whose value does

not justify any record at all. The cost of their stores record for purposes of a statement of assets, for charging out, and to safeguard against loss, might easily exceed any potential value of the control. A useful rule is, therefore, to compare the cost of any checking process with the potential loss against which the check is being made, remembering the obligation to discourage theft and pilferage. Apart from wasteful records, other elaborate checks may be found purposeless because they do not in actual fact prevent pilferage or loss.

There are various ways of reviewing office work to improve methods. One of these is to make a simple procedure review to test whether a detailed investigation will be worthwhile.

Procedure Review — The X Chart

For this purpose one may write on the left-hand side of a large columnar sheet the various items which are recorded in an existing procedure: e.g.

ORDER, LEDGER, etc.

	CLERK A	CLERK B	CLERK C	CLERK D	CLERK E			TOTAL
Name of customer		X						
Address of customer			X					
Quantity of goods ordered			X	X				
Type of goods ordered								
Price of goods ordered								
Value of goods ordered								
Delivery details								
etc.								
etc.								

FIG. 21

At the top of each column one then enters the clerk engaged on the process. In each column is indicated the clerk working on each item whether writing, typing, or otherwise recording information: e.g. if the order clerk himself writes the name of the customer an X is marked on the first line in his column. After completion of this analysis the X's are totalled across in the last column. This exercise is quick, highlights any duplication, and provides a pointer, and even an encouragement, to action.

When preparing the list care is needed not to miss any item of entry. Omissions can easily arise because an item recorded in a columnar analysis has to appear more than once.

A review of this kind can be most valuable. For example, a columnar sheet was prepared in an office whose manager said he did not think there was any duplication of effort. The last column of the sheet, when prepared, showed the number of times each entry was made as 14, 8, 6, 7, etc. The sheet took a methods investigator only one day to prepare and disclosed a considerable amount of unnecessary labour.

Procedure Map

A picture containing the actual forms and showing the flow of the work is a great aid to methods improvement and provides a means of:

Getting a complete view of the forms used in an existing system. These may be too numerous to be laid out on one desk or table. Maps provide a means of placing the forms in their order and so of programming them visually and in a logical sequence.

Enabling a number of persons to see all the forms clearly whilst discussing the process involved in them. Overcoming a shortage of desk space and keeping the working papers together in an easily portable form.

This kind of map involves the following procedure:

I. Prepare an analysis of the present methods, i.e. writing down the details of each step in the work, noting against each any special points regarding the way the task is done.

II. Collect copies of all forms in use, with specimen entries on each. Coloured pencils are used to highlight duplication.

III. Sew or paste the forms on to a length of linen (Holland blind linen is excellent for this). Tape and slips of paper show the flow of work and record action (see illustration on page 28).

IV. Ascertain and record any requirements which are not provided for in the existing process.

V. Obtain details of:

Work load (average and peak, incidence, duration, etc.).

Time limits.
Staff operating, numbers and times, (over-time, slack periods, etc.).
Framework of responsibility.
Location (and problems arising, if any).
Source of original data.
Use of information produced.
Equipment used.
Cost of forms and equipment.
Accounting controls and audit needs.

VI. With the aid of the analysis and the map, try to write down clearly and concisely *what is required*, remembering that the finding out of what has to be invented or modified may be more difficult than the later stage of meeting that requirement. Find out:

The minimum information and action to satisfy the needs of the business.
The necessary controls and checks on security and accuracy.

When working out *what is required* the investigator should imagine himself to be the owner of the business and spending his own money. He should ask himself what he really wants in the way of information and control. We think more clearly for ourselves than we do for others. '*I Wonder What They Want?*' is a difficult question, and sometimes nobody seems to know. Reference to existing practices should be avoided while getting a clear idea of *what is required*. The investigator must think for himself and write down what he decides are the fundamental requirements.

VII. Confirm any ideas of what is required with all those concerned.

VIII. Having confirmed *what is required* try to outline a form or set of forms, which, like a multi-purpose machine tool, will do all the work in a single set of operations, without requiring the information to be copied in other records. Initially, ignore the exception that requires special action, i.e. design the procedure for the normal case. If the job takes more than one document and more than one recording the investigator must keep the forms and

records to an absolute minimum and try to make each achieve more than one purpose. He must keep clearly in mind the operations involved: e.g. sorting, summarisation, reproduction, and make the form provide for these with the minimum of effort. He must consider the method of completing the new form and compare manual with existing mechanical processes, or with his own ideas of modified or new mechanical processes.

IX. Make a rough map of any process which appears to be good and carefully study it for faults. The investigator must carefully check it with the established requirements and consider the production times and the movements involved in the new method. If it appears that the saving to be made is really useful, he should discuss the idea with his colleagues and welcome any criticism.

X. Prepare an analysis of the new method.

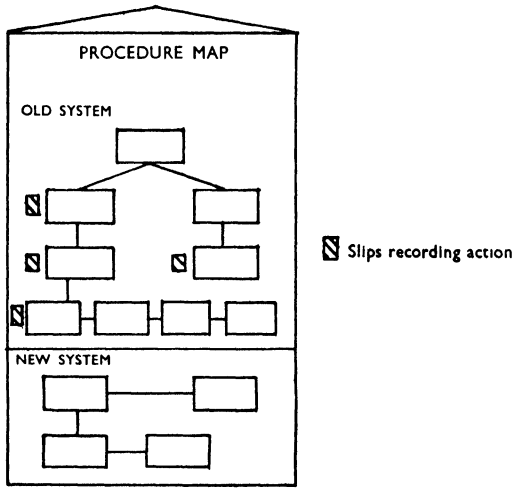


FIG. 22

XI. With the aid of the map, the investigator will need to discuss with the management concerned whether the new method would meet the requirements previously agreed. If the proposals are not well received, and if the criticisms appear to be valid, he will consider possible modifications.

XII. If the reception is good, he will polish up the details of

the new methods and make test runs to check production times and motions involved. He will check stock and supply position of forms, equipment, etc., and check location and layout of work.

XIII. Remember that prices of forms and equipment are needed to give a final estimate of cost.

Selling the Idea

The following notes on preparing a demonstration may be of interest.

In the ordinary run of methods assignments, after making the investigation and deciding on suggestions, two simple work flow charts are prepared. One sets out the existing system and the other what is to be proposed. As already described, a map can combine both charts. Draft forms should be prepared and the pros and cons of the new system set out in a few notes occupying not more than one sheet of quarto.

A meeting should then be arranged with the manager concerned to show him these exhibits and to discuss what will be involved. At this stage the object is to arouse interest but not to sell, unless the presentation in this visual form sells itself. As they might create misunderstandings, working papers (other than the map showing before and after) should not be left with the management. At this meeting try to arrange for a demonstration of the draft recommendations to selected and receptive section leaders, who will benefit from a study of a live exhibition of the proposals away from their immediate working environment. If discussion with the management is resumed in the presence of such section leaders, the investigator will often find that they will sell the system for him.

During the discussions the following rules should be carefully observed:

The staff must get full measure of credit for every scrap of aid given during and after the demonstration.

The shortcomings of the old system should be mentioned but not elaborated. Criticism of the old system can often cause resentment and will certainly waste time. If the listener is conversant with the existing methods, he will appreciate the opportunity to consider constructive ideas and the tact employed in presenting them. If he is not,

then the investigator will at least avoid being sidetracked into a lengthy discussion to justify his comments.

If an apparent weakness in the method proposed is brought to light, it should not be hidden or bluffed out. A frank admission is the only line to take. It breeds respect and challenges the listener to help in finding an answer — a frame of mind well worth cultivating even to the extent of raising a few simple problems and listening to the obvious answers with approval.

If additional proof of the efficiency of the proposed system is called for, get permission to operate a shadow test, in distinction from a complete pilot run. This may mean a good deal of work, but if the improvements involved in the system are sufficiently great then the test is worthwhile and is the next best selling method. It will prove a check on 'teething problems' and afford the opportunity to estimate times of operation. Both the demonstration and the shadow test methods have a distinct advantage over the reporting system. Whilst it is easy to avoid action on a report it is difficult to refuse facilities for a demonstration or a shadow test.

Demonstrations and tests are not easy for O and M departments to plan and stage, but they occupy less management time than is normally involved in the reviewing, checking, and editing of lengthy reports. Most important of all, good ideas are sold quickly and protracted correspondence and differences of opinion avoided.

Work simplification by Group Discussion

Apart from discussion between management and advisers, individually or collectively, on occasion there are special advantages to be gained from organising discussions, in groups, between the staff concerned and the advisers.

O and M has no monopoly in the simplification of office work. The staff actually engaged on the work are usually in the best position to develop ways of simplifying it; they have a wide field of knowledge and ideas which can be very fruitful if explored under proper guidance. A method of handling this is to form each section of the office in turn into a discussion group which meets periodically. The group, assisted and guided by the

advisers, whose job is to stimulate ideas and draw out suggestions from the staff themselves, prepares complete analyses of the work (see procedure map page 28), reviews the procedures involved, and discusses ways of simplification. This approach can be very effective and has the advantage of widening the interest of the staff in their work and its purpose.

Office Processes

The essential office processes have, in this chapter, been limited to three only. These are the key processes needed in the simplification of hand work, yet there will be other elements of physical and mental work involved which can be classified under such headings as:

Physical Work: Receiving and Registering
Sorting
Recording
Copying
Comparing and Checking
Summarising
Collating
Storage

Mental Work: Analysis
Classification
Reference
Recognition
Selection
Comparison, of subject
Testing Accuracy
Design
Decision
Composition
Computation
Aggregation, casting
Calculation

Clarifying the intended purpose, particularly when there was a confused procedure serving it, may by itself suggest how to redesign or ease the procedure. Purpose and procedure are obviously parts of one whole but on occasion the purpose may be perfectly clear or unavoidable and procedure may have to be

studied separately. The problem is then to consider the alternatives by which individual tasks such as those in the classification may be made easier and therefore quicker for the operatives to carry out.

'*Making the Process Easy*'

Some of the aids to efficiency mentioned above are now discussed.

Receiving and Registering

Letter opening machines may be used to speed up the opening of mail.

Date and time stamping machines may be used to record times on documents but should only be used where the timing of receipt is of importance.

Recording may often be limited to registered mail and cash only.

Sorting equipment may be improved.

Coded envelopes for regular correspondence could help sorting work.

Distribution of mail could be helped by suitable carrying devices.

Electric light boxes can help the checking of empty envelopes.

Sorting

O and M can contribute to easing this work by ensuring that all internal documents used are easily sortable. Methods of numbering, coding, use of colours, symbols, standard or variable size may help, and reduce the margin of error from mis-sorts. Other aids will include:

Specially designed pigeon-holes with variable jigs to hold them.

Ambidex and other flap type sorters.

Special sorters made to suit the job.

Tag listing; i.e. listing on a perforated tally roll which can then be split into slips for sorting.

Cross feed tally rolls. When invoices or requisitions are prepared by the embossed plate method a print of each

item is obtained on a tally roll which traverses horizontally whilst the document moves vertically. The tally roll can then be split into slips for sorting.

Paramount or Findex or Brisch systems (useful for complicated sorts).

Right to left sorting (used in sorting cards or papers into numerical order).

Recording

The work involved in this process may be considerably simplified by making each operation do two or more jobs in one.

By multiple form design.

By holding devices such as three-in-one writing boards.

By saddleback carbon and strip carbacking (for production of copies).

By 'No Carbon Required' paper.

Note: A good principle to follow when designing a record is to leave space also for the use of the receiver and thereby save him from copying.

Copying

Apart from the use of carbon paper, already mentioned, many devices are available to eliminate the work of copying. These include:

Addressing machines which are invaluable for giving an automatic copy of any repetitive data such as names and addresses, quantities, descriptions, prices, value of goods required for invoicing, etc.

Various photographic processes such as dyeline, reflex, auto-positive, etc.

Triacetate can be used in conjunction with dyeline.

Shuttlecards for customers' orders, stock requisitions, etc.

A combination of a carbon copy system with a holding device issued to representatives so that in a single writing daily records of cash collected are produced as a carbon copy of receipts issued to customers.

Comparing and Checking

Good Forms Design can serve as a most useful aid to this office process. In addition, consider the following:

A heavier line every third or fifth line, either horizontal or vertical, helps to lead the eye and avoid errors.

Columnar shading has the same effect.

The placing side by side of figures to be compared.

The production of proof sheets by using a carbon of original entries.

Checking by bulk calculation instead of individual calculations.

Use of control totals.

Use of templets to facilitate vertical or cross casting by cutting out all but the significant figures.

Summarising

O and M has developed various aids for this process:

Peg Boards, Magnet, and Plastic boards.

By special folding, more than one column on the same form can be peg-boarded.

The coding of special items so that they can be summarised by code although not in horizontal sequence.

Use of proof sheets.

Bulk calculation whenever quantity summarisation is easier than that of values.

Note: As sorting is invariably involved with summarising, the notes on sorting should be reread.

Collating

There is now a sufficient number of makes of collators on the market, simple or elaborate. Apart from these, there are holding devices to be considered, as well as the teaching of motion economy in the use of both hands, and a pre-determined positioning of the material to be collated.

Storage

There is an increasing number of pieces of equipment offered on the market and these will be summarised in a later chapter.

Space can be saved by:

Using reply form memos.

Taking a carbon copy of reply on back of incoming letter.

Ceasing to make unnecessary copies.

Using microfilming equipment.
Using clip-to-rail or shelf filing.
Regular weeding of files to remove out-of-date papers.

The simplification of office work is very much a continuing process. By the time a first solution has been worked out and seen in actual operation the beginnings of a second are taking shape in the mind. The follow-up operation on Mark I, to see that it is working well, will normally start thought on Mark II and in the same way Marks III and IV will evolve. Further simplification, with or without new machines or aids, will be applied to old jobs or new alike. O and M must not of course wait for the ideal solution but introduce simplified methods as it thinks of them, i.e. as soon as possible. Those who specialise in this work must continually review old assignments to find the next step towards efficiency and always realise that the best idea of today is only the best idea for the time being. Further improvement should always be possible.

In this short section no more than an introduction can be offered to a field of knowledge which has never been fully documented and at present remains the private property of experienced O and M staff. As suggested, what they do is to challenge the purpose of any work that is being carried out and to get rid of anything unnecessary. This done, they have to apply all their experience and creative ability to the actual procedures involved, bringing to bear suitable alternatives for carrying out the purposes they have established as necessary. Unfortunately, there is no short cut to experience. New staff are recommended to familiarise themselves with the various types of equipment, the various short cuts suggested in this section, and in the later one on Clerical Aids. They must also acquire the right attitude of mind and realise that originality rather than copying will produce the best results.

CHAPTER II

FORMS DESIGN

In Britain about three million people are estimated to be engaged on clerical work of one kind or another. They work on the office procedures by which business activities are initiated, carried on, controlled, recorded, changed, or brought to an end. In order that information and instructions shall be set out in a predetermined, orderly fashion forms are used. If forms did not exist all instructions to employees and advice to customers or anyone else might well have to be presented by letter or memorandum.

Whether forms increase or decrease the effectiveness of a procedure depends on the degree of care and skill with which they are designed. In the past their design has all too often been an afterthought. Forms provide a means for the smooth and efficient working of clerical procedure. The forms and the system together provide most of the information needed by management to operate efficiently at all levels. Well-designed forms assist the clerk, save time and labour, and reduce the risk of mistakes and misunderstanding. The multi-purpose form, the three-in-one for instance, can reduce many operations and effect large savings. In hand and machine work, labour-saving design in forms is essential. The ability to recognise bad design and to know what constitutes a well-designed form is essential in O and M.

Design must be functional and forms suited to their use. The requirements of the user (who puts information on to the form, who reads it, who files it, or who will have to find it later on) must be continually borne in mind and incorporated in the form. The circumstances in which the form will be used, the place, the methods, the kind of people who will be using it, when they will be using it, and what they are going to use it for, must all also be considered.

However important the function of the form, other considerations must not be neglected, such as its appearance and the costs

of preparation and use. Good design successfully blends these three giving due regard to each without emphasising one at the expense of the other. A packing note printed on high-quality ledger paper is an example of faulty design and has a comparatively short life: a cheap light-weight paper is usually quite adequate as the use of expensive paper suggests that costs have been overlooked. Obviously some forms will need to be printed on high quality paper, for example, where a long life is required, or much handling is involved. Too much regard can, however, be paid to reducing the initial costs so that a form looks and is cheap. Common examples of this are forms produced from a stencil, on absorbent paper, which if used outside the business may create a bad impression.

The economics of design are not always studied correctly. Though difficult to measure, the costs in clerical time alone of using a form are certainly many times greater than the cost of production. The form that is functionally correct can reduce clerical costs, but in estimating savings the recurring cost of repeat orders must be brought into account. A good form serves as a means of recording information formally in the logical and predetermined layout most appropriate to the procedures which it serves. Appropriateness is the crux of successful design: how to integrate the various requirements of users is the underlying skill. In practice, the design of forms is intimately connected with the design of the procedure itself and discussion of the one must overlap the other.

Poor design is exemplified by misfit features, e.g. inadequate entry spaces, illogical grouping of entries, and errors which only a knowledge of needs of the procedure can put right. Isolated, a form can be superficially judged on draughtsmanship, but the main value derives solely from the office procedures served, and the craft of design works towards this end without fixed rules.

The approach to design is the same as that to method study and is based on a complete knowledge of the relevant facts, which must be subjected to thorough questioning. The rules of method study apply to forms construction. Thus, that which:

Is unnecessary should be eliminated.

Can with advantage be combined should be so combined.

Is necessary should be in its correct sequence.

Is necessary should be reduced to its most simple form.

From this common basis other rules may be stated which bear directly on the designer's problem.

Firstly, eliminate and/or combine:

Reduce the number of forms to the minimum consistent with proper service.

Make one form fulfil several uses.

Reduce the number of operations and the possibility of error (from copying, addressing, etc.).

Secondly, establish the correct sequence:

Associate the related forms in a procedure by a similar sequence of information.

Restrict the number of eye, hand, or machine movements by locating entries from left to right.

Thirdly, simplify:

Assist recognition by common descriptions, symbols, or colour values, precise captions, and instructions.

Create a design that is attractive in appearance and easy to follow.

Choose suitable materials for the job.

Adapt the form so that it is easy to make entries by whatever means are chosen.

Use standard equipment and sizes when not incompatible with the most efficient service to the procedure.

The method study approach should enable the designer to analyse his requirements and visualise the finished form before putting pencil to paper. To decide exactly what is wanted before the attempt is made to do it may seem obvious, yet failure to do this is a common cause of indifferently designed forms. A saving of space can be obtained by making the hand-written form vertical rather than horizontal. This is because the title needs less paper. Whether forms design can or cannot be divorced from methods investigation is a matter of argument. Some O and M departments have a specialist forms design section: the idea is that the person who decides the requirements of a new form may not be the best to design it. Others feel that design should not be delegated on the grounds that:

A great deal of time is then lost in query and explanation, and that

It is good for the investigator to put his own ideas into a practical shape.

Considerations of Design

A form is defined as:

'A printed, typed, or hand-drawn piece of paper, card or other material on which there are blank spaces for the insertion of required information.'

'A standardised arrangement of classified entries.'

The second definition accents two important features of forms — classification and standardisation. Classification demands that the form be entered in such a way that, when completed, the information is in the most convenient shape for analysis and that the form should show, without ambiguity, where all items of information should be entered. Standardisation emphasises that the only practice should be the best practice.

Appearance

Not all forms can be made simple and easy to understand, but they can often be given an impression of clarity by proper design. If neat and legible entries are wanted, a balanced and clean appearance of the form itself will help to achieve this.

Content

It is an advantage for the designer to know the actual procedure. He will then know: what information is required, and why; the source of the information; where the form will be used; how the operations are carried out, and by whom and when; how often and how many a day, a week, or a month. The inclusion of superfluous information because 'it may come in useful' must be avoided.

Identification

The work involved in handling forms is considerable and costly. It involves their collection, sorting, selection of items from them, re-sorting, filing, transfer and so on. Method study will minimise these operations, but what remains must be made easier. Various devices can assist handling, e.g. sorting trays, file guide cards, etc., but the design of the form can aid recognition and access.

A clear title reminds the user of what is wanted, or will suggest this to the occasional or unskilled user. The title should

be informative yet brief, and should indicate if possible not only the use but the movement of the form. References are useful for identification between near-alike titles and for reordering. They can sometimes be given a functional significance to codify the purpose and use of the form.

The position of titles and references on the form may vary from form to form but generally the title is at the head and the reference at the foot.

Colour can assist identification if intelligently used to attract and direct the eye without confusing it.

Defective colour vision is common, especially amongst men, and mixed colours such as brown, or different tints or shades of the same primary colour should therefore be avoided.

Some colours irritate, and for this reason the GPO prohibits (except for one special purpose) red packets or envelopes. Some colours clash or dazzle, especially when printed in alternating bands. The contrast between coloured and white paper can strain eyes in daylight and may be lost in artificial light.

Colour may assist sorting and the homing of documents but adds to the difficulties of reading.

However reasonable the original choice of a range of colours, new classifications will develop and additional colours may be difficult to find. Dark ground colours should be avoided in principle. Black entries are difficult to read against critical colours, and may not photograph. Reproducing documents in colour is not yet possible by photographic means, and colour intensities are completely altered when reproduced in monochrome. All things considered, the advantage lies with printed symbols for recognition rather than colours.

Instructions

Instructions on the form should be avoided if possible because they slow up completion, or make the form appear forbidding. Instructions may be of three or more kinds:

On how to complete the form.

To explain why the form has to be completed.

To indicate the routing, on completion, of the form or its parts.

A comprehensive procedure statement covers the last of these points, but if instructions are still required on the form, their layout should fit into the sequence of operations. An introductory note should appear at the beginning of the form, or at the head of the subsection to which it belongs. Entry instructions should be placed where they will be seen before the entries are filled in, usually at the top, preferably boxed for emphasis. This applies equally to the number of copies required if the form is not padded in sets. If instructions and notes are lengthy an accompanying explanatory document may be used as with the income tax assessment form and instructions sheet. Sometimes, on a form that will be filed in a binder, instructions may be printed on the binding margin. They are then visible only while the form is in use.

Entry spaces

These will receive the varied information required and their design should receive special attention. Writing will be the principal medium and should determine the spacing horizontally and vertically. If forms are to be filled in by hand, eight characters to the inch and $\frac{1}{4}$-in. vertical spacing are considered standard. Where narrative entries vary widely, to cater for the maximum is wasteful, and continuation sheets provide for extra long entries. When copying on to printed documents a small tolerance is allowed to compensate for possible registration errors and good carbon is necessary because faint impressions can be lost or misread if superimposed on firm printing ink.

Entry spaces receive original information and that taken from other documents. In the latter case, a similar arrangement of spaces should be used and the same captions. There are three kinds of entry space:

The box or panel for single entries, usually a rectangle but sometimes a circle.

The column for a number of common entries. By using horizontal lines a column will provide separate spaces for each entry.

Printed questions with blank spaces for answers. The method is untidy, and is best restricted to subjects known to have a wide variation in answer content.

The captions on boxes and columns should be visible whilst

the entry space is being completed. Preferably, they should be placed in the upper left-hand corner of the box, and be small enough to avoid dominating the subsequent entry. Because they are neat and define the entry space, boxes help to discipline the entry: this is important in these days of indifferent handwriting. Captions should be precise, serve as recognition signals, and speed the process of accurate entry. Nevertheless some companies object to the use of boxes.

When a typewriter is used, it is an obvious advantage to align common tabulating stops with continuous vertical and horizontal lines on the form: unproductive forward and back spacings are avoided, the typist's job becomes easier, and output is increased. Continuous vertical lines have another value in that disconnected lines complicate the appearance and have a bad effect on users.

Pre-printing can save work if the range of alternatives is small and is particularly useful when speed of entry is essential. The pre-printing of all static information on, for instance, factory job cards reduces production workers' 'clerical' duties, improves legibility, and reduces the risk of error. Use of indefinite symbols such as ticks and crosses has disadvantages for their significance lies in their positioning relative to the pre-printed data. When taking copies on to blank paper this significance is lost. In all pre-printing self-evident symbols are preferable, such as the initial letter of the alternative concerned.

The arrangement of entry sequence provides the best single measure of an efficient form. All the information to be filled in should be analysed to determine the most efficient writing and reading continuity. Related items should be grouped for ease and speed in making and reading entries. As already mentioned, the form should be planned so that the eye follows a natural left to right reading movement without having to range haphazardly to find what is wanted. By proper attention to the order of entries the physical appearance of the form is improved and, more important, the form becomes easier to understand and to enter, faster to process. When a particular entry has to be emphasised the space can be defined by heavy lines, coloured lines, stippling, skeleton arrows, or variations in type and numbering of spaces or columns.

Calculations are made more easily with vertical columns.

Vertical staging is helpful when adding or multiplying multiple quantities and when carry forwards have to be converted into new measures. With handwritten entries, feint verticals are useful to position figures and to assist subsequent mental arithmetic. If cross-casting is necessary this too should be from left to right. The use of templets should also be considered.

Any device should be considered which enables the eye to home quickly to the appropriate entry. A most depressing form is one which uses an unrelieved mass of rulings. Heavier or coloured lines, or double lines, will segregate columns and horizontal sections in related groups. If there is no natural segregation of related items, divisions may be made arbitrarily to speed up operations and reduce the inaccurate location of entries.

Forms sent through the post have to comply with certain GPO regulations mainly concerned with the size, shape, form and colour of the outside covering. These regulations are subject to change and the current Post Office Guide should be consulted.

Machine entries

Forms designed for machines permit less latitude than those designed for written entry, but the exactness of the machine enables the designer to work to finer limits. Office machines are the subject of a later chapter but this section considers some implications of machinery in forms design. As before, cost is important. Unproductive time, as in preparing documents for feeding, carriage movement without printing, platen spacing separating copies, and so on, adds to the unit cost of processing one form.

A rich field exists where form design allied with mechanisation can produce a good harvest. In large and medium-size businesses an astonishing amount of writing and rewriting of the same information takes place. Consider the familiar documentation concerned with dispatch. Advice notes, consignment notes, shipping specifications, packing notes, and invoices all contain a great deal of common information. Assuming that they are necessary at all, are these documents being produced with the minimum of effort in writing and copying? In stores routines, are reorder requisitions, urging notes, and goods

received notes, being laboriously copied one from another? How much repetitive writing goes on in the production control and progress offices? Is it being avoided in wages and salaries procedures?

An O and M department is directly or indirectly concerned with this problem. Simplification of office procedure teaches that as much information as possible should be incorporated into a single writing operation and the extent to which this is accomplished is an important measure of the efficiency of related forms in a procedure. Mention of the means for copying entries may be appropriate here also. There are two basic methods, using:

Carbon or similar impressions made simultaneously with the original entry, via carbon paper, carbon backing, NCR paper. Unwanted entries on copies can be prevented by carbon cut-outs, spot carbonising, etc., or largely suppressed by printers' ornaments.

Entries reproduced from masters prepared in advance. Wanted entries can be suppressed by altering masters or by printers' ornaments again.

Various considerations associate the means of entry with forms design.

When a pencil is used a rough surface takes better impressions than a smooth. If the paper is thin a backing sheet is necessary.

With pen and ink, a calendered surface is best. Coloured writing inks should be tested since they tend to penetrate some papers and blur entries.

With the typewriter, the following points are important:

The spacing of horizontal and vertical entries must be related to the pitch and throw of the particular machine. Vertical spacing (throw) is commonly $\frac{1}{6}$ inch, whilst the standard horizontal spacing (pitch) is 12 (élite) characters and 10 (pica) characters to the inch. For part-typed and part-handwritten entries, the minimum allowances should be 8 characters to the inch, and $\frac{1}{3}$-inch throw.

The number of typing lines should be reduced to a minimum. Typing should start at the extreme left-hand margin stop in order to get the maximum typing line.

To assist the rapid location of a point of entry, use guide lines or angles.

Remember that the width of form and width of writing line is governed by the typewriter in use.

Normally leave $\frac{1}{4}$-inch margin at the top and $\frac{1}{2}$-inch margin from the bottom of the form.

Ensure that all the reference entries are visible.

By Keyboard Accounting Machines. In this context, these can be regarded as developed typewriters insofar as they offer more automatic features during tabulation (e.g. printing of totals, carriage opening and return, positive form alignment), as well as the facility for accumulating and cross-footing in registers. But in some ways they restrict the forms designer. Specific printing positions may be fixed, e.g. date entry, whilst provision may have to be made for the inclusion of automatically printed symbols. In the printing of stationery for accounting and other machines capable of close registration work, jobbing printers can be used to provide forms in a hurry, but for high-quality work, precise registration, and correct paper qualities the larger and more experienced printers are best.

By Punched Cards Machines. The main feature that distinguishes these from typewriter and keyboard accounting machines is that the carriage does not tabulate. The carriage is fixed and the print banks print simultaneously line by line: this is an immediate restriction on the forms designer. There are several units of ancillary equipment to assist forms completion, e.g. form feeds and guillotines, and their use can have an important influence on the design of the form itself. Side-by-side printing on small forms attached by perforation is a convenient method provided the carriage width and print bank capacities permit.

By Addressing Machines. It must be remembered that the plate or stencil layout should be designed to meet all the addressing needs of a whole procedure. By putting the maximum amount of information on to a plate or stencil, the facility for masking any unwanted information makes possible a variety of reproductions from the one layout. The printing arm of an addressing machine is fixed, and the entry spaces have to be placed very carefully to avoid folding or rolling the form when taking an impression. This must be remembered for plate impressions, where forms are fed in face downwards.

For designing column widths or grids to contain plate/stencil entries, the easiest method is to devise a layout to cater for the

maximum number of digits per item; impressions should be printed out and outlines drawn around them.

When listing automatically, the minimum heading depth must be known together with the maximum line capacity that can be reproduced on to one sheet. The throw can be adjusted, usually to a maximum of about 4 inches. For single print work, one must be sure that the form is big enough to place under and extricate from the printing head without difficulty.

By Duplicating Machines. There are three main office processes which operate on the master principle. These are hectography, stencil, and offset litho. Dyeline photocopying is a fourth method which might, from the functional point of view, be grouped with the other three. With the true duplicating processes, registration accuracy and appearance vary, offset litho giving the best results in both respects. Offset litho can reproduce well on most papers; stencil and hectograph are rather more limited, the former favouring an absorbent coarse wove paper, and hectograph a smooth-surfaced paper of greater bulk.

Offset litho or hectographic processes are versatile. In either case the hectograph master itself can be partly completed at one stage and copies rolled off: additional entries may then be made and further copies rolled off. This process can be repeated several times, a facility by no means easy with offset litho or stencil. A hecto-master can be used for multicolour work simply by using appropriate coloured carbons as required. These colours then reproduce simultaneously in a single run of the duplicator. There are also machine models which will reproduce line or item selectively.

Stencil and offset litho are more suitable processes for long run work, and the masters tend to preserve better. Stencil is a reasonable proposition up to 5,000 copies. Offset litho, which gives a very professional-looking job, is particularly recommended for:

Long runs which are not large enough to justify outside printing.

When the plate will need to be revived at a much later date for further copies.

When copies are needed on paper having a good writing surface.

Where permanence of the copy is important.

All three types of master can be pre-printed with reproducing outlines: rolling off on blank paper eliminates any problem of misregistration and may also be cheaper.

Proving the Design

A completely satisfactory design is rarely achieved 'off the cuff'. Several attempts may be necessary before the design is satisfactory to the designer and prospective users. With any but the simplest layouts the designer should produce specimen forms and arrange for these to be completed with actual entries in order to check that the spacing is adequate. With a complicated procedure, a complete dummy run may be advisable.

The élite typewriter face (12 characters to the inch) is the most popular in current use but according to exhaustive tests is not the most conducive to long, easy reading. Again, specimen entries should be tried to make sure that the latter are not swallowed amidst blocks of printing which are either too large or too dense. Pastel decoration is generally best, giving a perfectly legible print, and at the same time ensuring that attention is not distracted from the entries by dominant static data.

The designer should be more than willing to listen to suggestions from users, and should encourage a critical interest in his designs. He should then be prepared to accept minor modifications (which he may privately think detract from the form's beauty) for the sake of getting major improvements accepted. On the other hand, he should allow no basic principle of design to be contravened.

Make-up of the Form

In practice this subject may directly affect the construction of the procedure and thus precede design in all but detail. For example, in certain circumstances the elimination of repetitive entries may demand the use of multi-part sets. Make-up describes the physical arrangement of the forms at the point where they are first brought into use, and therefore includes:

The combination of the various parts or copies which comprise a single form, and

The assembly of a number of forms into packs, pads, or books.

Where the number of copies to be taken varies, made-up stationery is handicapped since the introduction of extra paper and carbon presents difficulties.

Forms may be supplied loose or made up in one of several ways. Thus they may be:

Padded, i.e. gummed or taped along one edge with or without a backing board.

Bound in books by means of stapling or sewing, with perforations to enable the forms to be detached from the stub.

Supplied in the form of continuous stationery whereby the forms are joined end to end, and after entry, detached by perforation or guillotine. Because the forms must usually be printed on rotary presses, this type of stationery is generally economical for long runs only. A further restriction is that imposed on form size by the necessity to print from reels of paper. The main advantages of continuous stationery are rapid feeding of forms by minimising make-ready time and accurate registration.

Producing the Forms

The form designer's responsibilities do not end with the evolution of a satisfactory design. He must translate design into a supply ready for use. Production cost must be considered but only 'as a restraining factor'.

The overall dimensions of the form should be roughly worked out before the material goes to the drawing board. As paper is a costly item wastage should be avoided by using even cuts of one of the standard paper sizes. This question is complicated and should be discussed with the printer because the size of rollers may govern the size of the sheet to be used for the form. The main objective is, however, to reduce the total cost of usage and the best design for the job may still be a non-standard size on a high quality paper.

Having determined the size, the layout, the quality of paper, the quantity of forms required, the printing, punching, and perforations (if any), the designer must now order the forms. He may not deal directly with the printer, but he will be expected to produce a draft from which the printer can work. The amount of extra information required will depend upon the designer's relationship with the printer and his appraisal of

the printer's experience. Some things, for example, style of type and size, can often be left safely in the printer's hands. Other information must be provided, and this is normally done by submitting a specification with the draft (see Appendix, page 50).

The draft should be an accurate and full-sized drawing of the form required. Panels and columns should be drawn accurately, and the relative importance of captions and printed matter indicated. The overall dimensions of the form should be shown, and wherever column widths are critical the actual dimensions should be shown also. This is particularly important where a column comes at the edge of the form. In this position, careless trimming may reduce the width appreciably and the draft should show that this must not be allowed to happen. In general, the draft should be made to resemble the finished product as nearly as possible.

The specification will normally cover all the information required to produce the finished job, e.g. the quantity of forms required, grade of paper or board, colours of printing and/or paper, whether the forms are required printed tumbler or head to head, how the forms are to be delivered. Double-sided printing may be considered since this virtually provides a second form: the paper must, of course, be sufficiently strong and opaque to take the entries.

Since the implementation of a new procedure is dependent upon the arrival of the new forms, they must obviously be ordered in good time. Stocks of existing forms used for the old procedure should have been run down, and the O and M man should have taken steps to see that this had been done. If the implementation of the new procedure is delayed, small quantities of the old forms can be ordered to keep things going on a short-term basis. When the new procedure is installed and if, despite all precautions, a considerable quantity of the old forms remain, they can, if printed one side only, be trimmed and reprinted on the back and perhaps used for some internal job. An important factor to keep in mind is that delay in installing the new procedure in order to use up stationery stocks will invariably bring about a loss, because further improvements to the new procedure, which will be inevitable, will also be delayed. The time loss occasioned and the efficiency progress lost will not be recovered.

Using the forms

Strictly speaking, the stage of design is now completed but the O and M man must still make sure that the new design is going to work in practice. Instructions in the use of the new forms will have to be given to the staff concerned. If the form is at all complicated, specimens of the new forms complete with dummy entries, can be provided with a careful explanation of how the entries are to be made. When the O and M man is satisfied that the staff is familiar with the new forms and can use them confidently, and that the forms themselves have proved to be satisfactory clerical tools, he can retire from the scene. But only then can he be sure that the forms have been designed in the real sense of the word.

FORMS DESIGN APPENDIX

The Draft

In preparing the draft for the printer, it is desirable to:

(*a*) Use, normally, strong plain white paper or board so that it will stand up to handling by compositors.

(*b*) Use a sheet large enough to leave a space all round for notes and instructions: see (*g*) below.

(*c*) Draw the outline required. If the form is to be printed on both sides of the paper, draw the front and reverse side by side or on separate pieces of paper.

(*d*) Draw in any boxes, columns, lettering, etc. which are required to be printed.

(*e*) Affix in the appropriate place(s) actual specimen(s) of any hatching or stippling which is required to be printed.

(*f*) Sketch any punch holes required, giving the number, their exact position, size of holes and distance between them.

(*g*) Insert the instructions to the printer in the space all round the form, viz:

Exact overall size of the form, when trimmed (vertical dimensions first) with other actual measurements where important. If the form or any part of it has to be in dead registration with any other form or part, this must be clearly indicated and a sample of the other form attached.

Colour, kind, and weight of paper/board to be used.

If important, the direction of grain of the paper/board; this should be expressed by stating that the grain is to run parallel to a specified edge of the paper.

Colour of printing including any flashes.

Whether printing is to be on one or both sides of the paper/board; if on both sides, whether or not it is to be in tumbler fashion.

'Make-up', e.g. padding, if any.

Carbo backing required, if any.

Interleaving with carbon paper.

Serial numbering, if any.

Cut off or rounded corners, if any.

Spacing for horizontal entries down the form: e.g. $\frac{1}{6}$ or $\frac{1}{4}$ or $\frac{1}{3}$ or $\frac{1}{2}$ inch.

Punching of holes for filing or binding: distance from two edges, size of holes, and distance between centres of holes.

Position and purpose of perforations.

Where possible, an instruction should be written on or alongside the part of the form to which it refers. If it has to be written at any distance, or if it may not be quite clear to which position of the form the instruction refers, it should be connected by a coloured line. General instructions, e.g. colour and kind and weight of paper, should be collected together in the most convenient place, normally the bottom margin.

Where forms have a large number of vertical and horizontal rulings it is better to reproduce them by offset litho or pen ruling. This is because typeset lines are broken and cause strain to the eyes of the user.

(*h*) To write in the actual dimensions of all columns, in cases where it is intended to make photo copies of the draft, as there may be distortion during the drying of the photo copy. As printers' measurements (printers' points) are not multiples of typewriter spacing it may be wise to instruct the printer to make the form in dead register with the specimen when machine entries are involved.

Whenever the specification details are very lengthy, it is usually more helpful to the printer to supply a separate specification sheet with the form draft.

FORMS DESIGN: SUMMARY

The Salient Points in the Approach to Design

It may be useful to remind forms designers that they should:

Adopt method study principles.

Remember that the well-designed form has a positive influence on the smooth, efficient working of a procedure.

Give each form a meaningful title and a precise reference.

Minimise instruction data pre-printed on the forms.

Study very closely the factors which affect the size, formation, sequence, description, and prominence of entry spaces.

Create a pleasing and simple-looking form.

Learn to use colour effectively.

Exploit the advantages of different writing or copying methods by adroit design.

Consider production costs in their true perspective.

Integrate user requirements and design features into an accurate, clearly-drawn draft for the printer.

Prepare the specification.

CHAPTER III

CLERICAL AIDS

The emphasis during the first sections of this book has been laid on the simplification of office purpose and process, the elimination of any procedure or step in it found unnecessary, and the streamlining of what is left by improved paper work and forms design. This section and the following chapter swing away from paper to mechanical aids to efficiency, and to equipment and machines, subjects separated by use, complication, and cost.

For convenience these two subjects of aids and machines have been distinguished and the first is restricted to apparatus of a fairly simple character and is not therefore concerned with office machinery such as computers, punched cards, or accounting machines which are reserved for the next chapter.

Various office aids may be summarised according to the clerical processes as follows.

The Processes

Recording

A loose-leaf device or Visible Recording Binder can form the basis of a very efficient procedure for maintaining records and achieving speed of reference with a minimum of space and cost.

Record cabinets, card index cabinets, visible index cabinets, and strip index cabinets or racks may be used alternatively if the volume justifies them.

Binders or cabinets of the visible edge and strip index varieties lose some of their value if there is considerable movement in the record, i.e. insertion and extraction of sheets.

Signalling is difficult to justify and is rarely kept up to date.

Writing

The desk register is a useful device for recording and producing copies, and uses continuous stationery.

A variety of 3-in-1 writing boards is now on sale for use in wages and ledger work, etc., but in most instances the methods man can himself produce simple devices which will more exactly meet his requirements.

Some other examples of equipment which can speed up writing and, if required, produce copies, are saddleback carbon, strip car-backing, and no-carbon-required paper. These can generally be combined with some form of holding device if required.

Summarising

Various aids have been developed to assist in summarising: e.g. Peg Boards, Magnet Boards, Plastic Boards, etc.

Filing

Various types of filing equipment are available and in choosing the most suitable type consideration should be given to the relation of space and speed of reference. Some examples of filing equipment are:

Lateral Suspended.
Loose Leaf Systems.
Plain files.
Suspended Systems.
Rotary filing cabinets.

Sorting

Some aids to sorting documents are:

Flap type sorters.
Special sorters made to suit a particular job.
Pigeon holes with variable jigs to hold documents, etc.

Collating

Except in special departments where collation is a major problem and may justify a collating machine, several simple hand-carding devices are available on the market: e.g.

Collating Racks or Boxes.
Circular Lay-out.
Circular table.

Referring (and Recording)

Manual punch card systems, perimeter punching, and centre punching provide valuable means of referring to records under a wide range of variables. The speed of reference of these hand systems is faster than that of the machine type.

Cardwheel Equipment is available in portable or cabinet form and has the advantage of quick operation, easy insertion of new cards and removal of old cards.

Charting

Various forms of Wall Charts or Visual Charts are on the market and the choice depends largely on the application. Visual charts offer a quick and easy method of showing the up-to-date position on such things as sales, stocks, labour, materials, budgets, targets, order progress, etc. The main drawback is that these charts must be kept right up to date.

Selecting Equipment

As an instance of the types of question to which an investigator must know the answers when selecting efficient equipment for a job, let us consider a case where he needs some sort of card (or sheet) record. After satisfying himself that the objects or purposes of the record (facts, aggregates, or statistics), are really necessary, these are the direct considerations that he should check:

- Size and quality of card or sheet required.
- Number of cards or sheets required.
- Life of record and security against theft or fire.
- Number of records required to be within reach of one operator.
- Special facilities required, e.g.
  - Ability to move cards easily within the system.
  - Need for portability.
  - Need for signalling individual cards or group of cards.
  - Possible need for interchange of units.
  - Possible need for more than one operator to work on one unit of the record.
  - Ability to deal with frequent turnover and change of records.

Subsidiary equipment, i.e. tables or desks.

The considerations so made will narrow the choice of a system.

He must examine next the associated efficiency aspects such as:

Speed of reference.

Ease of entry.

Space required to house the records.

Can peak-period loads be handled, i.e. can more operators work if necessary?

Comfort of operator and problems of fatigue.

Effectiveness of index.

Problems when reordering stationery.

Work-bench Techniques

The variety of work in different companies, and the variety of considerations that affect the work, together mean that standardised systems and standardised equipment are unlikely to make an exact fit with the actual requirements of any one company. There is a need therefore to modify a standard system, and alternatively to devise or invent some very simple and often cheap apparatus to meet a particular office requirement. This does not suggest that improvised equipment is outside the powers of improvisation of machinery suppliers, but merely that manufacturers are naturally interested in a standardised product; the variations required by different companies are not always in quantities which justify manufacture in a large way.

For these reasons there is some scope for the introduction of a work-bench in O and M departments for:

Modifying standard equipment to meet specific needs.

Producing prototype equipment to do special jobs not normally catered for by outside suppliers.

This does not mean setting up a workshop to produce repetitive articles. Once a modification or prototype has been made and proved, production in quantity may be put out to tender.

Experiments have been made in a number of problems calling for simple ways of summarising entries from original documents.

Holding Devices

The magnet board is a sloping board with a strip of metal set into the top and with a ledge at the bottom. Forms placed

against the ledge are held in place by magnets placed over them at the level of the strip. The figures recorded on the visible edges of the forms held in this way can be cross cast. The printing of the document from the base upwards must of course be in exact register.

Where two columns of figures have to be summarised from a set of forms, a transparent material with a natural static meets the need. The forms are folded and fed between two sheets of suitable plastic hinged with transparent tape. Each side of the forms held by this means is visible and can be summarised.

Further experiments with plastics produced a simple device to assist in planning office layouts. A floor plan placed behind a sheet of plastic will adhere to it and on the other side pieces of polished PVC (Velbex) cut to scale can be placed to test experimental layouts. The Velbex will hold firmly if pressed on to the surface of plastic like Cobex, for instance.

A portable plan board has provided a solution to a problem of bulk loading and dispatch supervision. Sections of orders were held in pleated pockets to show:

Delivery van reference.

The shops to which delivery was to be made.

Quantities ordered by those shops.

The summary for purposes of bulk loading.

Like the portable plan board idea, this particular device uses pleated material in the size of pocket required, stitched with an ordinary sewing-machine, and the whole riveted to a stiff backing board. At the point of van dispatch, the folders are held in flap sorters.

For posting over proof sheets such documents as accounts payable, remittance advices, expense cards, etc. various devices have been produced for holding the proof sheet in a suitable position:

A board with a clip on the right enables a proof sheet to be held with a saddleback carbon on the left-hand edge. Over this a folded form can be fed (to the next free line on the proof sheet) and posted so as to give an original, a copy entry on the proof sheet, and a second copy entry on the second sheet of the folded form. Where only an original and the proof sheet entry are required, the strip-board enables a sheet or card to be fed to the left

edge and lined up with the next free line on the proof sheet over which a carbon is clipped.

From a tally list of logs felled in timber plantations, Paramount cards were punched for a complicated sorting and summarising operation. The production of a holder enabled details of the original entry on the tally list to be reproduced on the Paramount card, thus simplifying punching and reducing the margin of error.

In endeavouring to simplify the work of salesmen, it was noted that receipts for cash collected during the day were issued on the spot but that the cash sheet had to be prepared as a separate operation later. A special holding device was developed so that the cash sheet could be automatically produced as a carbon copy of a number of receipts. The device was also designed to act as a holder for all the forms a salesman would require while taking orders in a shop.

A very large amount of clerical work will also be simplified if proof-sheet copies of entries can be produced at the same time as loose-leaf original records are written.

Planning Boards

To satisfy a need for portable planning boards for personnel and progress work, black Holland blind material may be pleated and stitched to form pockets of any size required. A board measuring approximately 2 feet by 3 feet can provide 900 pockets $1\frac{3}{4}$ inches wide, of any depth and having a visible edge of $\frac{1}{2}$ inch. These plan boards are extremely simple and inexpensive. When rolled they are easy to carry and store.

Ready Reckoners

During the past ten years a large variety of ready reckoners have been made to speed the work of calculation. Here are brief notes on one or two of them:

When orders have to be priced the slide-rule type of reckoner can produce value, tax, and (at the back), special discounts in a position suitable for computation, i.e. three answers in one.

The circular type shows (against a cubic capacity reading)

the freight, Free-alongside to Free-on-board, and the harbour-due costs.

The elastic type produces a rough percentage of orders to calls.

If the field of calculation is small, the ready reckoner is usually speedier than a machine.

Many tasks can be simplified by the use of templets. If a work-bench is available it can help in the design and assembly of aids such as these.

Single Print Addressing Equipment

Single-print addressing equipment for the production of invoices simplifies the invoicing task, but further appreciable savings are possible if the stationery costs can be cut. Padded sets of invoices used to cost a firm between 2½d. and 3d. a set. Study of the design of the form showed that the set, if printed as a single sheet with perforations, could be produced for less than ½d. Experiments at the work-bench produced a simple platform device fitted underneath the single-print machine so that the necessary number of prints could be made side by side. This added little to the operator's work; in fact the operation became more rhythmical and speed tended to increase.

Further experiments in this case showed that by this means of production the prints could be made to vary, i.e. the first and second could be ordinary invoice detail prints while the third could have depot codes and weight in place of value. This side-by-side printing has saved £26,000 a year on stationery alone for one company which has made in all more than a dozen varieties of single-print modification, many of them now standard products of single-print suppliers.

In the cases already described only mechanical and handy-man skills were called for, but the work-bench need not be limited to simple mechanical aids. If skill in electro-techniques is available, the field of possibilities is wide indeed.

Productivity in factories has been improved by the invention of multiple jigs or tools which in one operation will do a task which previously needed several. As already mentioned, the office equivalent of the jig or tool is usually a multiple form, and as requirements become more complex not only a well-designed

form is required but also some device which will handle that form, or parts of that form, in such a manner as to provide all the information required. For this type of problem the work-bench is invaluable.

The work-bench is a useful addition to other O and M techniques. A fully-equipped workshop is unnecessary. An odd corner with a second-hand work-bench, an electric drill, and the usual collection of tools that can be found in most homes is all that was used in the cases mentioned. What is most desirable is to encourage original thinking by furnishing the methods officer with reasonable facilities for producing prototypes of aids and new equipment.

General Notes

When considering the cost of new equipment an essential study is the problem of 'second cost'. In the majority of cases, office equipment incurs a 'second' cost greater than the 'first'. Quite often the capital expenditure on a piece of apparatus may (at the normal depreciation rate of 10 per cent) cost only £100 per annum but the second cost may well be many hundreds of pounds per annum, e.g. in the cost of material needed for photographic reproduction by various processes.

CHAPTER IV

FIELD OF OFFICE MACHINERY

Introductory

There are two kinds of information an O and M man requires on the subject of office machines. Firstly, he needs a wide general knowledge about the whole range of machines available, including different types of machines, their functions and how different groups are related in terms of the operations they can perform. Secondly, the practising O and M man will, on occasion, need detailed information about a specific class of machine or even a particular model. It is not possible for anyone to remember all the details of the hundreds of different machines available. Apart from the wide range currently on the market, new models, new processes, revised specifications and price changes are continually being introduced. The best that the O and M man can do is to keep his general knowledge reasonably up to date and to know the sources he can use for more detailed information as the need arises. These two aspects are discussed below.

In devising any system of work, it is essential to decide upon the objective to be achieved before selecting the means, whether manual or mechanical, which will accomplish it most economically. It is dangerous to choose a machine and then tailor the system to fit the machine. This has been made clear in previous chapters and it will therefore be taken for granted in this chapter that a proper approach and investigation has preceded all consideration of the considerable field of office machinery.

Sources of Information

The first step is to build up a general picture of the whole field of office machines, logically according to the type of operation they perform. Once this bird's-eye view of office machines has been established it becomes relatively easy to see where any new machine that comes on to the market fits into the general pattern. If it is simply a new model — an addition to an existing

range of machines — it can immediately be related to the other members of the group. If it is a new kind of machine, then its appropriate position within a functional classification can be established.

The following reference documents are useful for general information on a wide range of machines:

The appropriate chapters of this book which are designed to provide a basic description of the main classes of machine.

The Manual of Modern Business Equipment (OABETA), which contains descriptions of the operation of different machines, representative illustrations and the names of those members of OABETA who are able to supply the machines described.

Machines and Appliances in Government Offices (HMSO), which includes notes on applications as well as brief descriptions of the main types of machine and is well illustrated. Descriptions of machines therein are less detailed but more objective.

The problem of keeping up to date can best be solved:

By a regular subscription to one of the technical journals, such as *Office Magazine*, *Business*, *Scope*, *Office Management*, which have articles and regular features dealing with new machines.

By contact with machine manufacturers.

By contact with other users through professional organisations, e.g. the Office Management Association.

When detailed information is required about a particular model the manufacturer will be the prime source of information. To track down the manufacturer of a particular machine the *Business Directory of Office Equipment and Appliances* is a useful reference. If possible, information from the manufacturer should be supplemented by finding out the first-hand experience of existing users.

The Basic Clerical Operations

Before considering the part to be played by the introduction of machines into offices, the probable advantages to be derived from mechanisation, and the possible difficulties that may arise, the investigator must study the work itself. What do the staff do?

What does an office set out to achieve? How does it go about attaining this objective? A special chart has been designed (at end of volume) which illustrates the break down of clerical work into basic clerical operations. All clerical work consists of carrying out one or more of these operations, and the analysis into seven operations — as opposed to three for manual work — provides a useful framework within which to consider mechanisation. The seven basic clerical operations as numbered on the chart, are:

1. *Communicating*, or transmitting of information; transporting, handling, conveying information from one person to another.
2. *Writing*, or recording of original information.
3. *Sorting*, or distribution into classes; classifying and collating; analysing, selecting and arranging.
4. *Copying*, or reproducing of information; duplicating, posting from one document to another.
5. *Checking*, or comparing one piece of information with another; examining, identifying and proving.
6. *Calculating*, or computing; the basic arithmetical processes of adding, subtracting, multiplying and dividing.
7. *Filing*, or storing of information; housing records, binding.

Each operation is a mixture of mental and manual work. The mental element may be small, as when copying information from one document to another. On the other hand, calculating is mainly a mental process, and the manual element of writing is small. The degree of mental effort depends not only on the nature of the operation but also on the intrinsic characteristics of the information being dealt with. Comparing statistical returns, analysing trends and checking forecasts may, for example, involve difficult and complicated mental processes. Calculating may be more or less difficult depending upon the complexity of the figures handled. At the other end of the scale, the mental effort involved in selecting the right form on which to write is never likely to be very great.

All these basic operations have, however, one common element — *perception*. Before the operation can start, the information has to be perceived, read or heard. This consideration acts as a limiting factor in the development of office mechanisation. At present all office machines need operators for input of

information, to read or hear it, and then to feed the information into the machine in such a way that the machine can deal with it. This is equally true at the present time of a simple barrel calculator and of an electronic computer which, for certain operations at least, represents the latest development in mechanisation. Human beings are still necessary to translate the basic information into a form which suits the 'perceptive faculty' of the machine. In the case of a computer, this means producing punched cards or tape, magnetic tape or film.

Conventional office machines have been developed to assist in the carrying out of basic clerical operations, but because of their limitation of input these machines can only *partly* mechanise clerical work. Much still has to be done by human hands and brain. Signs of a change are however apparent, and the latest developments have been towards overcoming the inability of a machine to perceive. Machines which can read ordinary writing and machines which can be given oral instructions are being developed, although the day of their general application in practice is still some way in the future. Such machines represent a considerable advance in a process of mechanisation which has been going on for many years, but a large field will still remain where machines will never be able to compete with human beings.

An important development in the mechanisation of clerical work is that concerned with the *combination* of two or more basic operations in one machine. There is, for example, a large class of machines which can be used for calculating, some of which are designed primarily for adding and subtracting, some for multiplying and dividing. These include machines that can be used not only for calculating, but also for writing results. By using a suitable reproducing medium, the machine can be used for calculating, writing and copying automatically. Alternatively, the writing facility can be used to produce a master which can be used for copying where the machine itself cannot produce enough copies.

Again, some machines can be set to accumulate results for subsequent comparing and checking operations. Electronic computers can be programmed to carry out the same calculation in different ways to compare results and to signal if there is any

difference. Some machines can be made to produce a punched paper tape simultaneously with the written record, and this tape becomes a convenient form in which results can be stored and later transmitted for further processing. The range of machines available to help in carrying out any one of the basic clerical operations will be examined in detail below, but for the present some consideration of the problems of mechanisation in general might be useful.

The Pros and Cons of Mechanisation

Mechanisation may give one or more of the following benefits:

Cost reduction.
Greater speed.
Less effort and drudgery.
Greater control of accuracy.
Improved legibility of records.
Easier control by supervision.
More information for management control.

These benefits are not isolated, and indeed they often operate together. Greater speed can lead to information being available earlier for management control, or to more information being processed in the same time. The ability to combine operations (which is a feature of many office machines and has already been mentioned) can lead to accuracy and legibility being combined with increased speed and even with less effort.

As a direct result of the faster operating speed of a machine, when compared with the manual or mental effort, mechanisation can, in suitable circumstances, achieve savings in manpower. Some savings may also result from the facility to record information on two or more documents, i.e. to copy, with the effort of one operation only. Further savings may result because a mechanised system introduces an improved method of controlling the accuracy of the entries, recording or locating any error which may be made.

Outputs from machines are generally more easily measurable, thus allowing for work to be planned more easily and going some way along the difficult path towards an accurate technique for establishing clerical standards. Again, improved legibility which can result from machines is of considerable importance at a time when the general standard of handwriting is low.

On the other side of the account, we must recognise some of the shortcomings of machines and mechanical systems:

Less flexibility than the human brain.
Less flexibility of method in modification or change.
Initial capital outlay.
Upkeep cost, special stationery, maintenance, etc.
The need for a special training of operators.

Machines are not capable of original thought and will only do what they are 'told' to do, the initial direction necessarily coming from the designer and from the operator, or in the case of a computer, the Programmer. Man's brain differs from a machine in five ways that are important:

Man has a relatively large storage capacity.
His time is relatively slow.
He can do many operations in parallel.
He can carry out inductive processes.
He can forget.

In many systems which are presently mechanised only parts of a routine have been mechanised, and indeed mechanical operations are interspersed with manual ones to a marked degree. Those which remain unmechanised are more often those where individual choice and selection and the use of human experience are preponderant. Obviously, repetitive routine jobs where exceptions are few are those for which office machines in their present form are best suited. The greater the number of exceptions and the greater the choice available to a clerk, the more difficult it will be for a machine to prove economical.

Sometimes mechanisation leads to too high a degree of specialisation and the job is broken down too finely. This may in turn lead to personnel difficulties. In these cases mechanisation may mean, in effect, replacing manual drudgery with machine drudgery, and the boredom of mental arithmetic may be replaced by that of manipulating a keyboard. As a general rule, one machine requires one operator and, with the exception of some punched card equipment, the cycle of operations in most machines is too short to enable one operator to look after two or more. Therefore, operators and stand-ins have to be trained, and the speed of reserve operators kept up by practice.

With regard to the problem of cost, an important considera-

tion is that office equipment must compete for capital resources with all the other claimants of the business. Also, the maintenance of office machinery must not be forgotten. Equipment produced by reputable companies is generally very reliable, but random breakdowns are inevitable, and a small business using a single general-purpose machine could find itself in an awkward situation if the possibility had not been foreseen. Speed of service and the use of preventive maintenance is of great importance.

Finally, the fact must not be forgotten that the efficiency of an office machine is directly related to the efficiency of the operator. If the wrong figure is entered, or registration is poor, the correction of these errors may be more costly than that of any equivalent hand method. The training of operators and the maintenance of a sufficiently high standard of quality are often overlooked; yet they are essential for the best results.

The Scope for Mechanisation

Large offices are likely to offer the widest scope for mechanisation. A large office is more likely to have a considerable volume of routine repetitive work which, as has already been mentioned, lends itself most easily to mechanisation. Wherever a large volume of information is being handled, either written, calculated, transcribed or assembled in one form or another, there is potential scope for machines. In offices where the base of the departmental organisation is wide and where routine clerks are being employed in large numbers, machines may be employed; similarly, where the same or similar jobs are being performed by a number of clerks at separate points. None of these conditions is sufficient in itself to advocate mechanisation, but merely establishes a prima facie case for survey. However, there may occasionally be some development in the field of office machinery which makes itself apparent quickly, where its economy and efficiency are easily recognisable. A good example of this is the development since the war in the field of photo-copying equipment which has had a ready market and which has undoubtedly taken a great deal of the labour out of reproduction work.

At the other end of the scale is a small office. No matter how small, there is usually some mechanisation in any office, the

typewriter being, of course, the best example of this. Obviously the scope for mechanisation will depend, to some extent, on the number of transactions being handled. The essential feature of a machine in the small office should be adaptability, the advantages lying in the general-purpose machine which is easily learned and easily operated. There is probably no room for very much specialist equipment, and in a small office it is important that manual methods should be improved as much as possible. For example, it may be more economical to use a front feed typewriter to prepare two different but related documents[1] with the figures cast separately than to use an accounting machine which provides the same writing facility and, at the same time, totals the entries. In a small office, outside services for calculating, typing and duplicating may prove to be more economical than the installation of machines to handle this load.

The Choice of Machine

Once clear decisions have been reached on the basic requirements of the job, and the qualities of the method to be used have been properly defined, for example, what degree of speed and what degree of accuracy is needed, the choice between machine and manual methods, or between two types of machine, should be based on the following seven considerations:

Comparative costs.
Comparative speeds.
Quality of work produced.
Flexibility of equipment.
Ease of operation.
Effect on operators or staff.
Reliability of equipment.

Comparative Costs

Costs fall into two main groups:

Initial cost — capital expense, installation charges.
Operating or manning costs, which can be subdivided into variable costs — labour, stationery, operating supplies, maintenance, and fixed costs — depreciation, rent if applicable.

[1] See pages 114 and 152.

Of these cost elements, labour is usually the largest and always the most difficult to determine accurately. Very often, the only precise way of measuring is to list every detail of each operation to be done, and to determine the work content for each. This approach is lengthy and may be costly in itself, but may be preferable to accepting the assurances of the salesman who states that his machine 'will save the work of two people'. Certainly some degree of work measurement will be involved, and this is unavoidable. In determining comparative labour costs, care must be taken not to attribute economies to the machine that are really the result of other improvements in the procedure developed simultaneously with the machine proposal. In other words, the cost of the proposed new method should never be compared with the cost of the existing method unless the latter is known to be as simple and as efficient as possible. In computing the labour cost of an office machine application, it is important not to forget:

The make-ready or set-up time.

The need for using practical operating speeds and not maxima in setting unit times for various operations.

Some of the other more important cost elements which will have to be considered are as follows:

Space. This may not be significant if the rival systems are equally demanding in space.

Cost of auxiliary equipment. Examples are filing equipment, safe-ledger trays, the need for sound-proofing, or even partitioning off a machine installation.

Depreciation. The rate is usually a matter of company policy. The following is suggested as a guide to what might constitute the useful life of various machines:

Duplicators	5 to 8 years
Register machines	10 to 15 years
Calculators	12 to 15 years.

Non-recurring items. Examples are the training of operators, installation costs and the complete conversion of existing records to a new system.

Hidden costs. Mechanisation may make possible some reduction in hidden costs where the work of one or more persons is being saved. Examples are National Insurance and supervision.

Comparative Speeds

Theoretically, variations in speed between two methods are reflected in their respective costs, for once the times have been established the assumption is that both will be suitably manned and equipped. Thus, even though output per person may be greater by a particular machine method, the required output would presumably be met under a rival manual method by employing more people, which would show up in operating costs. There is, of course, a practical limit beyond which any manual routine cannot be staffed without considerable risk of idle time, and not all manual activities can be speeded up by adding more pairs of hands, e.g. transmission of information over distances. For these reasons, some consideration must always be given to speed of performance under each method. The speed must be judged in relation to the requirement, i.e. if one method is faster than another, but each is sufficiently fast, then speed is irrelevant.

Estimation of Requirements

Some figure for machine performance is necessary and caution is needed on this point. Whatever the machine, be it a typewriter, a calculator, or a punched card tabulator, rated capacities, or a salesman's estimate of performance, will be available. However, generous allowances should be made for idle time, operator inexperience, work-flow interruptions and so on.

Quality of Work

With machine book-keeping, the automatic computing and printing of new balance figures is likely to be more accurate than by manual posting. By reproducing successive documents from a single duplicating master, errors in transcription are avoided. The quality of work produced is important and this quality is reflected in appearance.

Flexibility

Some estimate will be needed of the ability of the machine installation to handle peaks of work or changes in procedure. A machine installation may become a bottleneck because of a limitation in the number of machines and operators; whereas

under a manual method, the work could be broken down and distributed among many people. It is important to try to predetermine peaks, their frequency and their size. Unavoidable exceptions should be noted, and some consideration given to the problems of an increase or decrease in absolute volume. Some study should also be made of the possibility of changing the routine.

Ease of Operation

Some thought must be given to the degree of skill necessary to operate the machines being contemplated. There are two aspects of this problem, one being the possibility of having to pay a higher wage rate to man the machine, together with the possibility that skilful operators may be in short supply. The other aspect is concerned with the time taken to train new operators. The facilities offered by the manufacturers of machines for training operators should be investigated.

Effect on the Labour Force

The effects on the clerical staff of mechanising an erstwhile manual process should be foreseen and their reactions anticipated. Opposition to mechanisation on the score of redundancy is generally countered by an unequivocal announcement to the effect that redundancy will be taken care of by normal wastage. If opposition is directed to conditions of operation, steps must be taken to reduce noise, to ensure that operations are not fatiguing, and to provide protective clothing, etc.

Reliability of Equipment

The mechanical reliability of the particular equipment under consideration must be investigated. If the machine is new to the company other users should be approached for their experience of reliability, breakdowns and the promptness of repair and services.

Conclusion

An important point in mechanisation is to remember that the advantages claimed for the machine must in fact be inherent in the mechanical method and not just brought about by an improvement in the system which could be applied manually

with equal effectiveness. The following check list of questions is suggested as a useful guide:

What is the best possible manual method and how does this compare with the best machine method?

What specific benefits are expected? Are they all exclusively inherent in the machine method?

Can a simpler machine be used by rearranging the work flow?

Is the load of work likely to be more than the machine can carry at times? If so, will the machine bottleneck slow up other work and have other disadvantages?

Will trained staff be needed? If so, what will happen if one or more is absent through illness or other causes?

Can the machine give all the service needed? Does it provide features which are unnecessary?

What are the estimated total capital and operating costs, measured not by the manufacturer's declared machine speed, but by the speed and output likely to be realised under actual working conditions?

What are the maintenance facilities?

What is the expected working life?

Are improved models in course of development?

What is the cost of any proprietary stationery or other consumables that might be needed, and are there any difficulties in obtaining this material?

A machine installation should be carefully considered on its economies, whatever the machine utilisation. It is wrong to impose work on to a machine merely in order to use up spare capacity, without considering the mechanisation merits of each.[1]

Writing

In the previous section we have endeavoured to bridge the gap between the work and the machine, proceeding from the known to the unknown, with, however, some emphasis upon the pros and cons of the machine process. This section will take the reader a step further by listing and discussing the various machines which will do some of the operations already charted and described, postponing consideration of punched cards,

[1] See also The Conduct of an Assignment — Chapter V.

computers and communications until later. Once more, reference to the chart (at end of volume) is suggested in order to put any operation or any machine into the perspective of the whole.

The basic clerical operations considered here are writing, copying and calculating which are numbered on the chart 2, 4 and 6 respectively. The main *classes* of machines have been numbered consecutively within their 'basic operation groups', e.g. automatic typewriters (Chart ref. 2/5), stencil duplicators (Chart ref. 4/2), lever set calculating machines (Chart ref. 6/7) and these numbers are used in the text (as shown) for ease of reference.

Writing in the clerical sense means the *original recording* of information on paper, board or similar material. Very often, however, a record is required by more than one person, or in more than one place, and the information must be copied. Copying is the *reproduction* of an original text and, in general, can be carried out in one of four ways:

By using chemically or carbon-coated papers so that a facsimile is produced simultaneously with the original writing.

By rewriting the original text as a separate operation.

By duplicating, i.e. by preparing a *master copy* from which further copies can be made.

By photographic methods.

The method to be adopted for producing copies depends chiefly on the number of copies required and the frequency. Machines are available, designed to produce copies economically in quantities ranging from one to ten thousand as often as required. The economic and practical limitations of the different machines and processes will be considered later, but the general point should be noted that machines used for an *original writing* — typewriters for the most part — can nearly always be used to provide a limited number of copies as well. This aspect is considered under the heading 'Coated Papers'.

Calculating machines include not only machines designed to carry out the four arithmetical operations — adding, subtracting, multiplying and dividing — but also an important class of machines where, although the arithmetical functions may be limited, the machines can be used to record results. In other words, these machines can, within limits, do two basic

operations, both calculating and writing. In some cases, the same machines can be used to do copying as well. Lists of makes of machines in the various categories are included at the end of the appropriate sections. These lists are merely meant to be representative of machines currently available, and although most well-known makes have been included, no claim is made that these lists are comprehensive.

Writing Machines — General (Chart ref. 2)

Machines used for writing may be divided conveniently into three categories:

Machines used where the text is completely variable. The operator has full control over what is written and this is variable at will.

Machines primarily designed for the *repetitive* writing of static information where the operator's choice is limited to selecting certain parts to be reproduced from a fixed text.

Machines where some of the text is fixed and is automatically repeated but the operator can add or insert variable data.

These classifications are convenient for discussion purposes but they are not mutually exclusive. Addressing machines, for example, are machines designed for reproducing a fixed text, falling into the second of the above categories; yet the operator's choice is normally limited to arranging for certain parts of the text *not* to be printed. It is still possible, however, with the larger machines for the operator to add extra information which is not part of the fixed text. The amount of information which can be added in this way is strictly limited and is normally confined to a date or a serial number.

Writing — Variable Text

Standard Typewriters (Chart ref. 2/1)

The most commonly used office machine of all is the standard manually-operated typewriter. The basic design of these machines has changed very little during the last thirty years, and the features of standard typewriters are well known. One or two points are, however, worth noting:

The standard vertical spacing is one-sixth of an inch. This is common to all British machines and most Continental makes, but there are one or two exceptions amongst imported machines.

Horizontal spacing on standard typewriters is normally either ten to the inch (Pica type) or twelve to the inch (Élite type). This may again vary with certain Continental machines. Variations in standard horizontal spacings can be obtained for special purposes.

All typewriters are fitted with tabulating keys and stops to facilitate right to left carriage movement from one predetermined position to another. These stops are rarely used to their fullest advantage.

There is a limit to the typing area, and this varies from one make of machine to another, although the carriage widths, as specified, may be the same.

There are a dozen or so well-known makes of manual machine on the market, including imported machines, but there is very little difference basically between different makes. Some manufacturers offer a wider range of carriage widths, others interchangeable type, and so on, but for the most part modern developments have been concerned with *appearance*, a modern 'streamlined' shape in pastel colours, non-glare finish and 'cushion top' keys. Practically all modern machines have facilities for setting margins and tabulator stops from the keyboard, for adjusting the machine to the typist's touch, and for stencil cutting. Some machines permit half spacing vertically, interchangeable platens and carriages.

There are rather fewer electric machines available and they are all of American or Continental origin. Again, machines differ only in detail. The majority are of the fully electric type, having electrically-operated keys, carriage return, tabulation and vertical spacing. Miscellaneous features which vary from one machine to another include automatic repeat, sometimes on under-scoring only, sometimes on any character, and an automatic cut-out switch on the electric motor which operates within a short time of the typist having stopped work.

The advantages claimed for electrically-operated typewriters include:

Uniform impression of characters.

Less fatigue on the part of the typist.
A greater number of copies at one typing.
Increased output.

Electric typewriters produce a uniform impression because the pressure with which the type bars strike the platen does not vary with the typist's touch. This gives an improved appearance, and since uniform impressions are one of the marks of a skilled typist on a manual machine, this means that a comparatively unskilled typist can produce work which looks as good as that typed by her skilled colleague. Uniform impressions are, of course, a positive advantage when cutting stencils or typing hectographic masters. The ability to produce more copies in one operation may not necessarily be an advantage, since any error made in the original typing will be repeated that many more times, and will bring about a corresponding increase in the time taken to make corrections.

Electric machines sometimes produce an increased output, perhaps through a reduction of fatigue, but it is very difficult, if not impossible, to say exactly how much of the increase obtained is due simply to the fact that electrically-operated machines are used. The installation of electric machines may be accompanied by other things such as improved work flow and improved morale, and these may play some part in producing better output figures. Exaggerated claims are sometimes made by some manufacturers about the possibilities of increased output, and a figure of 20 per cent increase is sometimes quoted. This is almost certainly unrealistic, and the true increase likely to be obtained is probably between 5 and 10 per cent.

Makes of Standard Typewriters:

Adler	Oliver
Bluebird	Olivetti
Everest	Olympia
Facit	Remington
Halda	Royal
Hermes	Smith-Corona
Imperial	Triumph
	Underwood

Makes of Electric Typewriters:

Adler	Remington
Hermes Ambassador	Rheinmetall

IBM	Royal
Mercedes	Smith-Corona
Olivetti	Triumph
	Underwood

Special Purpose Typewriters and Attachments (Chart ref. 2/2)

Special purpose machines are for the most part standard machines which have been adapted to fulfil a particular function. An exception to this rule is the 'flat-bed typewriter' which is constructed quite differently and is dealt with under a separate heading.

Some features of special purpose typewriters commonly found are as follows:

Right-hand justification. Machines can be obtained which will automatically 'stretch out' lines of type, where necessary, to produce lines of even length and consequently an even right-hand margin. Right-hand justification always involves a second 'justified' typing, and on one type of machine this second typing can be carried out fully automatically.[1]

Proportional spacing typewriters. These are machines where different letters occupy a greater or lesser space according to their size, e.g. an 'i' may take only one-third the space occupied by an 'm'. Hand or electric machines are available, and it is claimed that proportional spacing gives improved appearance to the typescript.

Variable type face. This is a feature of machines which are primarily used for composing printed matter. The style and size of type (varying from 6 point to 18 point) can be changed in a matter of seconds. The machines give automatic right-hand justification, and the vertical spacing can be varied at will. The *characters* can be changed on some *standard* machines by either removing the type basket completely and substituting another, or by substituting individual characters as required.

Hectographic master machines. These are designed to help the typist to avoid handling the hectographic carbon. Three types of machine are available. One uses a carbon-coated paper ribbon and is electrically operated. The second

[1] See *Automatic Typewriters*, page 84.

type is manually operated, and comprises a standard machine fitted with a special carriage on which is mounted a roll of hectographic carbon paper. The third group includes a number of attachments which can be used for typing hectographic masters, which can be fitted to a standard typewriter. Attachments using paper ribbon or rolls can be obtained.

Noiseless typewriters. These machines are designed so that the type bars are pushed rather than struck against the platen of the typewriter. They are not entirely silent in operation but considerably quieter than standard machines.

Continuous stationery machines. This category includes a range of typewriters which are basically standard machines fitted with an extended carriage over which the stationery travels before being fed round the platen of the typewriter. The carriage incorporates a device for holding a number of sheets of carbon paper which, after being used for the completion of the first set of documents, can be 'pushed back' into the new starting position for the next set. The stationery is then fed through the machine and the completed set detached. Both manual and electrically-operated machines are obtainable, and there are also a number of attachments on the market, mostly sold by continuous stationery suppliers, which can be used on any standard machine and made to serve the same purpose.[1]

Flat-Bed Typewriters (Chart ref. 2/3)

These constitute a special class of machine in which the paper to be written upon lies flat instead of being wrapped round a cylindrical platen. The keys strike downwards, thus enabling considerably greater pressure to be applied to the keys which in turn produces a large number of copies. Flat-bed machines can be used for typing on cards which would be too stiff to go round the standard platen, and can also be used for typing in bound

[1] A special class of continuous stationery attachments is used in conjunction with punched card tabulators. Besides attachments to carry the stationery, machines are available to 'burst' or detach completed forms and to decollate. See Section 3b 'Punched Cards', page 125.

books. Good registration of multiple forms can be obtained, and alignment to varying positions is quicker than with an ordinary standard machine. Both manual and electrically-operated flat-bed typewriters are available.

Makes of Special Purpose Typewriter:

Continuous stationery
Imperial
Mercedes
Underwood
Elliott Fisher

R.H. justification
Adler
IBM Executive
Justowriter
Varityper

Proportional spacing
IBM Executive
Olivetti Graphika
Varityper

Variable type-face
Varityper

Noiseless
Remington

Hectograph master typing
IBM Hectowriter

Flat-bed
Underwood
Elliott Fisher

Miscellaneous Typewriter Attachments

Besides the continuous stationery attachments and others already mentioned, there are a number of specialised applications. These include card holding, stencil cutting, quick feed and front-attachments.

Makes of Typewriter attachments:

Continuous Stationery
Alacra
Econojet
Egry
Fanfold
Lamson Paragon

Hectograph Master
*Adler
Block and Anderson
Fordigraph
*Olympia
Olivetti — Comet
Valmor

(*Attachments fit own machines only)

Stencil Cutting Attachment for Addressing Machine Stencils
Imperial

Front feed
Imperial
Hermes
Underwood

Writing — Simultaneous Copies with Coated Papers

As mentioned earlier, nearly all the machines so far considered can be used to produce copies automatically by using coated papers. Such papers can be used in either of two ways. One is to have either the original or the copy paper, or both, coated with appropriate 'copy producing material'. The other is to have separate sheets of paper, coated on one or both sides, which are then inserted between the 'top sheet' and the paper on which a copy is to be taken.

Carbon Paper

The second method is the one in general use at the present time using what is commonly known as 'carbon paper'. Carbon paper consists of a body paper or tissue and a coating of colouring pigment such as carbon black mixed with oils and wax, the proportions of oils and waxes used determining the hardness of the carbons. The tissue paper needs to be uniform in composition, non-porous and strong. A soft carbon coating gives dark and full impressions and a large number of copies, whilst hard carbon gives sharp contours, fewer smudges and a large number of impressions. Thin tissue contributes to sharpness of letter contours and number of copies; a thick tissue contributes to the number of impressions made and is more easily handled. The colour of carbon paper is not restricted to black. Red is frequently used in accounts work, while others, such as blue or green, and paper coated with alternate strips of red and black carbon, are available.

The number of carbon copies which can be obtained in this way depends on the type of carbon paper, the copy paper, and type of machine used. With a standard manually-operated typewriter, six good carbon copies is the upper limit, though this may be increased by using special carbon and copy paper. Twenty copies or more in one writing can be obtained on an electric typewriter with a special platen using lightweight copy paper and special carbon paper.

Chemically-Coated Paper

An alternative to carbon paper is a paper coated with a colourless chemical emulsion known as 'NCR'. Two coatings are employed in 'NCR' paper, one being applied to the back of

the original sheet and the other to the face of the copy paper. When the two coatings are subjected to pressure a chemical reaction produces a blue dye on the copy paper. Up to six clear copies are claimed for this method, depending on the writing instrument used, but, since two coatings are always necessary, all intermediate copy sheets have to be coated back and front. However, a recent German invention claims to be able to produce copies from one coating only applied to the face of the copy paper. This means, in effect, that original sheets, e.g. letter headings, need not be coated. In early 1959 no information is yet available about the number of copies to be obtained by this method, and the paper cannot yet be obtained in the U.K.

Carbon Paper — Pros and Cons

The advantage of having separate sheets of carbon paper is economy. Carbon paper can be used repeatedly since only a small portion of the carbon is removed at any one time, and good carbon paper can be used at least fifty times and still produce readable copies. The disadvantage results from the time spent in inserting and removing a separate sheet for each copy required. Nevertheless, this disadvantage can be overcome in one of three ways:

By using carbon-backed forms.

By using made up sets of stationery with inserted sheets of 'one time' carbon paper.

By using continuous stationery.

Carbo-backing. A coating of carbon can be applied directly to the back of the form from which copies are required to be taken. This saves time in handling carbon paper and, since only those parts which need to be copied will be coated, some selection is possible. The number of copies obtainable in this way is about the same as that possible with carbon paper. There are two kinds of carbon backing: one is more expensive but gives better results and is known as 'hot carbonised', a name which is self-explanatory; the other, sometimes known as 'cold carbonised', is produced with what is, in effect, a thick coating of printers' ink. This is less expensive but does not give such good results. In either case, stationery with carbon backing should be stored carefully and steps taken to ensure that the quality of the carbo-backing will last until the forms are brought into use.

One-time Carbon Paper. As the name implies, this is a light-weight carbon paper with a very thin coating of carbon designed to produce one copy only, and sets of forms can be obtained ready made up with sheets or strips of one-time carbon in the appropriate places. Copies are taken and the pieces of one-time carbon removed and then thrown away. Small pieces of one-time carbon paper are sometimes used as an alternative to 'spot carbonising', and both are sometimes incorporated in continuous stationery sets.

Continuous Stationery. The make-up of continuous stationery sets has been considered in greater detail in Chapter II. The object, however, of using continuous stationery is to reduce paper handling time. Complete sets of forms are produced in a continuous strip and are detached after completion. Continuous stationery can only be used successfully when the bulk of the information required on the documents can be entered in one operation.

Substitutes for Carbon Paper

Wax-coated Papers. These are dark-coloured papers which are given a coating of white wax. The wax coating is displaced where the manuscript or typewritten entry is made, and this allows the dark colours to show through for legible reading.

Multiple ribbons. These can be fitted to some typewriters and are sometimes used in accounting machine application, having the effect of making all copies appear as originals. Multiple ribbons can be used to produce up to five copies including the top one.

Writing — Fixed Text Plus Variable Data

There are two distinct classes of machine designed to write or print automatically certain fixed information, this varying from one word to a complete paragraph, but which have in addition facilities for adding or inserting variable information. The two classes of machine differ in the amount of fixed information which can be printed, and also the degree to which variable information may be added. The two classes of machine are:

Imprinting machines. This is a collective term which includes postal frankers, cheque writers, ticket printers and perforators, etc.

Automatic typewriters. These differ from imprinting machines inasmuch as there is no limit to the amount of information which can be repeated automatically, and equally there is no limit to the information which can be added or inserted by the operator at the time of writing.

Although both imprinting machines and automatic typewriters are used primarily for producing what is, in effect, an original writing, because of their facilities for rewriting, they can also be regarded as copying machines. This is particularly true of automatic typewriters which are frequently used to produce what are ostensibly a number of original letters but which in fact differ only very slightly from one another.

Imprinting Machines (Chart ref. 2/4)

Cheque writing and perforating machines. These are machines which can be used to write and shred, or pin-point, the amount in figures, or in figures and words. Some machines can be used to date the cheques but the payee's name has to be entered by some other means. Machines are available which will also imprint signatures, or alternatively this operation can be carried out by a separate machine. Similar equipment can be used for endorsing and cancelling cheques.

Postal franking machines. These are used to imprint a facsimile of a postage stamp and the cancellation mark on outgoing mail. The value of the stamp can be varied at will, and the same machine can be used to print advertising slogans, the sender's address, etc., simultaneously. Machines similar in operation are also obtainable for use in stamping National Insurance cards.

Miscellaneous imprinting machines. These include a variety of machines for printing tickets — price tickets, job cards, etc. — and there is also a selection of numbering machines available for similar applications. Date/time machines and recorders are included in this category.

Makes of Imprinting machines:

Amount writing	*Cheque signing*
Todd — Protectograph (Keyset)	Roneo
Checker (lever set)	Director (UPF)

Combined writing and signing

31/33 Unit Todd Tandem

Postal frankers	*Miscellaneous*
Universal Postal Frankers	English Numbering Machines
Roneo Neopost	IBM
	Dapag

Automatic Typewriters (Chart ref. 2/5)

As mentioned earlier, these machines were developed primarily in order to produce automatically individually-typed letters, which may be largely composed of pre-selected form paragraphs. These machines operate at roughly twice the speed of an average typist. There are two main types of machines, those operated from a perforated roll of paper which operates an electric typewriter pneumatically, and those operated by a punched paper tape which is fed into a tape-reading unit attached to an electrically driven typewriter. With all types of machine, operation can be stopped at a predetermined point to enable the operator to insert variable information. The tape-operated machine can also be used to produce the punched tape, which can be used subsequently for reproducing information which has been typed. A number of automatic typewriters can be connected in series to a 'master' manually-operated machine and used to produce two or more typings simultaneously. A recent development in this class of machine is a third machine type-operated by punched cards, these machines having been developed primarily as an alternative form of computer output.

Makes of Automatic Typewriters:

Punched paper roll	*Punched cards*
Autotypist	IBM
Robotyper	Olivetti
	Remington
	Underwood

Punched paper tape
Flexowriter
Hermes Intromat

Writing — Fixed Text with Selection of Parts Addressing Machines

These are machines designed for the frequent or intermittent writing of relatively static information. Although a large number of machines is still used for the purpose for which originally designed, i.e. printing names and addresses, the scope

of this equipment has been greatly extended and addressing machines now have a large number of applications. Factory documentation, wages preparation, invoicing, stock recording are all common uses for this equipment. There are two main types of addressing machine:

Those which print from an embossed metal plate.

Machines which reproduce from a cut stencil.

Metal Plates: Information to be reproduced is embossed into a metal plate. There are two types of machine using different kinds of plates, the one-piece type self-indexing type, and the three-piece plate which comprises the plate itself, an index card carrying an imprint from the plate, and a frame to hold the plate and card. Both types of machine print through an inked ribbon, and the plate is brought into contact with the paper by means of a flat or roller platen carried in the printing head. Hand or electrically-operated machines are available, and all machines have the same basic features:

A platen or pad.

A plate channel.

The inked ribbon.

A receptacle for the plates after printing.

Plates are passed along the channel and under the inked ribbon at the printing position. The form or document to be printed is positioned face downwards, and the printing head is brought down to cause an impression to be made. The printing head is then raised, the form removed and the plate passes into the receiving tray. In some machines, this arrangement of plate, ribbon and platen is reversed. The platen is in the base of the machine, and the plate is in the movable printing head. In this type of machine, documents are printed face upwards. Machines available range from the single-print hand-operated machine to the large electrically-operated machines with a number of auxiliary features.

There is a wide range of plates available, the largest having room for nine lines of type with up to forty-six characters on each line. Embossing can be carried out as a service by the supplier, or can be done on the user's own embossing machine. The plate is essentially permanent, but alteration can be made by blanking out and re-embossing and this can be repeated several times.

Selection of information is achieved by causing sections of the plate not to print, and this is accomplished by using different platens which have had the appropriate part cut away. To a limited extent, additional information can be printed simultaneously with the plates, this being done by means of numbering boxes, and/or data channels holding loose type and/or additional fixed embossed strips. These facilities are, however, only available on the larger machines. Carbon copies can be taken and special ribbons are available for specialised application.

There is a wide variety of auxiliary features with which addressing machines can be fitted, apart from those already mentioned. The more important are:

Listing attachments which enable machines to list entries automatically. Spacing is adjustable in multiples of one-sixth of an inch. Listing attachments are available to print two or three impressions side by side.

Selection mechanism which can be used to control the 'skipping' of plates, repeat print, etc., automatically.

Automatic paper feeds which include continuous stationery attachments. These can be combined with automatic stops to check the machine when the last plate of a particular group is printed or at the end of a sheet.

Multiple printing heads which can be used to avoid multiple printing run of plates.

Coloured plates which are available to give a degree of visual selection.

Stencil machines. Stencil addressing machines work on the same principle as ordinary stencil duplicators.[1] The stencils used, however, are considerably stronger than those used for duplicating, being made of impregnated fibre and mounted in, or on, a cardboard frame. As in embossed plate machines, stencils are fed successively into the printing position, and ink is forced through the typed parts of the stencil by a roller or pad, different machines having the inking mechanism located either below or above the stencil. The different types of stencils available are:

One-piece, where the stencil is permanently fixed to the frame.

Two-piece, where perforated strips of stencil are cut,

[1] See '*Copying — Duplicating*', page 88. See also *Document Copying and Reproduction Processes*, by H. R. Verry (Fountain Press, 1958).

detached, and gummed or clamped to the frame. These frames are very often extended to carry an identification label printed from the stencil, and provision is made for indexing or recording other information.

A development of the two-piece stencil is the type with an extended frame which can be punched to give automatic selection — this is the equivalent to 'pipping' an embossed plate — enabling a wide range of categories to be selected. Coloured frames for visual selection are also available.

The range of machines using stencils and the attachments available is roughly equivalent to that in the embossed plate field, which extends from hand-operated single-print machines up to electrically driven machines for systems work with automatic feed, etc. Again, facilities are available for printing part only of the information on the stencil.

The stencil machines differ from the embossed metal plate equipment in that:

No embossing machine is required, and stencils can be prepared on a standard typewriter fitted with a stencil attachment.

A greater range of classification for indexing or auto-selection is possible on the extended frames.

Carbon copies cannot be taken.

Liquid printing ink is used for reproducing.

Hectographic addressing machines. These machines work on the same principle as hectographic duplicators.[1] There are one or two machines used purely for addressing, but no machines are available for systems work, this kind of application being fully catered for by the larger duplicators with facilities for selection of lines and columns, etc.

Makes of Addressing machines:

One-piece embossed plate	*Three-piece embossed plate*
Bradma — Adrema	Addressograph — Multigraph
Stencil	*Hectograph*
Addressal	Renaddress — Block and Anderson
Haywards	
Ellams	
Ronco	

[1] See '*Copying — Duplicating*', page 88.

Copying Equipment — General (Chart ref. 4)

Two methods of producing copies of original writings have already been touched upon. By using carbon paper, or other similar material, a small number of copies can be produced simultaneously with the original writing. Alternatively, the original text can be rewritten. Both methods are severely limited in the number of copies which can be produced economically, and thus where more than about half-a-dozen copies are required, one of the reproduction processes described in the following section should be used.

Broadly speaking, there are two kinds of document copying methods: those which involve preparing a *master copy* from which a number of further copies are 'run off', commonly called duplicating; and methods used to copy *existing documents*. The methods used for copying existing documents are photographic in origin and recent developments in the field of document copying in offices have been in the direction of extending the use of such methods as an alternative to duplicating.[1] Different reproducing processes can sometimes be combined with advantage, either to achieve economies in the cost of materials, or as a first step in the preparation of masters for one of the duplicating processes. This aspect is touched upon in the notes under the heading 'Master Preparation' following 'Optical Photocopying'.

Copying — Duplicating and Printing

Hectographic Process Duplicators (Chart ref. 4/1)

The most commonly used type of hectographic duplicator is the *rotary spirit machine*, either hand or electrically-operated. Copies are taken from a master copy which has been made by writing, drawing, or typing, on a sheet of paper in contact with a hectographic carbon transfer sheet or ribbon, best results being obtained when the master copy is made on art or semi-art paper. The actual duplicating process consists of first bringing the rolling-off paper, i.e. the copy paper, into contact with a damping pad or roller fed with spirit. The slightly moist rolling-off paper is then pressed against the master copy, and the spirit

[1] In this section, the term 'duplicating' is restricted to mean copying processes which involve taking copies from a specially prepared master *not suitable* for photographic reproduction.

on the rolling-off paper dissolves a portion of the 'carbon' deposit on the master leaving an impression on the copy paper.

Machines may be hand-fed or equipped with automatic paper feed, and some machines have an automatic master change feature. Special machines are available for reproducing parts and selected lines of the master, or for selected lines only, or for selected columns. Larger machines can be equipped to operate with two master copies, e.g. one master for static data and one for variable information to appear only on selected documents.

Carbon papers of different colours can be used for different entries on one master, thus enabling multi-coloured copies to be obtained in one operation. Short-run carbon is available which can be used three or four times. The process is suitable for up to three or four hundred copies, depending upon the type of master and copy paper used. The process is commonly used when up to one hundred copies are required and when permanence of the image is not important. Copies made by this process have a slight tendency to fade if exposed to daylight, but the process has two distinct advantages:

The master can be filed and re-used at a later date without difficulty.

Further information can easily be added to the original master when this is required, to appear on subsequent copies.

A criticism often made of hectographic duplicating is that it is 'dirty'. There is a tendency for the colour to 'fly' and to discolour the equipment and surroundings, including operator's clothing. The dyes used in normal hectographic carbon are water soluble, and operator's hands can easily become stained not only by flying particles but also by direct contact with the carbon coating. This can happen in two ways, by handling actual sheets of carbon, or by touching the carbon imprint on the back of the master after typing or writing. Purple carbon, which incorporates a methyl violet dye, is probably the worst offender in this respect, although the copies produced are clearer and more intense than those in any colour, thus making purple the most commonly used colour.

Stains brought about by handling sheets of carbon can be avoided by using one of the 'clean' carbons available, which are produced by coating the carbon with a waxlike material. This is

only effective, however, up to the time that the carbon is used, since typing or writing breaks up the wax coating and destroys the protection. 'Clean' carbon is just as likely as any other kind to stain the operator's hands if she touches the back of the master. Operators are usually provided with removing cream to use on their hands, and are often given overalls to protect their clothing from the risk of marking by hectographic carbon.

A number of manufacturers have developed improved methods in an attempt to overcome this inherent disadvantage of the original hectographic process, and their efforts have met varying degrees of success. The crux of the problem is to find a suitable transfer material which will incorporate a dye to give a copy as strong and as intense as methyl violet, but which will not at the same time stain the operator's hands if she comes into contact with it.

A method devised by one manufacturer uses azo dye — as used in diazo photocopying processes. The process is known as 'Azograph' and makes use of a transfer coating in which the constituents of the dye are held chemically separated until they come into contact with the fluid in the duplicator, so that until this happens the dye does not actually form. Because of this the 'carbon' is perfectly clean to handle, but the process has two disadvantages. The fluid used is corrosive, which means that special machines have to be used, since the parts likely to come into contact with the fluid must be made of stainless steel. Secondly, the chemical reaction between the coating and the fluid takes time to 'build up', with the result that the first copy taken is rather indistinct and the intensity of image gradually improves as more copies are made. 'Improved' copies can be produced by first passing a piece of accelerator paper through the machine, but this can be time-consuming on short run work. The image produced by this method is strong but rather less intense than normal hectographic purple.

The principle of splitting the constituents of the dye has also been adopted by other manufacturers who have developed similar processes. One method makes use of a special copy paper, the coating of which contains one constituent, whilst two others are contained in the transfer material and fluid used. This process is not yet available in the U.K. An alternative method relies on a minimum aluminium sulphite content in the

copy paper used to produce the necessary chemical reaction.[1] This process is available in the U.K. Both processes make use of non-staining transfer material, and the special fluid used in each case is non-corrosive and can be used in standard machines.

To avoid the complications of special fluid and copy paper, a new blue, as distinct from purple, carbon has been produced, which can be used with ordinary fluid and paper. The carbon, which is non-staining and non-water-soluble, will still mark the operator's fingers if they come into contact with it, but can be washed off with soap and water so that removing cream is not necessary. The copy produced is less intense than the conventional purple, but is perfectly adequate for short run work and efforts to produce a stronger line are continuing.

Makes of Hectograph, spirit Duplicators:

Rotary, hand or electrically-operated

Banda
Corona
Ditto
Fordigraph
Orlid
Polycopy
Valmor

Flat-bed, hand-operated

Renafix — E. G. Solomon

Azograph (Direct fluid), Rotary, hand or electric

A. B. Dick

Stencil Duplicating Process (Chart ref. 4/2)

The master, from which copies are made by this process, is a stencil consisting of two layers of material, one of which is a coating impervious to ink. Entries are made on the stencil by drawing, writing, typing or by photographic means which cause the coating of the stencil to be cut or otherwise made to allow the passage of ink. The duplicating process consists of forcing ink through the stencil at the points where entries have been made so that a copy is produced on rolling-off paper. It is usual, but not essential, to use semi-absorbent rolling-off paper to prevent offset effects. If calendered paper is used, then other steps must be taken to prevent offset, one common method being interleaving, and machines can be obtained, to do this automatically. An alternative method is for each copy to be sprayed with very fine powder as it leaves the machine.

[1] Aluminium sulphite is used in paper manufacture and many good quality papers are normally sufficiently impregnated for this process to work.

Rotary stencil duplicators may be either hand-operated or power-driven. It is possible to produce multi-coloured copies, but this necessitates a separate run for each colour, together with a fresh stencil and a change of ink.

There are two types of stencil duplicator. One type has two solid rollers mounted one above the other connected by a porous mesh. Ink is fed on to oscillating inking rollers, between the two main rollers, and is transferred by the rollers to the mesh. The stencil is attached to the mesh, and ink is forced through the stencil on to the copy paper. The other type of machine is the single drum type, consisting of one hollow drum, somewhat larger than the solid rollers used on the other machine, into which ink is poured. The surface of the drum is perforated and ink is drawn by capillary action through the holes in the surface of the drum on to a covering 'blanket' and so through the stencil. The ink consumption with this type of machine is claimed to be less, and this type of machine has advantages where multi-coloured work is contemplated, since changing the drum is comparatively quick.

This process can be used for up to ten thousand copies, depending upon the type of stencil; but the number of copies (as well as the quality) obtainable from a particular stencil varies considerably according to the skill exhibited in the production of the original stencil, and, to a lesser extent, the subsequent handling of the stencil. Copies made are fast to light. Stencils can be stored and reused, but this is more difficult than with hectographic masters. Pre-cut stencils can be supplied to the requirements of the user who can, if desired, cut further information on the same stencil. These can be useful where forms are required having common headings but containing otherwise variable matter. This and other methods of master preparation are dealt with in a separate section after 'Photocopying'. (See page 104.)

Makes of Rotary Stencil Duplicators:

Twin drum, surface inking	*Single drum*
Andrews	Bulmers
Fermaprint	Ellams
Gestetner	Roneo
Lion	
Remington Rex	

Makes of Flat-Bed Stencil Duplicators:
Baird
Ellams
Lion

Offset-Litho Process Printing Machines (Chart ref. 4/3)

The master in offset-litho duplication is a flexible metal, or paper 'plate'. The plate may be prepared by:

Writing, drawing or typing through a litho ribbon or litho carbon paper — known as 'direct image'.

Photographic or electro-static processes.

The lithographic printing process is based on the fact that fatty substances repel water. The image is made in a suitable greasy medium which readily takes the oily printing ink from the inking roller while the rest of the printing surface is covered with a film of water and repels the ink. Offset-litho machines are of the power-driven rotary type, and incorporate a series of inking and damping rollers. To produce copies, the prepared plate is fixed to the impression cylinder and ink rollers are brought into contact with it. The image is inked and this image is then set off (hence the name) on to a 'blanket roller' in reverse. The blanket or printing roller is then brought into contact with the rolling-off paper, and the reversed image transferred to the copy paper where it appears in a readable form.

The number of copies obtainable by this process depends upon the type of plate used. From twenty thousand to fifty thousand copies may be produced from a metal plate and up to five thousand copies from a paper plate. The method is particularly recommended:

When the plate will need to be revived at a later date for further copies.

When copies are needed on paper having a good writing surface.

Where permanence of the copy and good quality are essential.

Plates can be partly or wholly prepared by the makers. Since plates can be produced photographically, copies can be enlarged or reduced from the original matter and a high standard of reproduction achieved without difficulty. A wide range of machines is available, including machines fitted with various

auxiliary devices designed to speed up operations. These include suction feed, perforators, daters, stacking devices, etc. A special type of machine, known as the 'double-headed' machine, can be used for simultaneous printing of two colours, or for printing on both sides of one sheet of paper. Another type has been developed for 'systems' work, which enables the process to be used for short-run work, e.g. the production of despatch documents, and is achieved by equipping the machine with a device to permit automatic cleaning of the blanket roller.

Direct Litho Printing Machines

This was the original litho process where copies were printed direct from the plate without being first offset on the blanket. In this case, the image is put on the plate in reverse, as when making a hectographic master. This process has recently been revived for office duplication, and a direct litho printing machine will be put on the market soon.

List of Makes:

Offset litho machines (up to 14″ × 20″ sheet size)

Gestelith	—	Gestetner
Multilith	—	Addressograph-Multigraph
Rotamaster	—	Rotaprint

Plates and Equipment

Grant	Addressograph-Multigraph	Rotaprint
Algraphy		Hubex

Type-Set Duplicators (Chart ref. 4/4)

With these machines the information to be copied is set up in loose type on a slotted segment shaped to fit the drum of the machine. The duplicator has a number of inking rollers from which ink is picked up by the type and transferred to the copy paper. Both manual and electrically-operated machines are available, and attachments available include mechanical joggers, a signature attachment and a numbering device. Apart from type and blocks, horizontal and vertical rules are available to enable forms to be printed. A particular class of type-set machine is used for label and ticket printing, in which the printing area is naturally smaller, but the general

operation of these machines is similar to the standard type-set duplicator.

Makes of Machines:

Type-set Duplicators	*Label and Ticket Printing*
Addressograph-Multigraph	Dapag (1943) Limited
Roneotype	IBM

Copying — Photocopying

The processes and equipment to be considered under this heading are used mainly as an alternative to rewriting for copying existing documents. One process, however, uses a comparatively cheap copy paper which, in certain circumstances, is a practical alternative, to duplicating or to carbon copying. This process is known as 'Dyeline' or 'Diazo' and its use is discussed below. Photocopying machines and equipment use reproduction processes which, unlike duplicating and printing, are chemical rather than mechanical. These processes make use of the chemical reactions caused in certain materials by exposure to light rays. Such reactions may be made visible as contrasts in colour, or to destroy a static electrical charge, or to cause a stencil coating to harden.

Two distinct kinds of equipment are available, and the choice depends upon the *size* of copy required:

Non-optical equipment, which does not incorporate a lens and consequently precludes any reduction or enlargement of the original. Copies are made by contact printing and are always facsimile or 'same size' copies.

Optical equipment (cameras) in which a lens permits the production of enlarged or reduced copies.

The first category has wider application in clerical work and the equipment is simple to use, since there is no lens and consequently no focussing problem. Optical processes have specialised applications. Their advantages are considerable since the size and storage space of a mass of records can be reduced. Recent improvements to these micro-records are likely to increase their use in filing and reference in the future.

However, a clear understanding of the technical terms used is essential. Those most likely to cause confusion are 'positive' and 'negative'. These refer solely to the *tonal values* of the print. A copy which shows white printing made from an original where

the printing was black is a 'negative' copy. If in addition the printing is the 'wrong way round', i.e. as it would appear in a mirror, the copy is correctly described as a 'laterally reversed' negative. Such copies are also sometimes referred to as 'reflex' negatives, 'indirect' negatives or 'true' negatives. 'Laterally reversed' is a more exact description, and is to be preferred since 'reflex' and 'indirect' are also used to describe particular printing methods.

If the tonal values are reversed in the copy but the printing is still the 'right way round', it is best described as a 'readable' negative. 'Direct' negative may also be used to describe these copies. Similarly, a copy which shows black printing made from an original with black printing is a 'positive' copy. The printing may again be readable or 'back to front'. Readable copies are described as such or as 'direct' positives. If the printing is 'back to front', then 'laterally reversed positive' should be used. Reversed positives are also referred to as 'mirror' copies or 'indirect positives'.

PHOTOCOPYING (NON-OPTICAL) FACSIMILE COPIES

The three basic requirements for contact printing are:

A suitable light source.

Means of holding the original and copy paper in close contact.

Facilities for processing the exposed prints including, possibly, drying equipment.

The type and intensity of the light required depends upon the papers used. Tungsten filament, ultra-violet and infra-red lamps are used in different processes and machines. A general requirement is an evenly diffused light over the total printing area, and all machines should be designed to achieve this.

The method adopted for holding the original and copy paper in contact depends upon whether flat-bed or rotary machines are used. The flat-bed machine consists of a box to hold the lamps, and a glass platen on which the original and copy paper are laid. A pressure head, fitted with either a sponge rubber pad or a vacuum blanket, is brought down and clamped in position to hold the papers during exposure. On some machines this arrangement is reversed, and the papers are laid on the pad or blanket; the pressure head, which is located beneath the light

box being brought up to the glass platen, which is in this case at the base of the light box. On the other hand, rotary machines have a central light source arranged horizontally inside a revolving glass cylinder. A wide band of canvas or similar material is arranged so that at a certain point it meets the cylinder and travels round in close contact with it. The original and copy paper are fed through a slot at the front and picked up by the band, travel round the light source and are ejected after exposure. The exposure time in this type of machine is controlled by the speed at which the cylinder revolves.

With one exception, known as 'Thermofax', all photocopying processes involve some treatment of the copies after exposure. Conventional photography involves developing, fixing, washing and drying of exposed prints. Equipment has been designed specifically for office use to avoid, as far as possible, the complications of trays of liquid, running water, etc., but developing in one form or another must always be carried out. Sometimes no further processing is needed, although with some materials stabilising after development is necessary; and since in this case liquids are employed, prints must be allowed to dry.

Automatic developing units, either hand or electrically driven, are in common use. In both cases, prints are fed through slots, picked up by rollers and passed through one or two trays of liquid, depending on the process, to emerge on the other side in a damp condition. Alternatively, prints may be processed by hand, using the 'porous block' technique. In this, developing and stabilising liquids are applied in turn to the surface of the print and excess fluid removed with a porous roller. Separate developing units, or combined one-piece exposure units with a built-in developer, are available.

Contact printing with conventional equipment can be carried out in one of two ways, by:

Direct or transmission printing, where a direct positive readable copy is made by a single exposure;

Indirect or reflex printing, where the first exposure produces a laterally reversed copy, negative or positive depending upon the copy medium used. From this intermediate copy, a direct positive is made by further exposure.

In transmission printing, the original and copy paper (or film) are so arranged that the light passes through the original before striking the sensitised surface of the copy medium. This method can only be used with originals which are translucent single sided, i.e. with printed matter on one side only. Where the copy paper is shaded from the light by the printed matter on the original a direct image is produced. If the original to be copied is opaque or has printing on both sides, reflex printing methods must be used. In this case, the original and copy paper are arranged so that light passes first through the sensitised copy paper and is then reflected from the original on to the sensitised surface. This produces a laterally reversed copy. Transmission printing is then used to produce a direct positive.

The non-optical photocopying processes can be classified according to the type of materials used in the sensitised emulsions with which the copy papers are coated. There are two main groups:

Processes using papers coated with a silver salt emulsion, the material used on standard photographic plates or film.

Processes using papers coated with diazonium compounds. These are the dyeline processes referred to above, and the papers used cost roughly about one-fourth the price of a comparable sheet of silver salt emulsion coated paper.

In addition, there are two processes developed comparatively recently which use different materials:

'Thermofax', using a copy paper sensitive to the heat emitted by infra-red rays.

'Verifax', where the intermediate copy is made on a gelatine-coated matrix.

Silver Salt Emulsion Processes (Chart ref. 4/5)

The emulsion used for document copying is 'slower' than that used in ordinary photography, which increases exposure time, but reduces the risk of over exposure and fogging. Automatic processing equipment has eliminated the need for open trays of chemicals, and papers have been brought into use which do not require the negative to be separately developed; other papers have been produced to give a positive copy by one exposure.

The silver salt processes are:

Reflex.
Transfer.
Autopositive.

The reflex process most nearly approaches conventional photography and can be used to copy any document, opaque, translucent, single or double-sided. Reflex printing is used to produce the first copy, a laterally reversed negative, which is developed and either fixed and washed or stabilised. After drying, the negative print can be used to make as many positive prints as are required. The reflex process should be operated in subdued lighting, and direct daylight and strong artificial light must be excluded.

The transfer process is similar in application to reflex copying except that the negative does not have to be developed as a separate operation. After exposure, the negative is placed in contact with a sheet of positive transfer paper (which is insensitive to light) and both are passed through an automatic processing unit. The sheets are delivered moist and firmly pressed together. After twenty seconds they are separated, by which time the image has been transferred to produce a direct positive copy. The advantage of not having to develop the negative separately is obvious; the disadvantage attached to this process is one of cost, since for each good positive copy a fresh sheet of negative paper must be used. However, some progress is being made with negative papers from which two or more positive copies can be made. Two positive copies can often be produced from negative papers not specially designed for this, but some loss of quality is inevitable, and a good deal of skill is necessary to be able to judge when to peel the papers apart. This process is also known as diffusion transfer or photo transfer.

The autopositive or direct positive process eliminates the negative copy altogether, a special emulsion being used which yields a positive copy on development. With single-sided translucent originals and transmission printing, the copy obtained is a direct readable positive. With double-sided or opaque originals, reflex printing is used and produces a reversed positive or 'mirror' copy. Since autopositive paper is itself translucent, this copy can then be used to produce direct positives either by the same process or by dye-line.

List of Makes:

Reflex

Unicop — B & A
Contoura
Copycat
Duostat — Kodak
Dokuphot — Solomon
Ilford
Polyprint — Masons
Remflex — Remington

Transfer

Bandavelop — B & A
Copyfix — Anson
Economist — Copycat
Model 112 — A.B. Dick
Masoncopy
Ozarapid — Ozalid
Transcopy — Remington

Autopositive

Contoura
Copycat
Kodak
Lawes Rabjohn
Remflex — Remington

Diazo processes (Dyeline) (Chart ref. 4/6)

There are two kinds of diazo coated paper. With one the latent image is developed by exposure to ammonia vapour; the other type needs a liquid developing agent or coupler. The chemistry of the diazo or dyeline process (the latter term is generally used for the liquid developer type) differs from conventional photography. The emulsion used is not sensitive to ordinary light, but is destroyed by ultra-violet light. When, therefore, a sheet of sensitised material is exposed, using transmission printing, with an original, the coating is bleached away except where the coating has been protected by the printing on the original. This latent image darkens on development and produces a readable positive copy.

Direct dyeline. The dyeline process is commonly used to copy single-sided translucent originals. Successful prints can only be made from originals with a high density image, but the process has a number of advantages:

Economy, since dyeline paper costs very much less than silver salt coated paper.

Simplicity, since the only operations are exposing and developing.

Speed, since the developing process takes only a few seconds.

In addition, if the dry process is used (ammonia vapour

developing), no time is spent waiting for damp prints to dry off. A disadvantage of the ammonia developer equipment is the need to provide ventilation to carry away the ammonia vapour.

Reference has already been made to the use of dyeline as an alternative to duplicating or carbon copying. Where originals can be prepared on suitable translucent paper, copies can be taken quickly and economically. The only limitation to the original is a minimum density of image on one side only.

Special manuscript and typewriter carbon paper for making translucent masters for photocopying are available, with orange, yellow and green coatings, which have been specially produced for making high density translucencies for photocopy work. One-time carbon papers, coated yellow or orange on one side and black on the other, can be used for preparing a translucent master, where this forms part of a multiple set.

Reflex foil. This process has been developed to enable dyeline materials to be used in copying opaque or double-sided documents. The foil is coated with an opaque screen which has a large number of very small perforations. The screen is removed after exposure and the foil developed in an alkaline solution. The resultant copy is a highly translucent direct positive which is suitable for further dyeline copies.

Transfer foil. This is another dyeline process using a foil and perforated screen. The intermediate copy is a reversed negative, which is not separately developed but passed, with a piece of chemically-treated art paper, through a tray of clear water. The two papers are squeezed together by pressure rollers, so that after separation the image is found to have been transferred to the copy paper as a direct positive.

List of Makes:

Dyeline (wet developer)
Copycat
Lawes Rabjohn
Remington
Ilford
Masons

Dyeline (dry developer)
Ozalid

Transfer foil and Reflex foil
Ilford

Combined silver and dyeline processes. Processes are often combined to take advantage of the economies of dyeline copying. Where the original is doublesided, opaque or with a low density image, direct dyeline printing cannot be used. Transfer, reflex foil, and autopositive processes can all be used to produce an intermediate copy suitable for further dyeline copying. The auto-positive process offers the most economical approach, the translucencies produced by the other processes being more expensive, but more translucent than auto-positives and dyeline copies and quicker to produce. Dyeline prints made from translucencies are often of better quality.

Thermofax (Chart ref. 4/7)

This process uses a paper which is sensitive to heat. The original and copy paper are exposed to light which is reflected from the 'white' background but absorbed by the darker printing. Heat generated by the infra-red rays is conducted by the image on the original to the copy, causing it to darken. A direct positive is produced and no development is necessary. This process is fast, and the machine is simple to use, but exhibits one or two disadvantages. Copies can only be made from originals with carbon or metal-based printing; certain colours are non-effective, red being one; the paper remains sensitive to heat after exposure; and there is a tendency for copies to age and become brittle.

Verifax (Chart ref. 4/8)

This is a transfer process using two special copy papers and an activating solution. The paper on which the intermediate copy is made has a gelatine and dye-coated base and is called the 'matrix'. After exposure, this matrix is placed in the tray of activator solution for twenty seconds only with a sheet of special semi-absorbent paper, which is obtainable from the manufacturers. Both papers pass through rollers which squeeze them together and transfer the image to the copy paper. The matrix can then be put back into the activator to produce up to five more copies by repeating the operation.

List of Makes:

Thermofax	*Verifax*
Minnesota Mining	Kodak

PHOTOCOPYING (OPTICAL) ENLARGED OR REDUCED COPIES

Optical photocopying equipment can be divided into two categories:

Machines, mostly of the fixed focus, automatic type, which are used to make copies of documents of a reduced size, a process known as micro-filming.

Machines which can be used to make copies of either reduced or enlarged size.

Photocopying — Reduction (Chart ref. 4/9)

Of these two processes micro-filming has the wider application in clerical work. The fact that commercial documents do not vary much in size has encouraged the production of machines, sometimes called 'recorders', which, on 16 mm. roll film, will automatically photograph single documents up to 11 inches wide at a rate of up to 10,000 per hour. The speed of operation depends on whether documents are hand or automatically fed, but automatic feeding will only work with documents of uniform size and thickness. Various reduction ratios can also be used, 18 : 1 and 37 : 1 being common. With some machines, both sides of a document can be photographed simultaneously and printed side by side. 35 mm. equipment is also available, but this is more widely used for copying books and large documents; known as 'automatic repeat' this type of machine is much slower in operation than the continuous flow equipment described above, a reasonable output being 300 copies per hour.

Processed microfilm is generally stored on spools, and reference is made by means of a reader which throws an enlargement on to a screen, although some readers can be used to print a copy of the original by projecting the image on to photographic printing paper. The actual processing of exposed microfilm is carried out by the supplier. Microfilming offers advantages of economy in space, speed in copying, increased security and increased durability.

Alternatives to roll films are known as microsheet, or microfiche, and microcards. The sheets are translucent and provide better definition, but the cards are nevertheless cheaper to

produce. With other variations of the basic method, known as micro-strip and microtape, these are all attempts to combine the advantages of microfilming with those of filing and indexing in sheet or card form.

Makes of Microfilm:

Burroughs
Kodak — Recordak.

Photocopying — Reduction or Enlargement (Chart ref. 4/10)

There are two distinct types of large-size cameras designed for copying documents or drawings, known as:

Prismatic cameras.

Process cameras.

A third type of machine incorporates a camera, but the equipment is designed primarily for the production of offset litho plates. This is the electromagnetic process and is described under the heading 'Master Preparation'.

Prismatic. The prismatic camera can produce copies up to 18 inches by 24 inches in size on a roll of photographic paper, from which the exposed portion is automatically cut. It is then developed, fixed, washed and dried, the first copy being a direct or readable negative, which may be quite adequate. The tones are reversed, but because the machine incorporates a prism, all copies produced are readable. There is also no limit to the size of the originals which can be copied.

Process. The process camera can be used to copy an area of 60 inches by 40 inches. Reproduction is made on film (70 mm.), or on half or full size plates. Copies enlarged from the original can be made, which can be printed on a wide range of photographic papers. Process cameras, like prismatic cameras, can be used to prepare plates for offset litho printing.

List of Makes:

Prismatic Cameras	*Process Cameras*
Photostat	Kodak
	Barcro.

MASTER PREPARATION

The quality of copy produced by any duplicating or copying process depends largely upon the skill and care with which the master copy is prepared. Reference has already been made to

the common methods of master preparation — writing, typing or drawing, and also pre-cutting or pre-printing, for which printers' type is used. Apart from these, there are a number of other methods available.

Photographic Stencils

These are coated with a light sensitive material, which hardens on exposure to light. Facsimile stencils can be made by transmission printing of suitable originals, the coating protected by the image being washed away on development.

Photoscope Stencils

These are similar in application but can be used for half-tone work. The Photoscope is a stencil camera and consequently can make photographically reduced or enlarged stencils. The copy holder takes originals up to 16 inches by 9 inches, the maximum stencil size being 13 inches by 8 inches.

Electronic Stencils

There are several machines available for the production of stencils electronically. A feature common to all machines is a photo-electric cell, which scans the original as it revolves on a drum; the image is reproduced on a plastic stencil, carried on a second revolving drum, by burning or punching minute holes. Where the photo-electric cell 'sees' a black area, it makes a hole. Similar equipment can be used in hectographic or offset litho master preparation.

XEROGRAPHY

This process is used primarily for the production of offset litho masters. The first step is to induce a positive static electrical charge on the surface of a metal plate coated with solenium. The plate is then exposed in a camera with the original. Solenium is light sensitive, and thus the static charge is destroyed where light is reflected from the 'white' areas of the original. At this stage there is an invisible pattern of static electricity, positively charged on the plate forming a reversed image of the original. A negatively charged black powder is cascaded over the plate and is attracted to the positive charge; the reversed

positive image then becomes visible. Finally, an offset master is placed over the image on the plate and fixed by the application of heat.

As well as its use for master preparation, Xerography can also be used in place of conventional photocopying equipment. Used in this way, the apparatus is cumbersome, but it can produce copies on non-sensitive paper. Automatic machines are available to print enlarged copies in continuous roll form from microfilm originals at the rate of twenty feet per minute.

List of Makes:

Photographic Stencils
Gestetner

Xerography
Rank — Xerox

Electronic Stencils
Remington
Roneo

The Choice of a Copying Process

The choice of the right process or type of machine to use in any particular set of circumstances depends on a large number of variables. The following list of questions serves to highlight the main factors to be considered:

Type of Job

Is there an existing original?
Must a master be produced?
Can the master be completed in one operation?
Is information to be added to the master?
What is the incidence of alterations?

Frequency of Job

How often will copies be needed?
Can the master be used repeatedly?
How often?
What are the storage facilities for masters or originals?

Quality of Work

What is the condition of the original documents?
What quality and appearance is desirable in the copies?
What life is required of the copies?
How will they be used and filed?
What are the registration limits, if any?

Number of Copies

How many copies are needed on first run?
How many on any subsequent runs?

Speed of Production

How soon are copies needed?
How long will the master take to prepare?
How quickly can copies be produced once the master is ready?

Skill of Operators

How much training is necessary?
Are trained operators available?
What training facilities are available?

Cost of Reproduction

What will the initial cost of the equipment be?
What are the operating costs?

Calculating

General

As mentioned in the introduction to this chapter, the machines available to carry out office calculations fall into two distinct categories:

Machines where, with one or two exceptions, the calculations are limited to addition and subtraction but a mechanism is incorporated for providing *printed results.*

Machines which can perform all four arithmetical processes, again with minor exceptions, but without any printing mechanism, the results being read from *visible dials.*

The first category includes adding, listing, book-keeping and accounting machines. Most of this group can be used for addition and subtraction, some being limited to addition only. Some accounting machines can be used for multiplication, and there is a special type of machine — the printing calculator — which can be used for multiplying and, occasionally, division as well, but only in decimals. This category also includes punched card tabulators, these being dealt with in the next section — 'Punched Card Machines'.

The second category includes 'adding' and 'calculating'

machines as they are usually called. Adding machines, at least full keyboard ones, are not limited to adding. This is their main function, but they can also be used for all other arithmetical processes. Similarly, calculating machines are primarily designed to multiply and divide, but can be used for addition and subtraction as well.

CALCULATING MACHINES WHICH PRINT RESULTS (Chart ref. 6)

The mechanism inside the machine which records amounts added or subtracted consists of a series of adding wheels and is known as the register. A convenient classification of these machines is by number of registers, and on this basis three types can be distinguished:

Single register machines — known as adding/listing or listing machines.

Double register machines — known collectively as 'duplex' machines, different models being described by the makers as adding/listing, book-keeping or desk accounting machines.

Multiple register machines — being accounting machines, according to the usual sense of the term, having at least two registers, often many more, and a number of other features which enable them to carry out any accounting routine. Such machines are also known as billing or posting machines.

Not all double register adding/listing machines are suitable for book-keeping work. This depends on the type of carriage fitted to the machine and other features, which are dealt with below.

Also, registers may be designed simply to add amounts listed vertically. Very often, however, they are made so that amounts may be added or subtracted in vertical columns. Registers which can be used to add (and subtract) amounts vertically or horizontally are known as 'cross footers'.

Adding and Listing Machines (Chart ref. 6/1)

The combination of adding and listing in one machine has the following advantages:

The printed record is convenient for checking.

The combination of the two operations reduces effort.

Printing is substantially faster and more legible than handwriting.

In case of interruption the exact stage reached is known.

Machines with one register only can, in most cases, be used for adding and subtracting, although some models are limited to adding. Amounts are set up by depressing keys and then by using a lever, or a motor bar on electric models, the amount set up being entered into the register and simultaneously printed. At the end of the addition, a 'Total' key is depressed to produce a total (suitably indicated on the printed record) and to clear the register. There is a wide range of hand and electrically operated adding/listing machines.

Keyboards. There are two distinct types of keyboard found on adding/listing machines, and on accounting machines developed from them:

Full keyboard machines having rows of keys numbered 1 to 9 arranged in vertical rows. Each row represents a digit position in the pounds columns; the tens of shillings row is numbered 1 from top to bottom, and the units of shillings keys numbered 1 to 9. The pence keys are numbered 1 to 11, and keys which show fractions of a penny may be provided.

Small or simplified keyboard machines having twelve keys[1] (0 to 11 inclusive) arranged in a compact standardised formation, X's indicating the alternative position for keys 10 and 11, viz:

10	11		
7	8	9	X
4	5	6	X
1	2	3	
	0		

To facilitate touch operation, the tops of the keys 4, 5 and 6 are generally made perceptibly more concave than the others.

The operation of the two types of keyboard differs primarily in the way in which the amounts are set up:

Full keyboard — amounts are set up by pressing the keys in the appropriate columns. Noughts to the right of the

[1] Twelve keys on a sterling model to allow for '10d.' and '11d.' — decimal models have ten keys only.

first digit are set up automatically and printed on these machines

Small keyboard — amounts are set up by reading the figures from left to right and depressing the appropriate keys in succession. Most machines have an indicator to show the digit position in which a figure has been set up. Every digit, including the noughts, must be set up on the keyboard.

There is little difference mechanically between the two systems, and each may have advantages in particular circumstances. The differences from the operator's point of view may be summarised:

On a full keyboard:

Digits may be set up in any order.

Several keys can be depressed simultaneously so that small amounts may be set up in one movement; or alternatively, both hands may be used together.

Noughts are not required to be set up.

Visible checking is possible, since the keys remain depressed until the lever or motor bar is operated.

Errors in set-up can be corrected easily.

On a small keyboard:

Keys must be struck in the same sequence as the figures in the amount to be registered.

Keys can only be operated one at a time.

All noughts must be recorded.

Keys do not remain depressed; thus no check is possible unless a control dial is fitted (which is not common).

Errors in set-up can be corrected less easily.

The advantages claimed for the small keyboard are that touch operation is more readily mastered, and that with less hand travel there is a reduction in fatigue and increased operating speed. Certainly touch operation is much more difficult on full keyboards, particularly with large amounts.

A special feature of certain full keyboard machines is known as 'live keyboard'. All the amount keys on these machines are 'motorised' and are capable of operating the adding and printing mechanism. Amounts are set up in the usual way, but instead of a separate motor bar being brought into operation to add in the amount, an extra depression of the last key used

performs this function, irrespective of its position on the keyboard.

Operation. As well as the keys for setting up the amounts on the keyboard, there are a number of operating keys:

Total key — as already mentioned this is normally required to cause the machine to print the total, which is indicated by an asterisk, and to clear the register.

Sub-total key — causes the total to be printed without clearing the register.

Repeat print key — avoids the need to re-set the same amount on the keyboard.

Non-add key — causes figures to be printed without their being added. This is used for printing reference numbers.

Subtract key used to subtract amounts, which are printed and generally indicated by a minus sign.

These are common to nearly all machines. Small keyboard machines normally have in addition:

Correction key — used if a wrong figure has been set up.

Whole number key — which suppresses the printing of the noughts in the shillings and pence columns when these are not required.

Capacities. The capacity of an adding and listing machine is measured by the number of columns of digits it can handle. Full keyboard machines are available ranging from seven to thirteen columns (seven columns £9,999 19s. 11d.) whilst small keyboard machines range from eight to eleven columns, nine columns being the most commonly used capacity. Many adding and listing machines are constructed so that the totalling capacity is one digit more than the adding capacity.

For normal listing work, machines are fitted with a small fixed carriage with a narrow roll of paper tape on which results are printed. Most manufacturers, however, offer similar machines with a wide movable carriage which enables amounts to be printed in different positions. Machines can be obtained which are designed to allow amounts to be subtracted from a total previously entered, amounts subtracted always being indicated in some way, e.g. printed in red. If the amount to be subtracted is greater than the total already in the machine, a 'minus' figure will be arrived at, and on some machines, this will print out as a complement. Machines are available,

however, which will print a true credit balance, and these are more commonly used.

A special kind of adding and listing machine is the two-register or duplex model, whereby two registers enable two separate totals to be built up, printed and identified. The operator can choose the register into which a particular amount goes, or the machine can be set to accumulate amounts alternately in the two registers. Both full keyboards and small keyboard duplex machines are available.

List of Makes:

Single Register — Small Keyboard

Addo-X
Addmaster
Brunsviga
Olivetti
Remington
Ultra
Underwood

Single Register — Full Keyboard

Addo
Adwel
Burroughs
Clary
Monroe
National
R.C. Allen
Victor

Duplex Machines

Addo
Burroughs
National
Underwood

Book-keeping Machines. These have been developed from the duplex adding/listing machines. They may be regarded as the simplest form of accounting machines, and possess only the following elements:

A credit balance feature.
Some provision for writing descriptions or identifying items.
A movable carriage.

It is to be noted that some manufacturers limit the specification for a book-keeping machine even further by including mechanism for dating the entries as a necessary requirement.

A movable carriage is necessary for completing forms with several headings, and this feature may be considered the prime element in the adaptation of adding/listing machines to book-

keeping and accounting work. Three types of movable carriage are available:

Manually operated – the simplest type, fitted with a carriage release lever, the carriage being moved by hand from one tabulator stop to another.

Shuttle carriages — specially built for posting in two columns, the carriage alternating automatically between two set printing positions, which can be adjusted to suit column spacing. Machines can also be built to print in three columns.

Automatic tabulating carriages – controlled by adjustable tabulator stops, the carriage moving automatically to the next printing position after the completion of an entry in one column. Provision is normally made for automatic tabulation to be disconnected by the operator as required.

Accounting Machines (Chart ref. 6/3)

Modern accounting machines have developed along two main lines and (depending on their origins) are sometimes placed in the following separate categories:

Typewriter based.

Adder based.

Typewriter based machines have been developed from standard typewriters. The adaptation was made by fitting an actuating mechanism behind the keyboard together with a 'truck' to which a number of registers, or adding boxes, could be attached. These machines have a typewriter keyboard, twelve numeral keys and a number of tabulating keys used for the selection of adding boxes. The development has resulted from both standard and flat-bed typewriters.

The development of accounting machines from adding/listing machines was brought about by building in extra registers, making provision for writing dates and providing extra keys for descriptions, although these are normally limited to three letter codes, e.g. GDS for goods, CSH for cash. These descriptions are not always adequate and to overcome this machines have been evolved, which comprise in effect a 'developed' full keyboard adding machine together with a standard typewriter.

A third type of accounting machine has been developed

primarily for analysis work, and specially constructed with a very large number of registers. They have been developed both from cash registers with no moving carriage and from listing machines with a movable carriage to print entries in columns.

By a front feed device, provision can also be made for recording on more than one document at a time. This permits one document, e.g. a summary sheet, to be fed round the platen in the ordinary way, whilst other documents are fed into the front of the machine, so that entries made on successive unit documents are copied on to the summary sheet. The vertical spacing of the documents can be adjusted to suit the spacing of the entries.

Machines are available to carry out mechanically every kind of accounting requirement. The main advantages of mechanised accounting include:

Legible, uniform and neat records.
Improved arithmetical accuracy.
Ready means of tracking down errors.
Simultaneous recording on a number of documents.

Apart from the machines developed from the flat-bed typewriter, accounting machines are essentially designed for use with loose-leaf documents, which may be unit documents or continuous stationery. The importance of relating forms and documents to the characteristics of the machine, e.g. vertical and horizontal spacing and type size, has been dealt with separately (see 'Forms Design', Chapter II).

Operation. The operation of accounting machines is basically similar to that of the adding machines, typewriters, etc., from which they have developed. Accounting machines are electrically operated, and on most makes a separate motor bar, controlling the various functions of the machine, replaces a series of operating keys and a common motor bar. The functions which may be controlled by a separate motor bar include:

Adding.
Subtracting.
Vertical spacing.
Repeat printing.

Many other automatic features, designed to simplify and speed operations, may be incorporated in particular models, including:

Automatic dating of entries.
Selection of registers.
Automatic tabulation.
Opening and closing of front feed.
Return of carriage to next line of entry.
Skipping of columns in which no entries are to be made.

Most of these processes can be controlled from the keyboard, but where there are many identical sequences of operations it is usual for these to be controlled by a 'programme unit', known as a form bar, control panel or control plate, depending on the make of machine. These units are set up to meet the requirements of the particular application and are attached to the machine. At the end of the posting run, a different 'programme unit' can be substituted for another application. The effect is to bring about a considerable degree of flexibility in the use of the machine, and the changeover from, say, payroll work to sales ledger posting or stock control, need take only a matter of minutes. In general, any particular function operated by the form bar or control plate can be over-ruled by the use of the appropriate key or motor bar on the keyboard.

Capacities. The capacity of an accounting machine is indicated by the number of its registers. Machines developed from adding machines (including those equipped with a typewriter keyboard) have a fixed number of registers built into the machine. There is a wide variety available designed to meet particular accounting needs, the smallest being the book-keeping machines already mentioned, with two registers only, ranging through apparatus with three or four registers to a medium line of machines with nine, ten or even eleven registers. The very largest capacity accounting machines (excluding analysis machines) have nineteen registers.

The number of registers (or adding boxes or memory units) of accounting machines developed from typewriters may be fixed, as on the smaller models with three or four registers; or may be increased at will on larger machines by adding extra units to the truck. The number of extra units that can be added in this way will depend on the width of carriage available and the digit totalling capacity required in the individual registers.

Analysis machines have a very large number of registers, and again some considerable variation is found among different

makes. The smallest type will provide an analysis covering up to twenty-seven dissection totals, but larger machines with facilities for analysing up to nearly two hundred separate totals are available. Apart from the standard makes, other machines can be specially built to meet the requirements of a particular analysis.

List of Makes:

Accounting Machines — Adder Based

Addo-X
Underwood Sundstrand
Burroughs
National

Accounting Machines — Typewriter Based

Adler
Remington
Mercedes
Underwood Elliott

Analysis Machines

Logabox
Mercedes
National 2000
Remington
Burroughs

Multiplying Accounting Machines

There are two types of accounting machines which can be used for multiplication. The first is an adaptation of the multi-register, full keyboard, adder based, accounting machine, where, by means of additional multiplier keys, amounts can be repeat-added to build up the products. The second type of machine, specially designed as a combined typewriter and adding and calculating machine, is known as a multiplying accounting machine with typewriter. Unique in the accounting machine field, it carries out direct multiplication instead of repeat adding. The adding mechanism is quite different from the normal registers with adding wheels, but like them calculates in decimals. The machine has a full typewriter keyboard and ten numeral keys in a row underneath and is available with up to ten registers.

List of Makes:

Multi-register Machines with Multiplying Feature

Burroughs
National

Multiplying Accounting Machine with Typewriter

Burroughs

Printing Calculators (Chart ref. 6/2)

These have developed from the small keyboard type adding/listing machines. They are electrically operated and have, in addition to the conventional keyboard, a series of nine multiplying keys, arranged either in a horizontal row or two vertical rows. These machines work in decimals and multiply by repeated addition.

Three makes are available. One is designed to print the multiplier vertically down the side of the paper tape as well as printing the multiplicand and product; another machine prints the multiplier horizontally below the multiplicand, and can also be used to accumulate intermediate results. Both these machines can also be used for dividing, and again will print the factors as well as the quotient and remainder. The third is of simpler construction, cannot be used for dividing and does not print the multiplier. Instead it prints each amount added separately, the number of 'additions' in each digit position giving the value of the multiplier. All machines can be used for adding and subtracting in the ordinary way. In general, printing calculators are slower in operation than the rotary calculators to be considered under 'Visible Dials' below, but the printed record is valuable in some applications.

List of Makes:

Multiplying and Dividing	*Multiplying Only*
Olivetti	Addo-X 2000
Remington	

CALCULATING MACHINES WITH VISIBLE DIALS ONLY

There are two main classes of machine in this group:

Key-driven machines — commonly known as adding machines since this is their prime function.

Rotary or crank-operated machines primarily designed to multiply and divide — for which the term calculating machine is generally reserved.

Machines in the first category have what is known as direct registration. The figure keys are connected directly to the adding mechanism and to the visible dials. Amounts are registered by the depression of keys, and there is no motor bar or lever to operate. Rotary machines, on the other hand, do not

have direct registration. Amounts must be first set up, by means of keys or levers, and the mechanism then operated by turning a crank or, on electric machines, by using a motor bar. On all machines in this group, both key driven and rotary, multiplying and dividing can only be done in decimals, and on sterling machines is limited (with one exception) to the whole numbers, i.e. the pounds keys. However, adding and subtracting can be done in sterling on machines fitted with the appropriate keyboards.

Apart from the two main classes of machine outlined above, a third type has recently been developed, being a key set adding machine. Its mechanical operation is similar to that of adding/listing machines discussed in the previous section, except that there is no printing mechanism and the total is read from the dials. The salient features of this machine are noted below.

Key-Set Adding Machines (Chart ref. 6/4)

These are full keyboard single register sterling machines. Amounts are set up on the keys and added or subtracted from the register by the use of an operating lever. There are two makes of machine on the market, one of which has a device for converting a complementary figure on the dials into a true credit balance. Both machines are hand-operated. These machines are comparatively slow for adding, but have the advantage that amounts set up can be checked, and corrected if necessary, before being added into the register.

Makes of Key-set Adding Machines:

Valmor
Adsum

Key-Driven Adding Machines (Chart ref. 6/5)

Basically these are full keyboard single register machines in which the adding mechanism always operates in the same direction, unlike that in rotary calculators, which is reversible. As a result, adding is performed by depressing keys denoting actual values, but subtraction is performed by 'adding' complementary values, the complements being shown on the keys in smaller figures. Similarly, multiplying (which is actually repeated addition) uses actual figures, and division is performed by repeated subtraction using complements.

Machines are obtainable with sterling or decimal keyboards,

and sterling models with farthings keys are available, but as mentioned above, sterling keyboards can only be used for adding and subtracting. Standard machines have a full keyboard, i.e. rows of keys numbered 1 to 9, but there is no need to use the whole board for addition, when a skilled operator, working by touch will use the keys from 1 to 5 only. It is faster to register 9 by depressing the 4 key and the 5 key in succession than to move the hand to the top of the keyboard to reach the 9 key. In general all the keys need to be used when carrying out calculations other than adding.

A special type of machine is available for simple addition possessing only keys for the values 1 to 5, known as a half-keyboard adding machine. Again sterling and decimal machines are available; also models with special keyboards to add weights and other units.

Key-driven machines have direct registration, and consequently are very fast in operation, the total of the amounts added appearing instantly in the visible dials. Most machines are manually operated, but electrically powered machines are available requiring only slight pressure on the keys to operate. Both types need a skilled, properly trained operator if they are to be used to full advantage; facilities for their training are provided by the machine manufacturers.

Full keyboard machines have a keyboard capacity of from five to twenty columns, the most commonly used being those with eight or nine columns. The capacity of the adding register on most machines is one digit greater, e.g. nine columns on the keyboard will yield ten figures in the register. These machines have devices to indicate the position of the decimal point, to be used when multiplying, and built-in safety devices to prevent mis-registration. Two-register machines can be obtained with an extra accumulating register, whereby intermediate results can be added or subtracted to produce a grand total at the end of a series of calculations. Machines with accumulating registers are always electrically powered.

Makes of Key-driven Adding Machines:

Half keyboard	*Full keyboard — Single Register*
Contex	Burroughs — hand and electric
Plus	Comptometer — electric only
	Sumlock — hand and electric

Full keyboard — Duplex
Electric Only
Burroughs
Sumlock

Multiplication by Repetitive Addition

All calculating machines, with one or two exceptions, multiply by repeated addition. A key-driven adding machine has no mechanism for recording the number of times an amount has been added, i.e. the multiplier. Similarly, there is no visible check that the correct keys for the multiplicand have been depressed. The result of the calculation is shown, but not the component factors. It is usual, therefore, to do all calculations a second time as a check. Thus it is essential when multiplying on a key-driven machine, that the operator:

Depresses the right keys for the multiplicand.

Moves the hand correctly across the keyboard, i.e. without changing the relative position of the fingers.

Counts the number of key strokes made.

For example, to multiply 456×123 the operator would depress keys 4, 5 and 6 three times in the units position; move one place to the left to the tens position and depress twice; move another place to the left and depress once more. The number of depressions in each position must be counted mentally.

Therefore, to design a machine especially for multiplication, three things are needed:

Mechanism for entering or setting up the number to be multiplied (the multiplicand) arranged so that the figures can be checked after the calculation is completed.

A product register which can move laterally in relation to the set-up mechanism, or vice versa, so that revolution can be made in the units, tens, hundreds, positions, etc., and the result shown in visible dials.

A separate register to count and record the multiplier, the number of revolutions made in each position, i.e. the number of times the amount (the multiplicand) has been added into the product register.

A machine equipped with these features will provide a visible check that the factors are correct, and it follows that the result is

correct. The rotary calculating machines considered in the next section are designed to provide these facilities.

Rotary Calculating Machines

The basic difference between rotary calculators and key-driven machines is that on rotary machines the mechanism can be reversed for division. Complements are not used. With one exception, all machines in this category work in decimals. Multiplication is carried out by repeated adding, and division by repeated subtraction, and when dividing the set-up mechanism is used for the divisor. The product register holds the dividend (and remainder if any) and the revolution register shows the quotient.

The mechanism is actuated by turning a crank on hand-operated machines, or by using a motor bar on electric models. Although these machines are primarily designed for multiplication and division, they can be used to add and subtract, but they are comparatively slow in this capacity since each amount must be set up before the crank is turned either forwards or backwards, depending on whether the amount is to be added or subtracted. Apart from this, sterling amounts have to be converted to decimals before they can be used. This disadvantage of slow operation is particularly true of lever set machines.

An additional feature found on some models is known as back transfer. This enables the result of one calculation to be transferred automatically from the product register to the set up mechanism to become one of the factors in the next calculation, and is useful when three or more figures are to be multiplied together.

There are two main types of rotary calculators. They differ mainly in the way in which the figures of the multiplicand (or the divisor) are set up. The two types are:

Lever set, known as barrel calculators, which are almost always hand-operated.

Key-set, which may be hand or electrically operated with a number of automatic features.

Lever-Set Calculating Machines (Chart ref. 6/6)

On these machines, amounts are set up by moving a series of levers into position opposite the appropriate numbers marked

alongside the vertical slots (one for each digit position) in which the levers move. The mechanism is actuated by means of a crank turned by hand. After the appropriate number of revolutions in one position, the product register is moved by hand to the next position. Back transfer is available on a number of these models. The design and position of the levers used for clearing the registers is important here, since this is a frequent operation. Each register will have its own clearing lever, and some machines have special levers to enable the operator to clear any combination of two registers from three or all three together. Not all machines have three sets of dials; on some machines the visible check on the set up is provided by the levers themselves.

Makes of Lever-set Calculating Machines:

Antares	Muldivo
Brunsviga	Multo
Curta	Odhner
Hamann	Schubert

Key-Set Calculation Machines (Chart ref. 6/7)

Keys on these machines replace the levers on lever-set machines for the setting up of amounts, there being two types of keyboard:

Full keyboard, with rows of keys from 1 to 9 arranged in vertical rows.

Small or ten-key keyboard, with ten keys arranged either in a similar formation to that found on small keyboard adders and listers, or in two horizontal rows of five keys each.

The advantages and disadvantages of the two types of keyboard discussed under adding/listing machines are broadly applicable here. An exception to the general rule that all calculations are carried out in decimals is found on one type of full keyboard machine of Italian origin, which has additional rows of sterling keys which allow multiplication of sterling within limits.

Both types can be either hand or electrically operated. The hand-operated models are basically similar to lever-set machines, the crank being generally placed at an angle for ease of operation. A device for manually moving the carriage containing the product register is provided, and visible check of the set-up is

possible; this may be provided for by a separate row of dials which show the amount set up. Alternatively, the keys remain depressed and are specially designed so that any which are depressed are easily recognisable. Clearing levers or keys are provided, and on some machines the mechanism is reversed by means of a lever, instead of the operator reversing the direction, in which the crank is turned.

There is a wide range of electrically operated key-set calculators of both types. These can be divided into three groups:

Machines which are little more than motorised versions of hand-operated machines. A motor bar replaces the crank and other keys are used to move the carriage, clear the registers, reverse the action, etc.

Machines, known as semi-automatic calculators, where multiplication is carried out by repetitive addition in each unit position using the appropriate motor bars, but division is carried out automatically once the divisor and dividend have been set up. Alternatively, multiplication may be carried out automatically, division being by repeated subtraction.

Fully automatic calculators where both multiplication and division proceed automatically once the factors have been set up. The carriage moves automatically and registers clear as required. The method of setting up the multiplier varies with different makes. On some machines, both factors are set up on one keyboard; other machines have special multiplier keys, which may be arranged in a single row or in a compact formation with a separate control dial.

Apart from the straightforward fully automatic calculator, there are a number of more elaborate machines with facilities for accumulating products or quotients, for squaring numbers or for finding square roots. All these operations can be carried out automatically.

'*Duplex*' *Calculators* (Chart ref. 6/8)

There are a few machines available equipped with a product register and an accumulating register, which is used, as in other duplex machines, for storing intermediate results or for building up a grand total. Transfer of the product to the accu-

mulating register can be carried out automatically if required.

Capacities. The capacity of a calculating machine is always expressed in terms of three factors, e.g. $8 \times 8 \times 16$. This means that eight figures can be entered in the set-up mechanism (multiplicand or divisor), eight figures can be used in the revolution register (multiplier or quotient), and sixteen figures can be used in the product register (dividend and remainder). The third factor is not necessarily equal to the sum of the other two and very often a smaller capacity in the product register is adequate, enabling machines to be made more cheaply. Where machines are fitted with an accumulating register, this always has the same capacity as the product register.

Short Cut Multiplication. On machines with tens transmission in the multiplier register, it is possible to reduce the number of revolutions by short cutting. This means that to multiply by any figure over 5 the first step is to multiply by the next highest power of ten and then by negative revolutions to reduce the multiplier to the figure required. For example, to multiply by 987, the first step is to multiply by 1,000. The carriage is then moved to the units position and three negative turns made to reduce the 1,000 to 997. One negative turn in the tens position gives 987, involving a total of five revolutions as against twenty-four if this short cutting were not employed. There are two fully automatic key-set calculators which automatically short cut when multiplying by six or any higher figure.

Makes of Key-set Rotary Calculators:

Full keyboard	*10 keyboard*
Archimedes-Diehl	Brunsviga
Brunsviga	Everest
Friden	Facit
Madas	Hamann
Marchant	Precisa
Monroe	
Numeria	
Rheinmetall	

Duplex
Archimedes
Madas
Monroe

Punched Cards

In the chart depicting the field of office machinery, most machines are associated primarily with one only of the basic clerical operations. At the top of the chart, however, punched cards are shown as being related to all seven of these basic operations. Thus punched card equipment represents a greater degree of mechanisation than the machines described in the preceding pages and in this respect is exceeded only by electronic computers. These go further and completely remove the need for human intervention between successive stages which still remains with conventional punched card equipment.

Punched card mechanisation depends on the fact that numerical and/or alphabetical information can be accurately recorded by means of holes punched in cards. The significance of each hole depends on its position in the card. Machines sense or 'read' the holes automatically at high speed and are able to extract and process all or any selected data the card contains. Punched card equipment is particularly appropriate in high volume accounting and statistical work where the same basic figures are being used many times.

Manufacturers of Punched Card Machines

Two makes of punched card machines are available in Britain, namely, IBM and ICT. Those made by Bull may be available shortly through De La Rue Bull and machines manufactured by Remington Rand are marketed in North America. The three types available in Britain have a very similar range of equipment in terms of the tasks that can be performed, although the principle of operation can be different. The major difference in principle of operation lies between Powers machines, where sensing is done mechanically, and IBM and Hollerith machines, where card reading is by electrical brush sensing. (Hollerith and Powers were merged into International Computers and Tabulators early in 1959.)

Card Design

Punched card machines are designed to deal primarily with one specific size of card. The following sizes are available:

Hollerith — 38 columns.
80 columns.
IBM — 80 columns.
Powers — 21 columns.
40 columns (replacing 36 columns of which many installations still exist).
80 columns (replacing 65 columns of which many installations still exist).
160 positions (by use of 'inter-stage' punching on 80 column cards).

A considerable amount of information can be accommodated in a single punched card, and card design itself is infinitely variable. Standard cards may be used which are quite plain apart from the numbering of the eighty columns and the punching positions in each. Alternatively cards can be printed to suit a particular application. Whether specially printed or not, the use of the different columns of a card has to be carefully planned, and skill in this planning of card layout promotes efficiency both in card punching and in subsequent machine operation.

Recording of Information

In general each card column is divided vertically into twelve positions of which ten are used to record the numerals 0 to 9. Thus punching a hole in the fifth position records the digit 5. Grouping of two or more columns into 'fields' allows numbers containing two or more digits to be recorded. In these circumstances the punching of the fifth position could represent 5, 50, or 500, according to which column it occupied in a field of three columns.

In addition to the ten numeral positions the two extra punching positions at the top of the card have a significance which may vary from column to column. The three main purposes for which they are used are:

To provide for alphabetical punching. This is done by punching two holes in the one column combining one of the numerical positions with one of the over-punching positions, or the zero position.

To economise in column usage. The most common use in this respect is to cater for pence items of 10d. or 11d. in

sterling amounts without requiring two columns. Similarly, by use of an over-punching position, up to 19s. can be managed in one column. Over-punching positions can also be used to extend the capacity of a field by an extra digit, without using an extra column where the full range of nine is not necessary.

For functional purposes. The over-punching positions may be used as indicators, e.g. to indicate that a value is a credit. They may also be used to cause special tabulator devices to operate.

Based on these principles, card design consists of establishing what information is to be recorded, the size of the field needed for each piece of information, and the sequence of the fields, to ensure a smooth flow of reading from the original documents for the punch operator. Consideration must also be given to the way in which the cards will be used in the application. For example, when two or more card designs are brought together for tabulation, such as Stock Cards and cards for Receipt and Issues, partial uniformity may be required. Good card design can also aid economical use of plugboards or connection boxes.

Various special features can be incorporated in the cards, such as colour stripes to make for easy visual recognition. Coloured cards or special cards printed as cheque forms, etc., can also be obtained.

Basic Machine Operation

Punched card mechanised accounting techniques rely on four major machine operations — punching, verifying, sorting and tabulating. Each of these is briefly described below.

Punching. All punch machines have keys representing each of the punching positions in a single card column. In the simplest form of punch (a hand punch) depression of a key directly cuts a hole in the card and then causes the card to move to the left by the space of one column, ready for the appropriate hole to be punched in the next column. A space key will move the card one column should no punching be necessary. With these punches each card has to be put into and taken out of the machine separately.

A number of installations now use automatic punches, in which cards are fed into the punching position from a stack in a

magazine and are also ejected automatically after punching. These can incorporate extra labour-saving devices, such as the storage and automatic punching of constant data, or delayed hole-cutting so that the operator may correct conscious errors.

Verifying. Verification of information punched is in all cases based on the principle of a second operator repeating the work of the first. If both operators make identical punchings, accuracy is assumed. The method of proving that the two punches are, or are not, identical differs between the various makes.

Hollerith and IBM installations require a verifying punch very similar to an ordinary automatic punch. With these, if the second operator attempts to punch something different from the first, the machine locks. The operator would make sure that she herself was trying to make the correct punching, and if this is so, would take out the card and mark it as an error requiring correction. On the other hand, Powers cards are verified on the same machine as they are punched. The setting of the punch is altered slightly, with the result that perforations are made slightly lower in the card than during the first operation. Cards which have been punched and verified should thus have only elongated holes. These cards are passed through an automatic verifier and if a non-elongated hole is sensed the machine feeds in an indicator card next to it. The errors are then taken out, examined and corrected.

Sorting. Punched card records, like any other documents representing transactions, need to be arranged in logical sequence for subsequent procedures. One of their major attributes is that they can rapidly be shuffled into any desired order as often as necessary. The arranging of cards in a desired sequence is done on a machine called a 'sorter'. Sorting takes place in one column at a time so that, in order to arrange cards in terms of a reference number of five digits, the cards have to be passed through the machine five times. Batches of cards in any order are placed in the feed hopper of the sorter, the sorter having been set to read one particular column on the card. There are twelve receiving magazines corresponding to the twelve punching positions in a card column and the appropriate one of these is caused to open by the sensing of the holes in the card. The card travels along the body of the machine and is then collected in the receiving magazine. A thirteenth receiving

magazine marked 'Rejects' collects any card with no punch-hole in the column being sorted. Sorting is normally done first on the right-hand or least valued digit. The cards are collected from the receiving magazines in strict sequence and then sorted over the second digit from the right. This process is repeated for the required number of columns. To facilitate early tabulation, however, the cards may be sorted on the extreme left hand digit first, before proceeding with orthodox sorting from the right.

Each receiving magazine is fitted with a cutout by which it can be kept permanently closed during a run. This permits specific cards, appropriately punched, to be sorted without disturbing existing sequences. It also makes possible the selection of specific codes or values by a process of elimination. Alphabetical sorting makes use of these cutouts.

Any punchings in cards may be sorted, whether they be numbers, codes, letters, names, quantities, values, credit indications or other functional holes. Most sorters operate at speeds of from 24,000 to 60,000 card columns per hour.

Tabulating. A tabulator represents a combination of a printing and an adding machine. It extracts from the sorted cards their punched information, processes it and presents the results in printed words and figures in the required form. It is that part of the installation from which the finished products are delivered, i.e. invoices, payrolls, costs, statistical analyses, ledger sheets, etc.

Printing in the tabulator is normally carried out by causing hammers to hit selected pieces of type which then make their impressions on paper through an inked ribbon. One type bar is provided for each printing position and this contains all numerals, together with all letters of the alphabet, where alphabetical printing is technically possible and necessary for the applications in question. Card columns are connected with type bars through plugboards or connection boxes, and as the sensing mechanism of the tabulator reads the punchings in a card it causes the type bars, column for column, to be elevated, so that the piece of type appropriate to the number or letter read from the card is positioned for printing. A complete line of up to one hundred characters is printed at one time.

Adding, if required, takes place simultaneously with printing. Cards may be listed, i.e. printed out line by line with totals where required, or these may be added until a total is required

and the total line only printed. Automatic printing of totals is provided for by setting the tabulator to read certain punchings in each card and accumulate values while these punchings agree. When a card is read, on which this punching differs from that on the preceding card, the tabulator is automatically switched to a totalling cycle and the accumulated values in the adding units are printed. Sub-totals and grand totals are usually available and additions and subtractions in several accumulators can take place at the same time.

With all machines, paper feed can be by platen and pressure as on a typewriter, or by sprocket-drive. Carbon copies can be taken by using two or three part-sets interleaved with one-time carbon, or a carbon ribbon may be passed between two webs of paper. A degree of programming of paper movement is possible, e.g. spacing after a heading and before or after totals.

Auxiliary Machines

Besides the basic machines, the punch, the verifier, sorter and tabulator, various auxiliary machines are available to supplement them. Their purpose is to economise in time or labour, or to produce results not directly obtainable from tabulating. These are described below:

Summary Card Punch. This is attached to the tabulator and automatically produces summary or balance cards during a tabulation. Summary cards are used to break down the bulk of a large task. For instance, on sales statistical work, where figures are required every four weeks, one week's detail cards may be analysed and summarised. For the following week the summary cards are sorted amongst the current week's detail cards to give the progressive analysis. The final analysis for the period is then more quickly produced since only one week's detail cards, together with the previous summaries, need to be processed at the end of the period. Again, the costing of sales might well be done on summary cards rather than on the much larger number of detail cards.

Automatic punching of balance cards has its application in ledger type operation. Opening balance cards when combined with debits and credits tabulate to a closing balance. The balance cards which are thus automatically produced provide opening balance items for the following period.

Reproducing or Gang Punches. These are used for the preparation and replenishment of pre-punched card files, and copy the punching of a single master card on to batches of any number of cards. They will also copy, card for card, from one pack into another. The reproduction may be complete or partial and the positions of punchings may be transposed. For example, on a wages application new payroll cards might be prepared each week from the previous week's payroll cards. Static information would be copied direct but the item 'gross pay to date' would be transposed into the 'gross pay to last week' position. Subsequent operations would bring into account the current week's earnings and by addition the new 'Gross pay to date', a similar procedure being applied to tax figures. Another example of using this facility would be where pre-punched cards are used which include a rate or price which has undergone a change. The existing cards in the file would then be reproduced with the rate or price cut out and the revised amount subsequently punched into the new card.

In some cases these reproducing punches can also be used as summary punches. The normal speed of operation is around a hundred cards per minute.

Interpreters. Interpretation of cards is done to facilitate their reading. An interpreter translates punchings into normal letters and figures and prints them on the card itself, usually along the top edge. It may print all or part of the information on the card, but the order may be transposed as required. The usual speed is from sixty to seventy-five cards per minute.

Interpolators or Collators. These have four main purposes:

To merge two packs of cards.

To check card sequences.

To compare two packs of cards.

To extract certain cards from a pack.

For the first three operations cards must previously have been sorted to a sequence. The cards are held in two magazines and passed to separate sensing stations. The two readings are then compared and the cards from either magazine will be passed on only when the two numbers being read agree, or when their place in an ascending sequence is reached. During the run, cards may be rejected if there is no comparable number in the opposite pack. The fourth operation comprises selective

sorting. A given number is set up in one sensing station and any card from the pack placed in the opposite magazine punched with that number will be automatically extracted, without disturbing the sequence of the pack itself. These machines operate at two hundred cards per minute from one magazine.

Multipliers and Calculators. Prior to the development of electronic equipment little progress was made in the field of calculation. Apart from the adding and subtracting facilities of the tabulator, the only calculating machines available were cross-adding and multiplying punches, which were relatively slow compared with other punched card equipment.

Today all suppliers have a wide choice of electronic calculating equipment, ranging from electronic multipliers to electronic calculators with the extra facilities of division and internal storage and considerable programming flexibility. As electronic calculators become larger in terms of internal storage and programming flexibility they are transformed into computers, the difference being solely one of scale. The boundary line is an arbitrary one.

Developments in Input

The recording of the initial information on cards is a very costly and sometimes tedious operation and has therefore received much attention. The problem is simple to state: 'to record basic data in a form intelligible both to the human mind and to the machine at the earliest possible opportunity, speedily yet with a minimum of effort and cost.'

There is no general answer to the input problem, since each task has to be considered individually. Several solutions are possible apart from the conventional method of punching and verifying, and these are described below.

Mark Sensing. Machines are available which will read carefully made pencil markings on cards and automatically convert them into punched holes. These markings have to be correctly positioned to give them their proper significance and the process is slower than with written letters and numbers. Any verification can only be made visually. The pencil marks also require extra space, thus limiting the number of markings which can be made on each card.

One value of mark sensing is in conjunction with the use of

pre-punched cards. For example, a pile of cards might be pre-punched with a commodity code and a unit price. The extracted cards could be marked by pencil with the quantity issued and the account number or code number chargeable. The punching and other operations could then proceed mechanically.

Pre-Punched Cards. A method which should always be considered very carefully is that employing pre-punched cards or tub files. Standard information is pre-recorded on the cards, which are pulled from the file as required. With the combination of two or even more cards the elimination of all punching may become feasible. If variables have to be added which cannot be pre-recorded, they may either be punched and verified, or added by mark sensing. Such machines as 'Mark Sensing Reproducers' are now available, capable of picking up information from one or more cards and consolidating this into a single card for each batch, while at the same time transcribing mark sensed information into punched holes in their relative position in the card.

Punched Paper Tape. It may be possible to prepare punched paper tape simultaneously with the preparation of the original document. Many typewriters, adding and calculating machines and accounting machines are now available with paper tape attachments. The paper tape can subsequently be translated into punched cards by means of a 'tape to card translator' without involving any manual operation. This method has the added advantage that the paper tape can be transmitted over any teleprinter circuit; it may also have advantages where decentralised documentation is necessary. However, the relative speed and cost of the teleprinter as against the transmission of paper tape by post must be considered.

Card-a-typing. The 'Card-a-Type' machine, used where documents are prepared on a decentralised basis, is a composite unit with a card reading mechanism, a simple calculator, a card punch and a bank of several typewriters. Constant information is fed to the machine by using pre-punched cards and variable information is entered by typewriter. Calculations are performed and the results printed automatically. Each typewriter is set up with the required documents, e.g. an invoice, an advice note, shipping labels and consignment note. The machine then

sorts out the correct information for each form and prints it automatically, at the same time punching the necessary cards to record the transaction.

Character Recognition. The field of character recognition is as yet in the embryo stage. Nevertheless there are already machines in operation which can read printed information and translate it into punched holes, either in the same card from which the information was read or in another card. At present the operation is expensive and still very limited, but it must be regarded as one of the most encouraging developments in the field of input.

Developments in Output

Conventional tabulators, as described above, use type bars for printing. However, other methods of printing are now being introduced, one of which uses type wheels instead of bars. Another uses a matrix of 35 wires for each printing position from which certain wires are electrically activated to print a pattern of dots which make up a figure or letter. A third method uses a single wire as a stylus to etch a series of dots into the form of any required character and this method has increased the operating speed to three hundred cards per minute.

Application of Punched Cards

Punched cards can be used for a variety of accounting and statistical procedures, or for such applications as invoicing or production control. Two characteristics suggestive of the use of punched cards are:

The need to use the same information several times in different groupings.

A high volume of work.

One danger that should be carefully guarded against is the seemingly inherent tendency to growth in punched card installations. As always, the O and M man must keep before him the purposes to be served and must question the usefulness and cost of all tabulations produced.

Electronic Data Processing

Electronic Data Processing is the expression that has evolved to describe the use of electronic computers for commercial purposes. Electronic computers were first conceived for the

rapid and automatic solution of complex mathematical problems in the scientific and technical fields. In addition to carrying out the four basic arithmetical processes of addition, subtraction, multiplication and division, it was necessary for the machines to be able to transfer data automatically from place to place within themselves and also to be able to store information within themselves. It was the development of these latter facilities that caused people to consider the use of computers for business purposes, where the volume of calculation is not necessarily very great but where that of 'transfer' or 'manipulation', i.e. the 'processing' of data, is considerable.

To the O and M man electronic computers are merely another potential means of improving office productivity and should be considered thus, rather than as the ultimate answer to all office work and problems. He should have sufficient background knowledge of the subject to enable him to assess whether or not an electronic data processing system is likely to be the answer to the problem under review. There is a tendency to surround these machines with an aura of mystery, due in part to the popular misconception of them as 'electronic brains'. This is a most unfortunate description, since they cannot think and are entirely dependent on the instructions given to them by an operator, although they do have the ability to discriminate between different courses of action, on the basis of arithmetic rule, but only to the extent that these instructions permit.

The use of the word 'electronic' implies the employment of non-moving devices, such as valves or transistors, rather than electro-mechanical devices, such as relays, to control the movement of electric pulses. This field of technology seems to many to introduce to the business a mysterious air, but a wireless or television set is equally 'electronic' and holds no terrors, at least not while fully clothed! The O and M man does not need to know the technical details concerning computers, any more than he needs to know how his wireless or television works. He should, however, know in broad terms what they comprise and appreciate their capabilities. For those readers not already acquainted with computers there is at the end of this section an elementary description of the features of an electronic data processing system, and an outline of the very detailed type of instructions it is necessary to provide for these

machines, i.e. their programming, together with a bibliography from which to amplify this brief introduction to the subject.

EDP and the O and M Man

Electronic data processing is merely another way of doing office work, and fundamentally there is little difference between a survey which ends in the use of a computer and any other survey. Such difference as there is tends to be one of degree; because of the computer's enormous capacity for work the survey may cover a very much wider field, and owing to the equipment's moronic propensity it must be carried out with the greatest care and attention to detail. The O and M investigator may approach EDP from two angles, either from a study of a particular aspect of office work, or from the results of an investigation to assess specifically its merits over a wide range of commercial procedures. Whichever applies, it is almost certain that considerable improvements will be found possible, even with existing methods and equipment which, if properly implemented, might remove any need or justification for a computer. In assessing the merits of an EDP system it is therefore vital to compare it with the up-to-date and efficient alternative methods.

Irrespective of the approach, an EDP investigation can be divided into three phases:

Feasibility study, concerned with the appraisal of likely areas of work and economies to be achieved, and leading to the choice of the most suitable type of equipment.

Detailed investigation, concerned with the build up of new procedures in relation to the equipment selected.

Installation and implementation, concerned with the accommodation of the equipment, and the transfer of work to the machine.

The extent to which the feasibility study and detailed investigation phases merge into each other will be dictated by the size and policy of the organisation involved, and the time scale and number of personnel available. A danger to be avoided, however, is that of ordering a machine and working out afterwards what to do with it, particularly since the potentialities of these machines for commercial work are as yet largely unknown and there is little practical experience on which to

draw. The object should be to review the work in question thoroughly in relation to the new techniques available, to establish the purpose of a department or section and to work out anew how best to achieve it. Rarely, if ever, should 'what is done now' be followed by an identical system of work employing a computer.

Computers provide the facility for doing several tasks simultaneously from the same source data, thus enabling what have previously been self-contained procedures to be integrated. Investigation is therefore likely to be broad in scope and to cover the work of several departments. For this reason it is suggested that an EDP investigation is a job for a team rather than one man, and that to avoid any possibility of friction, top level management support is essential. Furthermore, one senior person should be in day to day control of the investigations to coordinate the activities of the various groups engaged in the different parts of the study, and with time to handle the myriad problems that arise in connection with investigation, installation and implementation. The amount of work connected with EDP investigation is very considerable and there is danger of its being underestimated. From start to finish a single major application may occupy as many as twenty man years (figures for the United States are even higher).

A successful EDP application depends on two main factors, the care with which the method study work is carried out, and the efficiency with which the instructions for the machine, i.e. the programmes, are prepared. Both investigation and programming require specialised knowledge and both are greatly improved by practical experience. The former requires a knowledge not only of method study and allied techniques but also of alternative ways of doing office work, while the latter requires a detailed knowledge of the characteristics, capabilities, limitations, etc., of the particular equipment to be employed. Each team, on the other hand, must know something of the work of the other. Some people consider that 'programmers' should do the investigation as well as the programming work, on the grounds that they alone know the machine's capabilities. It is suggested, however, that a more effective solution is that trained O and M people with a background knowledge of the computer and its programming should pursue the investigation

part of the study (i.e. What is the ultimate requirement? Where does information originate? What is done now etc.?); as soon as ideas for EDP application start to be formulated programmers should be brought into the discussions on an ever increasing scale, the process culminating in the passing of responsibility for the drawing up of the computer operations to the programmers, leaving the investigators to continue with the formulation of purely procedural matters, but still with frequent consultation between the teams.

Because the range of work to be covered can be so wide, the range of knowledge required by investigators tends to be very large, and it is suggested that it will be of advantage if two minds are brought to bear on the many problems involved, although more than two covering the same ground tend to cause problems in communication. Thus for each unit of investigation the ideal would appear to be a team of two persons of the right calibre, possessing as many as possible of the following qualifications:

O and M training.
A knowledge of computers.
A knowledge of alternative methods.
An awareness of techniques, such as operational research, coupled with the initiative to seek guidance where there are possibilities of their being applied.
The ability and imagination to recognise and develop fundamentally new approaches to problems.
A knowledge of local requirements and conditions.
A knowledge of the purpose of the subject under review.

To this team would be attached at least one programmer, the number depending on the range of programmes to be written, to whom would have been given a detailed training in the programming requirements of the particular machine, generally on a course organised by the manufacturer, but supplemented by as much practical application as possible. Familiarity with the operating capabilities of the various types of ancillary equipment (punched cards, punched paper tape, etc.) is a distinct advantage. The attributes required in a programmer include:

Patience.
An ability to get down to minute detail.

Puzzle-mindedness.
An awareness of business procedures and practices.
A logical mind (mathematical training helps, but it is not necessary for a programmer to be a mathematician).

One of the aspects of EDP requiring careful thought and planning is that of data preparation, both at the input and output stages. Unless very judiciously organised both from a timing and an originating standpoint, this can easily dissipate the savings and advantages to be achieved from data processing. Every effort should be made to have information raised at its source in a form immediately acceptable to a machine, e.g. punched paper tape, mark-sensed cards — or in a manner convertible to machine language with a minimum of effort, like pre-punched card files. Similarly, on the output side, it has been the custom in the past to produce schedules and tabulations containing all the information available even though only part may be really informative. With the ability of computers to store information and to discriminate, it is practicable to let the machine sort the wheat from the chaff and provide management with only the more pertinent items of information. This, however, requires management to identify in advance the criteria by which decisions are to be based — not necessarily an easy task but one certainly not insuperable. The benefits likely to accrue are appreciable.

Part of the justification for an EDP installation may be the reduction in staff that can thereby be effected. Because of the necessity for parallel running of the old and new systems during a changeover there generally has to be an increase in the staff employed before reductions can commence, a situation liable to aggravate any redundancy problems. The effect in such a case of the introduction of a computer can be minimised by planning staff movements carefully during the intervening period, by, for example, placing females who may be expected to leave in a year or so anyway in positions formerly occupied by males, or by retaining temporarily those who have reached retirement age, and by keeping the staff informed about what is taking place. The problem is not only one of fear of losing a position but also one of anxiety at the prospect of redeployment; the latter may be as serious as the former in the eyes of the individual affected.

In an EDP investigation the O and M man must build up the

usual procedure charts for the whole scheme. He must also prepare, in conjunction with the programmer, flow charts or block diagrams expanding the steps, designated 'computer' on the procedure chart, into the more detailed phases, which are required to enable the programmer to specify the individual operations through which the machine must pass in order to solve the problem. An example of what is involved is shown in Appendix I and Appendix II (at end of volume), the former being the normal procedure chart showing one symbol for the computer operation; whilst the latter is the block diagram setting out the machine operations covered by that one symbol. In the hands of the programmer this block diagram would be used to build up the list of individual machine instructions, which for this job would run into several hundred. This underlines the very detailed nature of any EDP investigation and the considerable care and attention that must be exercised.

Features of an EDP System

An electronic computer is made up of five main units and may be represented diagrammatically as follows:

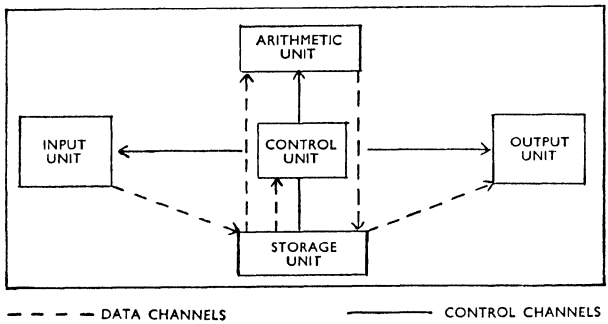


FIG. 23

Instructions are first fed into the machine via the input unit and held in the storage unit. Groups of data are then called through the input unit and processed step by step according to the instructions originally stored in the machine. During this processing the data may be moved about and go through arithmetical processes many times before the answer finally emerges. The compilation of these instructions is known as programming and is dealt with in more detail later.

This diagrammatical representation and description is not dissimilar from that of a conventional calculating machine where a human being controls the sequence of events. An electronic computer, however, has the following distinct differences and advantages:

The means of performing addition, subtraction, multiplication and division are electrical rather than mechanical or electro-mechanical, providing far greater speed and accuracy.

It has the facility for storing a large volume of data internally.

All instructions can be given to the machine at the outset to enable it to carry out its work automatically, without further human intervention.

It has the power to discriminate between different courses of action on the basis of information which may be generated within itself.

Input to a computer generally takes the form of punched cards, punched paper tape or magnetic tape. The punched cards used are the normal eighty column variety of Hollerith, IBM or Powers, and have input speeds ranging from a rate of 100 to 400 cards per minute or, depending on the number of columns used per card, 10 to 530 characters per second. They have the advantage of being readily punched and verified on well-tried equipment, and provide a unit document easily referred to, if necessary, at a later stage; they are easily sorted, but bulky if they are to be retained for any length of time.

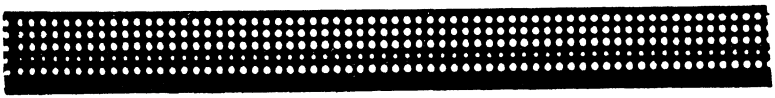


FIG. 24

Punched paper tape may be of the five, six, seven or eight channel variety with input speeds ranging from a rate of 25 to 400 characters per second.[1] It is readily punched but the means of verification is of more recent origin. It is more compact than a series of punched cards, and for units of information containing relatively few characters it is a faster input medium. The data

[1] All the speeds quoted are intended as indication of the order of magnitude and are based on equipment currently available in this country.

cannot be sorted outside the computer, nor does tape provide an easy source of reference.

Magnetic tape, on which the principle of recording information is similar to that on a dictating machine or tape recorder, is the fastest means of input involving speeds ranging from 3,750 characters per second to 15,000 characters per second. Magnetic tape for use as an input medium has usually been produced as a by-product of some other computer operation, but keyboard operated machines are being developed to record direct on to magnetic tape.

Output from a computer is generally required in legible form, but for some purposes a form giving automatic re-entry to the computer or to another machine may be required; thus the following devices are used for output purposes:

Punched paper tape at speeds up to 33 characters per second.

Punched cards at speeds of 100 cards per minute (i.e. up to 133 characters per second).

Magnetic tape at speeds ranging from 300 to 15,000 characters per second.

Character by character printers at speeds up to 20 characters per second.

Line printers at speeds ranging from 100 to 400 lines per minute (i.e. at the rate of 200 to 800 characters per second).

The *Arithmetic* unit undertakes the work of solving the problem in so far as it carries out the appropriate arithmetical operations on the data presented to it whether these be addition, multiplication, subtraction or division, shift left, shift right, etc. Processing times in this unit are measured in milli- or micro-seconds — indeed, two hundred and fifty multiplications such as 1234×5678 in one second would not be impossible.

The *Control* unit is the means of interpreting the instructions and generally directing the flow of data into, around and out of the computer.

Storage of information in a computer is achieved in a variety of ways but probably the easiest to understand and one very commonly used is the rotating magnetic drum. This has a metal surface capable of being magnetised in minute localised spots, divided into a number of tracks. For computer operation alphabetic and numeric information is grouped into 'words',

generally the equivalent of about ten decimal digits, each track on the drum being capable of storing a set number of 'words'. Information is recorded in a manner similar to that of a dictating machine and will remain recorded, however often it is referred to, until written over with new information.

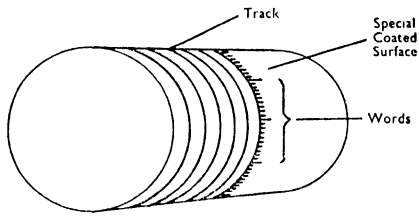


FIG. 25

The two main criteria by which storage devices are assessed are their capacity and the time taken to reach any item of information, known as the random access time. For example, with a revolving drum the maximum random access time is equal to the time taken for one revolution of the drum. The various types of storage employed are:

Magnetic drum or disc with a capacity ranging from one thousand to sixteen thousand words — medium speed of access.

Delay lines with capacity ranging from one to sixteen words each — fast access.

Magnetic core with capacity ranging from one hundred to one thousand words — immediate access.

These types of storage facilitate the handling of data within the machine and, in general, suffice for scientific and technical work. For commercial purposes, however, considerably greater quantities of data need to be stored and it is largely for this purpose that magnetic tape has been introduced. While it will handle bulk — a 2,400 foot reel will accommodate the information from twenty-five thousand punched cards — random access time is very slow. New means of handling bulk storage with random access times very much better than magnetic tapes are now coming into use and include:

High capacity slow speed magnetic drums.

Endless loops of three hundred feet of tape.

Juke box type magnetic discs.

The faster access storage involves a higher unit cost; hence commercial computers tend to employ several forms of storage. Their high operating speed is achieved by transferring blocks of information between the varying types of storage, for example,

from bulk storage on tape to working storage on a drum, to fast or immediate access storage on delay lines or magnetic cores, all while other calculations are going on on data already positioned.

Speed without accuracy is useless in commercial work, as is spurious accuracy. Electronic computers, however, tend to be more accurate than their human counterparts and the mechanical and electro-mechanical devices they are beginning to supersede. Self-checking facilities are incorporated in some machines, whilst in others the extent to which checking is required is left for the user to determine and is incorporated in the instructions given to the machine. Some errors are such that they will cause the machine to stop in any case, or to produce such nonsense that they are easily detected.

An electronic computer for business purposes then is not a single piece of equipment but rather a range of units each with a particular purpose, which may be linked together to suit the individual customer's requirements, thus enabling a start to be made with an installation which can be added to as the range of work expands. In general, an EDP system will comprise a centre containing the arithmetic, control and working storage units, to which will be linked as many auxiliary storage units (magnetic tapes or slow speed drums, etc.) input and output devices as are necessary for the work to be undertaken. An example is here illustrated:

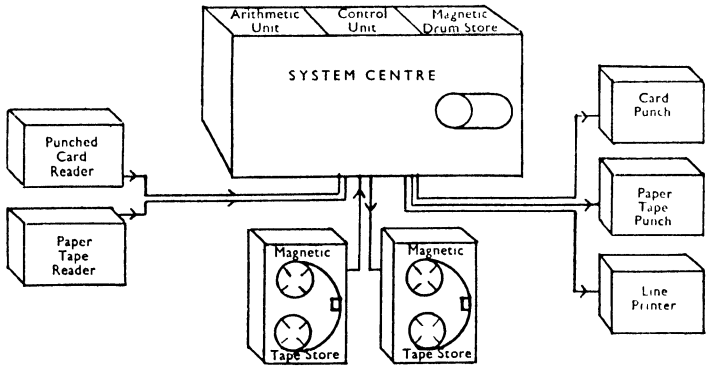


FIG. 26

It is not intended to catalogue the different machines now or soon to be available in this country, but the following is a list of some of the suppliers or potential suppliers:

British Tabulating Machine Co. Ltd.
EMI Electronics Ltd.
Ferranti Ltd.
IBM United Kingdom Ltd.
Leo Computers Ltd.
Metropolitan-Vickers Electrical Co. Ltd.
Powers-Samas Accounting Machines (Sales) Ltd.
Remington Rand Ltd.
Standard Telephones & Cables Ltd.
The English Electric Co. Ltd.
The National Cash Register Co. Ltd.

Prices range from about £20,000 to £500,000 or more, but in certain cases it may be possible to arrange rental terms.

An Introduction to Programming

Programming is the term used to describe the art of building up the set of instructions for a computer to follow for the solution of a particular calculation or series of calculations. This outline will endeavour to provide a general picture of the significance of programming an electronic computer without any attempt to relate it to a particular machine. For programming, an electronic computer is best thought of as a Thoroughly Obedient Moron — TOM for short. If we consider what TOM, as a clerk, requires by way of instruction to perform a simple task, the analogy with computer programming will be apparent.

As a clerk, TOM's range of equipment or work place might appear (see Fig. 27), in a form not dissimilar from the diagrammatic representation of a computer.

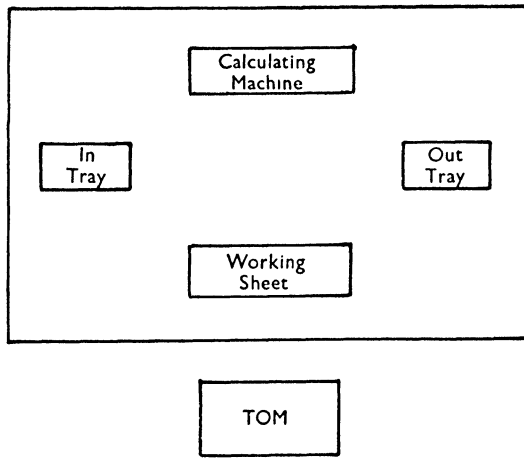


FIG. 27

The task TOM is to perform consists of a simplified wages calculation in which each worker is paid either on a time rate basis or on a piece rate basis. There is one document for each worker showing his works number, hours worked or quantity made, and a code identifying them. Such a document might look like this:

Work Record	
Works No.	12345
Hours Worked/ Quantity Made	46.5
Code	1

FIG. 28

The resulting wages slip which TOM is to prepare might be in this form:

Wages Slip	
Works No.	12345
Pay	£11. 12. 6.

FIG. 29

A flow chart for this job might look like this:

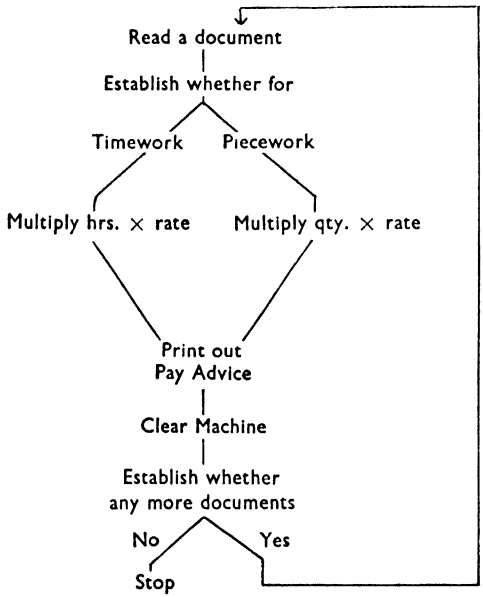


FIG. 30

Any normally intelligent clerk would do this with the briefest of explanations once the documents were in his 'in' tray, and would soon have the wages slips in the 'out' tray. TOM, however, is completely lacking in initiative and can only carry out a limited number of extremely simple operations; but these he will perform meticulously. His instructions must accordingly be made up of a combination of these particular operations; anything outside this range would cause him to stop work. Furthermore, TOM cannot appreciate the significance of any of the numbers with which he is dealing and handles them blindly; his instructions must thus tell him where the numbers he is to use are to be found and placed. To help him, therefore, TOM has a working sheet, i.e. a store, with all the lines numbered:

Working Sheet	
Line Number	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

FIG. 31

Each instruction to TOM consists of two parts:

The first part gives the kind of operation to be carried out, i.e. the *function*.

The second part tells him the position of the number on which it is to be carried out, i.e. the *address*.

The simple operations TOM[1] can carry out are as follows:

Read a new document, putting the three numbers on it into location 21, 22, and 23 respectively. - - R

Add into the calculating machine the number in the location given by the address in the instruction. - A

[1] Actual computers each have their own range of operations.

Subtract from the calculating machine the number indicated by the address. - - - - - - S

Zeroise the calculating machine, i.e. reset the register to zero. - - - - - - - - - - Z

Transfer the number held in the calculating machine into the location indicated by the address. - - T

Multiply the contents of the calculating machine by the number indicated by the address, leaving the result in the calculating machine. - - - - - M

Decide whether the number held in the machine is zero; if it is, take as the next instruction that given by the address. - - - - - - - - - D

Jump to the instruction given by the address. - - J

Print out a new document, taking the numbers for it from locations 24 and 25 respectively. - - - P

Find out whether there are any more documents to be read; if there are, take as the next instruction that given by the address. - - - - - - - F

Halt, i.e. stop work. - - - - - - - H

Thus, for TOM to perform this wages calculation let us assume the figure 1 to have been put on line 30 of his working sheet (a completed copy follows) and that the standard piece-rate is on line 32, with the standard time rate on line 33. His instructions would then be as follows:

(i) Read in a document putting the three numbers on it into locations 21, 22 and 23 respectively.

(ii) Add into the calculating machine the number in location 23, i.e. the code.

(iii) Subtract the number in location 30, i.e. unity.

(iv) Decide whether the machine contains zero;[1] if it does, go to instruction (x); if it does not, proceed with instruction (v).

(v) Zeroise the calculating machine.

(vi) Add in the number from location 22, i.e. the amount.

(vii) Multiply this by the number from location 32, i.e. the piece-rate.

(viii) Transfer the product into location 25.

(ix) Jump to instruction (xiii).

[1] Zero means that the code taken in was 1 and that therefore the man is on time work. If not zero then the code taken in was 2 and the man is on piece work.

(x) Add in the number from location 22, i.e. the amount.
(xi) Multiply this by the number from location 33, i.e. the time-rate.
(xii) Transfer the product into location 25.
(xiii) Zeroise the calculating machine.
(xiv) Add in the number from location 21, i.e. the works number.
(xv) Transfer it into location 24.
(xvi) Print out a new Pay Advice.
(xvii) Zeroise the calculating machine.
(xviii) Find out whether there are any more documents to be read; if there are, go to instruction (i); if not, go to instruction (xix).
(xix) Halt.

By using the symbols set against the various operations in the original list the table of instructions would be reduced to the following order:

Instruction	*Function*	*Address*
(i)	R	—
(ii)	A	23
(iii)	S	30
(iv)	D	10
(v)	Z	—
(vi)	A	22
(vii)	M	32
(viii)	T	25
(ix)	J	13
(x)	A	22
(xi)	M	33
(xii)	T	25
(xiii)	Z	—
(xiv)	A	21
(xv)	T	24
(xvi)	P	—
(xvii)	Z	—
(xviii)	F	1
(xix)	H	—

This could be called the programme to enable TOM to carry out the payroll calculation.

One further point remains to be examined before this

programme for TOM can be said to be the complete answer to our problem; how is the list of instructions or the programme to be presented to TOM? The answer is to have it permanently before him on his working sheet. If it is stored on lines 1 to 19 all that is needed to start TOM working at the beginning of the day is to provide him with a full 'in' tray and an initial prompting to 'start with the instruction in address 1'. If he then obeys consecutive instructions (except where an instruction tells him to do otherwise) he will carry out the job quite happily.

The above list of instructions for TOM is in all respects typical of a programme for an electronic computer. A programme is made up of the detailed instructions necessary to give absolute guidance to the computer in dealing with a problem. These instructions, orders, or as they are called, programme steps are represented by numbers or letters; the programme can therefore be held within the normal storage mechanism of the computer. The computer is designed to operate by obeying successive instructions which it reads in order from its store.

Bibliography of EDP

BOOKS

Bowden, B. V. (Editor), *Faster Than Thought — A Symposium on Digital Computing Machines*, London, Pitman, 1953.

Canning, R. G., *Electronic Data Processing for Business and Industry*, London, Chapman & Hall, 1956.

Canning, R. G., *Installing Electronic Data Processing Systems*, London, Chapman & Hall, 1957.

Kozmetsky, G. and Kircher, P., *Electronic Computors and Management Control*, New York, McGraw-Hill, 1956.

National Office Management Association, *Appraisal of Electronic Business Applications*, New York, N.O.M.A., 1956.

Political & Economic Planning, *Three Case Studies in Automation*, London, P.E.P., 1957.

Wallace, F., *Appraising the Economics of Electronic Computors*, New York, Controllership Foundations Inc., 1956.

Wilkes, M.V., *Automatic Digital Computors*, London, Methuen, 1956.

ARTICLES

Neuschel, R. F., *What Top Management Needs to Know About Electronic Data Processing*, American Management Assn., New York, No. 187 Gen. Management Series — Improved Technique of Admin. & Control.

'Survey of Digital Computor Users and Orders', *Automation and Automatic Equipment News*, April 1958 and qtly. thereafter.

Spooner, P., 'Electronics in the Office', *Business*, November 1955.

Institute of Cost and Works Accountants, 'Electronic Digital Computors and Business Data Processing', April 1955, *Cost Accountant.*

Bibold, J., 'Automation — A Break With The Past', *The Times Review of Industry*, April 1958, London, The Times Publishing Co. Ltd.

A Glossary of Arithmetical Terms

Complement: The complement of a number is the difference between that number and the next power of ten; thus the complement of 7 is 3, i.e. 10 – 7, of 88 is 12, i.e. 100 – 88.

Dividend: The amount to be divided.

Divisor: The figure by which the amount (the dividend) is to be divided.

Minuend: The number from which another is to be subtracted.

Multiplicand: The amount to be multiplied.

Multiplier: The figure by which the amount (the multiplicand) is to be multiplied.

Product: The result of the multiplication.

Quotient: The result of the division.

Reciprocal: The reciprocal of a number is the result obtained by dividing unity by that number; thus the reciprocal of 25 is 0·04, i.e. 1 ÷ 25.

Subtrahend: The sum or number to be subtracted from another.

A Glossary of Terms used in Mechanised Accounting

Cipher Cut-out: An arrangement on a machine with a full adding machine keyboard by which, when it is desired to work in whole numbers only on a sterling keyboard, the number is entered using the pounds keys, and the ciphers for shillings and pence are automatically suppressed.

Clearing: Clearing a total is the operation of emptying a register and printing the amount accumulated (also known as *Totalling*).

Control Account: An account to which is posted the total of the items posted to the individual accounts over which the Control Account is maintained. The balance of the Control Account is the net total of the balances of these individual accounts.

Cross-footer: A register which is capable of adding amounts vertically and horizontally across a page, i.e. cross-casting. A cross-footer is usually also capable of subtraction since it is used to produce balances.

Feed: Front-feed. A design of the carriage on an accounting machine which permits forms to be inserted in front of the platen, without rotating it or disturbing forms already in the back-feed.

Back-feed. The normal arrangement for inserting forms, as in the typewriter.

The front-feed is normally used for the individual account cards, while the back-feed takes the proof sheet.

Form Bar (or *Stop Bar*, or *Control Plate*): A device which controls the operation of a machine in its work. By removing the bar and substituting another, or in some cases by moving a lever, the machine can be prepared for another job.

Item Counter: A counter which indicates the number of postings made, or the number of additions made into a register. It is useful for recording the volume of work done, and for statistical purposes.

Lists: Pre-List. A totalled list of items to be posted, providing a predetermined figure for proof purposes.

Post-List. A totalled list of items made after posting, for proof purposes.

Pick-up: The operation of bringing forward and putting into a cross-footer the old balance in order to produce the new balance.

Double Pick-up. The operation of picking up the old balance twice in order to provide proof, by comparison, that it has been picked up correctly.

Platen: The roller around which forms are held in the machine.

Posting: The operation of picking up an old balance, entering a

debit or a credit, and producing a new balance on an account (not necessarily in that order). To this basic work may be added the printing of the date and a reference number, typing a description, and the carrying out of any further operations for the purposes of proof.

Posting Media: The dockets or vouchers, e.g. copy invoices, copy receipts, clock cards, etc., from which the information is obtained for posting or entering.

Unit Posting Media. Posting media in which each voucher carries the information for one account only.

Posting Run: A series of postings, of any convenient number, at the end of which the totals stored in the machine are printed for the purposes of proof and for posting to a Control Account.

Proof Sheet: The sheet on which a copy of each posting is made, either by means of carbon paper or by a separate printing mechanism; also called a *Posting Summary* or a *Day Book Sheet.* It is normally inserted into the back-feed of a moving-carriage type of machine.

Split Keyboard: A feature of a full adding machine keyboard which permits two entries to be made simultaneously, e.g. whole numbers on the left-hand side of the keyboard, and sterling amounts on the right, or sterling amounts on both sides. A Split and Normal Control allows the split to be removed when not required.

Split Totals: An arrangement, in conjunction with a split keyboard, whereby a register is made capable of accumulating two amounts simultaneously.

Split Platen: A platen in two sections, thus permitting two forms to be used side by side spacing up independently. A Split and Normal Platen allows the two sections to be locked together when the split is not required.

Transfer: The ability to add into, or subtract from, one or more registers, an amount already in another register, on either a totalling or sub-totalling operation.

Reprinted from *Mechanised Accounting Simplified* with acknowledgements to The National Cash Register Co. Ltd.

A Glossary of Terms used in Mechanised Calculating

Accumulating Register: On an adding machine, a grand total

register into which totals can be transferred from the adding register and accumulated.

Adding Dials: On machines with direct registration, indicating the total amount in the adding register.

Adding Register: On an adding machine, the part of a machine where amounts entered on the keyboard are added and from which totals can be read. It consists of a series of adding wheels connected by tens transmission mechanism.

Automatic Multiplication: Only available on electric machines; when both multiplicand and multiplier have been set up (usually by means of keys), the required number of revolutions will be made automatically.

Automatic Set-up Repeat: Permits automatic repetitition of a dial set-up locked into the product register so that when clearance is effected the figures reappear in the dials. Used for consecutive division with a constant dividend.

Back Transfer Device: A means of transferring figures from the product register to the set-up mechanism.

Capacity: The maximum number of figures that can be set up or contained in one register.

Clearance: Consists of restoring the registers or set-up mechanism to zero.

Control Dials: Windows in which the amount set up or the amount in a register is visible.

Decimal Indicator: A device to show the position of the decimal point. May consist of 'pointers', which slide along bars placed above the set-up mechanism, or control dials. Alternatively, 'decimal bars' are fitted, which run between the rows of keys and which have a contrasting colour on one side.

Direct Registration: Means that figures are entered into the register by depressing and releasing a key or keys without a motor bar having to be depressed or a handle pulled. These machines are known as key-driven or key-operated.

Direct Set-up: Means that figures can be entered directly into the revolution register or product register by means of thumb wheels or knobs.

Direct Subtraction: Effected by a series of negative revolutions of the product register.

Double Product Register: Will allow accumulation of products in

one register while the other is cleared after each individual calculation.

Flexible Keyboard: Means that depression or partial depression of a key in a vertical column automatically releases any other key in the same column previously depressed.

Full Keyboard: Has a separate row of keys from 1 to 9 for each digit, i.e. there are separate rows of keys for units, tens, hundreds, etc.

Half Keyboard: Has a separate row of keys for each digit but keys go from 1 to 5 only.

'*Key Lock*' *Device:* A protection against error on machines with direct registration. Incomplete or insufficient key depression locks either all the keys on the keyboard, or all except the row in which the key has been insufficiently depressed.

Key-operated: Also known as 'key-driven', a machine having Direct Registration.

Locked Keyboard Device: Enables the operator to retain part of the keyboard set up when clearing.

Overlapping Set-up: Enables one of the factors of the next multiplication to be entered while the machine is performing the previous calculation. Can be applied to direct coupled multiplier keys.

Positive-Negative Indicator: A device which shows whether positive or negative revolutions are being added in the revolution register.

Product Register: On a calculating machine is the register into which amounts are added or subtracted. When multiplying, it shows the product at the end of the calculation, and when dividing by repeated direct subtraction the dividend is entered and the remainder, if any, is shown at the end of the division. Always has a tens transmission device.

Revolution Register: On a calculating machine is a register in which the multiplier or quotient can be read when the calculation is finished.

Set Up: The entering of figures on to the set-up mechanism of a machine which does not possess direct registration.

Set-up Mechanism: That part of a calculating machine by which an amount is 'set up' before being transferred as a whole to the adding mechanism (product register). It consists of an

external and internal mechanism, the former comprising set-up levers or keys which, by shifting or depressing, move the internal mechanism to the desired position.

Short Cut Multiplication: A method of reducing the number of necessary revolutions. Involves multiplying by the next power of 10 and then subtracting to reduce the multiplier to the actual number required. Only effective for digits 6 to 9, i.e. over 5.

Split Clearance: Permits clearing one part of the product register — to the left or right of the split — without clearing the other part. Can be used for accumulation of individual products.

Ten Key Keyboard: Has only one set of keys numbered 0 to 9.

Tens Transmission: Or 'tens carry over'; this means that when an adding wheels moves from 9 to 0 the next wheel on the left shows an increase of 1. An essential feature of the product register, not absolutely necessary in the revolution register, but is a useful device.

CHAPTER V

THE ASSIGNMENT

In this chapter we proceed to consider the application of the knowledge and experience of general techniques and equipment which have been described in the earlier parts of this book. It is now necessary, as mentioned in the introduction, to formulate a guide or discipline of investigation for use by staff engaged on O and M work. The object here will be to draw the various threads together, and thus weave a pattern of behaviour to provide the investigator with answers for his questions: 'How do I approach the job?', 'Where do I start?', 'How do I end the assignment?', etc. The reader should therefore regard this as a guide to the techniques and 'tricks of the trade', but he must expect to have to make cross-references to other chapters, and to find some duplication of the varying material offered elsewhere.

In this work it is essential that the advice supplied by the person consulted should be based on a sound knowledge of the various subjects with which office management is concerned, clerical procedures, forms, office machinery and equipment. The adviser should not himself pose as an expert, in the sense of one able to draw on highly specialised knowledge, for problems in this work do not readily lend themselves to solution by reference to any predetermined body of principle. A knowledge of up-to-date office practice is important but does not rank as his sole asset. He also needs to know how to go about his job, how to approach people, how to obtain, record, and verify information, how to sort and classify it, and how to build up and test his conclusions.

The first merit of any advice is that it should look and be good. Not all recommendations will be accepted in full; yet loss of acceptance may be only temporary, and should not, therefore, be regarded as a waste of effort. Reports, if submitted, must be carefully prepared and must be thorough, to withstand criticism and the passage of time. Conclusions must maintain a reputation for integrity and judgment; and the enquiry, or

assignment, should be recognised as an efficient and ordered way of obtaining the information upon which the conclusions are based. In finding a satisfactory solution, compromise, salesmanship and technique all play their part.

The Preliminary Survey

Before an investigation can proceed it is essential to ascertain and define the purpose and scope of the assignment by conducting a preliminary survey, the extent and detail of which will depend on the nature and circumstances of the task, in order to fix the shape of the target. This should be accomplished before terms of reference are finalised. A general consideration of the assignment may quite possibly be unnecessary in the case of an organisation possessing an O and M Department which has been established for some years and has an intimate knowledge of the work of other departments, but this constitutes the exception rather than the rule. In most cases this method of approach should be followed.

The survey will require advance preparation of the subject, such as appraising existing records, finding out and making a note of the objectives and functions of the department, section, or particular part of the organisation under review, collecting relevant details for a broad view and considering any special circumstances of the work. It will also include some preliminary discussion with the staff concerned.

Terms of Reference

The purpose and scope of the assignment are usually defined in the terms of reference and should be drafted during the preliminary survey and agreed before starting upon the task itself. Sometimes the terms can remain tentative and be adjusted by consent during the progress of the work; for other assignments the department concerned must be consulted before terms of reference can be drawn. The terms are often wide and general, but on occasion the task is limited to an examination of specific problems of organisation or methods and the terms too are specific.

As an assignment develops and understanding of the subject grows, the terms may have to be widened to include other

subjects; where much of importance is involved, an interim report may even be needed to formalise an extension in the terms. When terms of reference are already in writing at the commencement of work, it may be as well to find out as much as possible about their intention, for to know the results expected from an assignment is always useful and may give the investigator an additional indication of how to approach the problem.

The Survey

Reconnoitring the ground preliminary to operations is important, and will normally:

Permit some study of the broad purpose of the work to be surveyed.

Assist in isolating separate problems and in determining the nature of each.

Indicate the scope of enquiries necessary on different subjects and the order in which each section of work should be taken.

Ensure the adequacy and accuracy of the terms of reference.

Disclose any interactions between the department studied and other departments.

Suggest concentration on particular sections, operations or aspects of the work, or alternatively the examination of one section in detail and the rest in broad outline, or perhaps the use of sampling.

Prepare the way for planning and programming the assignment in an effective way with the minimum expenditure of staff time.

Background Information

During the preliminary survey a selection of office instructions and policy statements affecting the department or branch should be made and perused to yield an understanding of the functions and duties that are involved, but too much reliance must not be placed on a 'paper' version of activities or procedures. Information soon becomes obsolete and is then misleading; thus lists of duties and other statements already available should be regarded only as an aid to fact-finding and not as a substitute for it.

An organisation chart, which should be compiled if not

readily available, should be studied. Likewise, details of staff for previous years may be helpful when making a comparison between establishments and between current and past work loads. Any special conditions or restrictions associated with the work should be noted in order to reveal any need for other enquiries outside the department. For example, the work may be done to a specified time cycle; there may be considerations to be made concerning customers and users, together with trade associations and government departments; and where trading or technical activities are involved these will suggest special enquiries.

Purpose and Objectives

A study must be made of the organisation and responsibilities of the department concerned. Sometimes the policy and purpose of an organisation determine its activities in which case the approach to the study should be from top level; on other occasions the particular departmental function will dictate that the approach to organisation, purpose and objective commence there. Normally the purpose comes first, but the purpose of a department cannot be fully understood except as a part of the whole. Readymade statements of purpose or objectives are not always satisfactory, and what pass as objectives are on occasion little more than what people have become accustomed to doing. A study of purpose and objectives should take place early in the assignment to gain an understanding of broad issues and to avoid spending too much time on minor matters, some of which may disappear later as a result of reorganisation.

How to Make the Survey

The preliminary survey will usually be undertaken jointly by the Head of O and M, or his deputy, and the man allocated to the assignment who, although not always present at the preliminary discussions of terms of reference, should always be involved in any examination of the work. At an early date this investigator should be introduced to the heads of the departments or branches that will be affected by the review.

The earlier meetings with the departments concerned are important and lay the foundation for cooperation and understanding. Normally their use is to obtain details or clarification

of the purposes, objectives, functions and organisation, together with a broad outline of the activities and procedures of the department to be examined; to discuss and agree the terms of reference and the programme for conducting the enquiries; to ask about any special problem or aspects of the work that should receive particular attention; and to obtain introductions to staff who will be interviewed early in the assignment.

The information collected should be recorded and first impressions summarised. Problems which warrant special consideration throughout the assignment should be noted. This outline of the survey and other notes will later serve as a basis with which to compare detailed observations, and may reveal a marked difference between what was expected and what has been found, thus proving the advisability of checking first impressions and, if necessary, verifying other assumptions. This cooperation between the investigator and his senior lays the foundation for advice and guidance throughout the whole assignment.

Planning the Work

Planning and starting a large assignment after the preliminary survey requires considerable thought and care. Where to start is sometimes difficult to determine, except where methods only are involved, but a wise choice may save trouble later. The time factor, i.e. how to prevent the assignment from becoming unduly prolonged and thus unprofitable, must be estimated and watched; the question of how to approach the task of fact-finding and how to approach the manager and his staff must be given consideration.

Where to Start

When an assignment is largely concerned with matters of organisation, the point at which to begin may be a post which coordinates two related activities, or one with direct authority and responsibility for the work to be examined. As suggested, when considering the preliminary survey, enquiries may proceed down from or up to top level, according to the nature of the assignment. Often an enquiry can be separated into 'subject stages', inside and outside the department under review,

or again into groups of staff or blocks of work. It is essential to decide these main stages carefully and collect the facts in the right order. In a methods assignment the point of entry of a form or of the creation of a record is usually the starting point.

The Time Factor

The time spent on each stage of the assignment should be estimated and tentative dates fixed for the completion of fact-finding and the draft report. These need not be rigidly adhered to, but should be regarded as the basis of a plan of campaign, to be adapted or amended as circumstances demand.

The collection and recording of facts forms a large and time-consuming part of the work and a reasonable balance must be kept between the cost of the study and the potential benefits to be gained from it. One of the best ways of avoiding time-waste is to prepare a check-list of the information and details required. Occasionally, and especially with office procedures, or services common to several departments, previous experience may be used to formulate a number of questions to be put to those doing the work, which will also reveal any significant point requiring special attention. Such a reminder must not, however, be confused with a written questionnaire, and the interviewer must not ask questions in any parrot-like fashion. A check-list serves an investigator merely as a test of his own thoroughness.

Approach to Fact-Finding

The collection of information must be selective and dictated by what is required by the problem. Accordingly facts for some problems are obtained in great detail and for others in broad outline. Information is required only as the basis for sound conclusions and practicable recommendations. Appraisal of the data should be made as soon as it is collected, to form a contribution to the situation and the subject of the assignment. As problems take shape, the collection of data can be centred round each separate problem, so that each item of information selected takes on its own significance and importance. 'Blind' fact-finding and the 'collector's instinct' are wasteful and must be avoided; they result in the accumulation of a mass of detail difficult to analyse or apply, which clogs the thought processes. This congestion is less if the problems and subjects to be examined

have been identified during the preliminary survey and are held in front of the mind during fact-finding.[1]

The enquiry should proceed at a rate which permits analysis and study. Discrimination in the collection of the information is a matter of experience and judgment; the 'purpose' should be kept in view and constant consideration given to the justification for existing activities, the scope for economy and the possibility of improvements from alternative arrangements. The proposals made on any assignment will be the subject of close criticism and unless soundly based upon fact they may be vulnerable. The enquiry must be thorough; fact-finding must have been adequate; no significant improvement should be missed.

The Departmental Manager

The investigator, approaching the assignment as an outsider, must study and consider the departmental manager, since his skill in management and attitude towards change will have a decisive effect on any suggestions made or action taken. He will have opinions and possibly prejudices which may help with some proposals but will certainly hinder others. He will all the time be conscious of the existing organisational and social framework of his office, and will be considering the effects of any proposals and the possible tensions and difficulties that will result. There may be resistance to specific changes, or resistance to change in itself; this needs to be diagnosed and the situation handled accordingly.

Ideally, the manager should be given a completely frank explanation of the objects of the survey and the means to be employed. In practice, however, the confidence of the manager may be gained by presenting him with limited aims in the first place, and by seeing that these are carried through successfully before embarking on a wider programme. Wherever possible, recommendations should be discussed fully with the manager before they are published in any way, although there may be occasions when this is not practicable. These are aspects of O and M work where experience and sound judgment are most important, and staff new to the work need the most careful support and guidance from their more experienced seniors.

[1] Reference is suggested to the closing paragraphs of the chapter on 'Verification of Purpose'.

Knowledge of the departmental organisation will be based upon information obtained from the departmental manager. He will provide organisation charts, and will know if these are up to date and complete. Should no charts exist, he can be asked for the information necessary to draw them up.

Important factors in the study of any department are the measure of delegation that the manager practises, the methods he uses to control the work of the department, the frequency of consultation with his section heads, the extent to which he keeps in touch with other members of staff, the statistics he requires to be kept and the way in which they are presented. So too are his descriptions of his responsibilities and those of his section heads, together with his outline of the relations of his department with other departments, and customers or suppliers.

Much time can be saved during the actual investigation by asking for brief activity lists to be prepared in the department, which should show very roughly how time is allocated between various jobs. A month is usually a good basic period for these lists, with the allocation of time shown as a percentage only, and with due allowance made for jobs which are done at less frequent intervals than a month. Where routine posting operations are involved some indication should be given of the number of entries made. Activity lists should be brief and in draft form. If the investigator can have these made ready and study them he may prepare much of the ground before talking to those concerned.

Other surveys may have previously been carried out, not necessarily by O and M, in the field contemplated for study. Useful information may already have been collected in reports or correspondence. There may also be special difficulties or unexplored possibilities of which the departmental manager is aware.

The cooperation and enthusiasm of the manager can be of immense value. During the planning stage ways and means of informing the department of events should be fully discussed with him, and the most suitable times chosen for introductions to the section heads concerned. Enquiries take time; thus the convenience of the whole department should be studied and respected. Hours of work, busy periods and holiday arrangements need to be taken into account. Also, if for any reason the

assignment has to be temporarily discontinued, all staff concerned should be notified.

The Section Leaders

An introduction should be effected to the section leader by the department head, who can then explain the object of the survey so that the section leader understands what is planned, and how it will be done. A clear description should also be obtained from him of his various responsibilities and to whom he is responsible, also his idea of the extent of his authority.

The section organisation should be checked with the organisation chart and each individual member of staff included. An outline of the work of each individual should be obtained together with a note of any special difficulties. Timing of the plan, and avoidance of inconvenience, should be checked. The main flow of the work should be followed and arrangements made to interview individual members of the section staff as necessary.

The section leader may need to provide a copy of each document or return typed over a period, e.g. a month, to measure the work passing through and give an idea of the kind of letters involved.

The Office Staff

Departmental managers or, if appropriate, section leaders, should inform their staff of the objects of a survey. It may be advisable for the O and M manager and his assistant to attend such sessions. News that a procedure survey is to take place spreads quickly. Each member of the staff will be curious to know how he is likely to be affected, and fearful that the effect will be a harmful one. This is not a simple matter of fear of redundancy; each person may dread the exposure of shortcomings and possible changes in his status, associates and work habits. In consequence, the staff should be informed as early as possible of the objects of the survey and its possible effects.

In times of expansion, improvements may be presented as a means of handling increasing volumes of work, or of giving an improved service, without radically changing the existing staff. Staff reductions, if necessary, may be catered for by natural turnover in that as people leave they are not replaced. Otherwise, a clear policy with regard to redundancy is required.

A successful conclusion to the assignment will show savings, direct or indirect, short term or long term, of time, of material or staff, or of improved service to management or customer. As already suggested, expansion or intake-policy may prevent any staff cuts but recommendations for increased efficiency are always delicate, and careful attention must be given to the good relations obtaining within the department and between the department and O and M.

Interviewing

Interviewing in O and M work has two main uses, to enable the interviewer to find out facts and to verify them, and to provide an opportunity to meet and overcome resistance. The first is an obvious necessity, for facts must be obtained and interviewing is sometimes the best way of obtaining them. The second springs from the first and is in itself invaluable as an aid in O and M work, for much of the success of an assignment can depend upon the reputation created for being helpful and sound in approaching the staff. Even greater success will depend upon the interviewer's ability to work round or avoid resistance that may develop on the part of those staff whose work and work habits will be altered by any improvements that may be recommended.

Obviously, therefore, a certain amount of skill is required on the part of the interviewer if these requirements are to be met. He should be impartial, tactful and, more positively, have skill in influencing others to accept advice they would prefer to ignore. Interviewing is the process of obtaining information — without upsetting the other party — by the means of conversation; this entails being a good listener, being apt at keeping the ball of conversation rolling and being able to keep the subject on the right lines. Conversation is itself an art relying not a little upon the ability to suit the treatment of any subject to the person, the place, the mood and the moment.

General Background of Interviewing

The rules for the interviewer to observe are more or less fundamental, and are applicable to most situations. The situations themselves, however, may vary considerably and the

skill of the interviewer depends upon his knowing how to adapt his approach to each variation with which he may be confronted. For instance, the atmosphere into which he is received may be chilly, so that he will have to effect a 'thaw' before he can hope to commence. He must also bear in mind that he will be dealing with a very wide variety of personalities, and not only that, but personalities at all different levels of authority. In a small department he may call on its head; in a large department the level at which he opens negotiations may be lower. But no matter whom he encounters, he will need to adapt his approach, timing and phrases to suit the particular person.

It is also a common happening that the man in charge will wish to accompany the interviewer on his round of the staff. Sometimes indeed, the head will attempt to answer all questions himself, or on the other hand, try to conduct the interview! This situation demands much tact from the investigator, but it is essential that he politely and firmly retains control of events.

Climate of the Interview

Resistance to change will often produce a somewhat frigid climate for the interview and some extra care may be needed to produce a thaw. The more effective the job performed, in that satisfactory results are being achieved, the less likely are those engaged upon it to welcome someone 'fooling around with the methods they are using' (one of the attitudes often encountered). Yet it is often the case in this sort of work that someone with an impartial approach and a good knowledge of method can make improvements and secure economies in any operations, however successful they may already be. Those genuinely interested in the results they are achieving often become wedded to their well-tried methods, are suspicious of change and may have never considered, or heard of, various alternative machines or processes. Most O and M investigations are concerned with existing procedures and well-established habits, rather than a fresh system to be thought out independently from first principles. As a result, until a first-class reputation for helpfulness and soundness of advice has been earned, the O and M man is met by some show of suspicion, by reluctance to changes and sometimes by resistance to any suggestion of interference with 'my job'.

Place of the Interview

In O and M work the interviewer works at the other man's desk, often in an open office without any privacy, and in full view and within the hearing of a number of other people. These other people may well be listening to what is happening and may themselves be interested in and affected by the conclusions reached at the interview. This lack of privacy heightens the risk of 'dropping a brick', and makes the interviewer's own approach of greater importance than, for instance, that in a personnel interview. But even a brick can be replaced, and admission of error is in some cases preferable to incomplete concealment. Errors may be of facts and their misinterpretation due to ignorance or accident; or may result from some personal misunderstanding.

The Interviewer and the Other Man

The success of the interview itself is conditioned by at least two variable and probably incalculable factors — the personal prejudices of the two people affected, the interviewer and the interviewed. Of course, the interview does not stand alone as a means of fact finding, but is used in conjunction with observation and examination. On the other hand, the interview is usually the only means of finding out something about that part of the job which cannot be seen, that which goes on inside the operator's head. And the higher the interviewer goes in an organisation the more important is this side of the work. Therefore, to achieve the best possible results, it is worth his reminding himself beforehand of the need to eliminate his own bias. He must not have a pet solution, or one that is pat, but must be impartial and thorough. Secondly, he has to think about the person whom he is interviewing and put himself in the other's place. Many people are very enthusiastic and wholehearted about their job and may regard a visit of an O and M nature as a suggestion that their own work is not well done, and take this impression to heart. The interviewer must recall his own feelings when having his work critically inspected and allow this to make his approach sympathetic.

Rules for the Interviewer

The two factors — that the interviewer is on the other man's

ground, and is up against considerable resistance, actual or potential — mean that any art or tact that may lie in conducting an interview is worth considering, in order to supplement the more definite process of studying what is actually done, what questions should be asked to complete the story already discovered by watching the job, and what meaning to give to the observations made or the answers received. To achieve this it is therefore necessary:

To make the interview impersonal.
To keep it objective.
To prepare for it beforehand.

Being Impersonal

When studying work methods it is necessary to disclaim any association with grades and wages; to confine questions and interest to the actual operations being carried out; and to avoid comparing one person with another, or asking anything that in any way reflects upon the person being interviewed. If possible, the investigator should encourage the operator to go through the motions of the job in detail so that he can get a factual picture of what is involved before listening to any account, for this is likely to contain a certain amount of 'opinion' based upon how the procedure appears to the person doing it.

Being Objective

The wider the interviewer's experience the easier becomes the temptation to recognise a problem at a glance. In fact, very few problems are exactly similar, and the discovery of some apparent cause that he has suspected to be operative is easily made. Hence the value of a strict self-discipline or freedom from bias, so that he refuses to guess, keeps his experience chained up, and does not prejudge the issue; when the stage of collecting facts has been passed, experience is needed to work on what has been found.

Being Prepared

The strategy of the interview is contained in the advice to approach it fully prepared. The investigator should have found out the names of the persons in charge and those with whom he is going to talk; he should know what part this particular

job represents of the work of the company, department or section, its purpose, and if possible, he should have found out any reason for the selection of the particular person to be interviewed (is he or she outstanding or average, easy or difficult?). He should also have ready a number of points upon which information is needed. On occasion, he may be able to formulate the actual questions required to gain the information he requires, though the words to be used are best left to come naturally. This will allow for the choice of expression to accord with the circumstances of the interview and the attitude of the operator, and will make his approach flexible. He must at all times think carefully, choose his ideas and words and reject any that may offend. Later, during the stage of observation of the process, it may be possible to arrange questions in a logical order so that each follows naturally from the last, so that the proceedings do not resemble an inquisition. This appeals to reason and helps keep the interview impersonal.

Arrangements

A subsidiary part of preparation is making arrangements for the visit, finding out, for example, whether a general announcement has been made about it, and if so, in what terms, or whether suspicion has been created by what has been said or left unsaid. The interviewer may be forewarned by finding this out. If no announcement has been made, he must ask himself whether he would like to announce himself or whether he would prefer the person in charge (usually the section leader) to perform the introduction. Some people consider an introduction from 'above' essential. Again some people consider that the initial interview should be on the operator's 'home ground'. These, together with enquiry to ascertain whether suitable desk or working space has been arranged, are considerations which will help smooth the path of any interview.

Conducting the Interview

Following these preparations and the initial introductions, the first stage in the interview is to state the reason for the visit. If possible, the interviewer should also mention the method he is following. Finally, he should remember the following points:

Words

Use simple terms. It is likely that the interviewer and the person being interviewed will use the same words but will have quite different meanings for them. Apart from this, it is essential to ensure that words which will not be understood generally are not being used, and that the interviewer's words have conveyed the meaning he wishes them to convey. If necessary, he must repeat the same thought in different words and notice whether it registers.

Atmosphere

While keeping the discussion strictly impersonal, the interviewer must try to enlist the interest and cooperation of the operator in the assignment. If possible he should say that he is trying to save any unnecessary effort, to make the organisation work more smoothly, to save time and improve the service. Most people are interested in at least one of these objects, and some in all of them.

Compliments

Sometimes during an interview it is possible to give appreciation, and this should be done, but it is most dangerous to approve what may later require to be changed. Appreciation should be given rather for method than staff. However, the interviewer should never criticise the staff and avoid anything which will diminish the sense of importance of the operator, which may already have been threatened by the enquiry. This quality may be restored by the investigator confessing that he has no first-hand knowledge of the job itself and is therefore at a disadvantage until he or she has shown what is done.

Behaviour

Throughout the interview regard should be paid to the small details of manner and politeness; for instance, it is advisable to ask permission to smoke, to arrange for both parties to be seated and comfortable; to cause the minimum of disturbance to the operator's work without forcing the pace or skimping the job. Neither will a show of politeness compensate for supercilious questioning or arbitrary interruptions. Affectations are unpleasant, and nervousness is catching. A straightforward and

simple attitude towards the operator is best at all times. The balance of formality and informality differs with everybody, but it may be as well to start fairly formally, especially if either of the parties is nervous. When nervousness has departed the interviewer may get more information through informality, but he must remember that the operator may have had very little experience of being interviewed and may need help in explaining his work, so that he will have not merely to study his own approach, but also to guide the person interviewed without asking leading questions that suggest the answer to be given.

Difficult Cases

Sooner or later the interviewer will meet the exceptional case, where the person to be interviewed is 'difficult'. It is necessary to decide at the outset whether this is a permanent state, in which case he may decide to leave him or her alone and interview someone else; alternatively it may be only temporary, due to the interviewer's own failure or that of the other person. If the failure is caused by the interviewer, the meeting might be adjourned for twenty-four hours and then taken up again with every precaution against creating resentment. Without indulging in flattery, respect may be paid to the other man's knowledge and experience of the job, sometimes by prompting someone to tell him about a successful and helpful job O and M has done elsewhere so that he may wonder if the fears about the job are justified, sometimes by a good 'desk-side manner'. However, before deciding that he is being purposely 'difficult', consider whether he is one of the following, who may yet respond to careful and courteous treatment:

The inarticulate.
The voluble.
The person who has been twenty-five years in a job and is so familiar with it that he cannot explain it.
The automaton.
The Empire Builder.
The obstructionist or deceiver.
The person with the attitude 'what can you find out in half an hour about a job that has taken me ten years to learn?'
The extremely diffident or shy.

The person with the 'no time to waste on you, too much work already' attitude.

The sick or hypochondriac.

The person with an outlook limited to his one job.

The man with a grievance.

The user of technical and unintelligible jargon.

The ex-O and M type.

There is always the possibility that the 'difficulty' results from a genuine clash of temperaments. In this case a colleague could perhaps interview this particular man because the original interview is not acceptable. At other times he may decide to continue, with an infinity of patience and reliance upon appeals to reason. He must remember that all resistance is either fairly reasonable, i.e. an objection to O and M in principle, or frankly emotional, i.e. due to some personal dislike or other disturbance. The first can only be overcome by an appeal to reason, by patience and by courtesy. The second, however, if sufficient time and personal inclination exist, may be avoided by using what has been called 'the technique of safety-valve interviewing', which involves the following points:

Giving full attention to the person being interviewed and, above all, making it clear that this is being done.

Listening patiently to what the other man has to say before commenting. It may then be necessary to comment on some of the things he has said, but he should never be interrupted (probably the quickest way to arrest self-expression is to interrupt). Moreover, the interviewer must put himself in the background; if he does all the talking he is either inexperienced or his technique is bad.

Never arguing and never giving advice. This is in effect part of the larger question of detachment. If there is any shadow of moral admonition, the person interviewed will not talk freely. Emotional relief is obtained by letting him talk freely, thus revealing not only to the interviewer but to the speaker himself the locus of the complaint.

Listening to what the other person wants to say, and appreciating what he does not want to say and what he cannot say without help. The interviewer should realise that what the speaker states to be the source of any given

trouble may not actually be so. Many a grievance about office routine is really based upon a dislike for the supervisor, or on an unhappy private matter, a situation about which the interviewer should be aware. This may also mean that there are subjects upon which the person being interviewed does not want to touch. This may be due to the fact that he is not facing up to the situation; but it may nevertheless be upsetting him.

Plotting out tentatively the pattern that emerges as the interview progresses. The interviewer should then present his summary for comment, but with great caution; it is permissible to clarify, but not to add or twist.

Remembering that nothing of a personal nature may be divulged to anyone, though this does not prevent some form of report on the more impersonal points.

The late Professor Mayo said of interviewing that it had two values, the one therapeutic for the individual, and the other as a method of enquiry. He considered that the interview aided the individual to advise himself; it restored, in a sense, his mental growing point. Also, that by listening to himself he sometimes realised that he had been behaving foolishly, and if he then started to give himself advice this would mean that he was convinced, and would take his own medicine. This process he considered to be far more effective than advice from others.

There may, however, even after careful attempts have been made, be some who will not cooperate. The only path then to the interviewer is to find someone else more willing to collaborate.

Concluding the Interview

When the interviewer has gathered all the information he requires, it is not sufficient merely to say 'thank you' and leave; he may have to return at a later date and, in any case, must make sure that his enquiry has not upset the staff or caused any ill-feeling or difficulties for supervisors. It is necessary, therefore, to leave enough time to establish a friendly and helpful relationship. The interview should not run on too long and waste time; on the other hand, it would be fatal to cut it short and thus hurt feelings. There is a need for keeping control of the interview, for a return to formality as opposed to a show of

firmness. Experience alone will teach how to weave a little authority into a free cooperative discussion so that the interview may be ended on the right note.

It is important to recapitulate very briefly the object of the interview and read any notes that have been made, in order to clear the suspicion of snooping. This should refresh the other man's memory of his earlier statements and give him a chance to correct himself. The interviewer may be well advised to ask then whether anything has been missed, which may encourage him to bring forth a valuable suggestion not previously mentioned.

It is also at this final stage that the operator may want to divulge 'unofficial' opinions or facts. He or she may have been looking forward to a chance of saying what the organisation looks like from underneath, what time is wasted, and how stupid some procedures appear to those who have to carry them out. Even though this commentary rambles, it is as well for the interviewer to listen carefully for ideas or revelations which, however remotely, may bear on his assignment, whether they concern the organisation, the management, the supervision or the work. He must not, however, unduly encourage such confidences or get involved in personalities by agreeing or commenting, but must merely listen.

It is obvious that no hard and fast rules can be laid down for interviewing. The possession of tact is a great asset. Yet there may be occasions when the interviewer has to stand his ground and point out that his duty is to get certain information and the other man's duty to the company is to supply it. Should this fail a 'showdown' would be a last resort, but only when tact has failed. Interviewing is perhaps the expression and use of this quality, whereas a showdown is an expression of force, reactions to which may be unexpected and unpleasant.

Note: The Council has made a short documentary film entitled *The Desk-side Manner* to illustrate interviewing in O and M work.

Conduct of the Assignment

The word 'assignment' has been stolen by O and M and used to describe the investigations that they make, perhaps since

some people regard the word 'investigation' as having some association with the word 'criminal'. Whatever the cause may be, much of the work in this field is highly personal and there are boundless opportunities for sacrificing good thinking to bad interviewing, or for doing good work in the wrong order. The subject of how to carry out an assignment is, therefore, of the very greatest importance to the O and M man. As a subject it must of necessity overlap most of the techniques, but the added emphasis obtained will be valuable.

Emphasis must also be given to the dangers and futility of trying to improve a method until as many as possible of the relevant facts are known, so that an improved organisation and procedure may be devised. The object is to prepare a factual analysis of the existing arrangements. The tracing of one procedure or form is seldom possible without encountering other procedures or forms which stem from it, and need to be considered. Many possible improvements may suggest themselves as each step is considered, but only by searching questioning of each step in relation to the whole picture can the best way be found.

Most important is the search for and the assessment of the reasons, causes and purposes underlying clerical tasks.[1] Only when these are found can the best way of doing the work (or whether it need be done at all) be considered. Reasons, or causes, are not always immediately apparent and considerable research may be needed. Some forgotten incident may have set up a chain of protective action and at such points staff who have been in the department a long time can provide valuable information. Purposes considered apart from existing procedures may be capable of achievement in some fundamentally different and more economic way.

The Questioning Approach — Fact-Finding

The questions of purpose (what?), reason (why?), person (who?), place (where?), time (when?), means (how?) and cost (how much?), have all to be considered. The following examples of the application of these questions may serve as a guide:

What is done? What is the broad process and its purpose? What is achieved?

See Chapter I.

Why is the work done? Is any part not essential? What would happen if it were not done? Does a study of the complete process show the possibility of cutting the step out? For instance, the use made of the information or records kept may not justify the work involved; additional copies of some forms may not be essential.

Who does the work? Are staff of the correct calibre and experience used on each operation? Should any of the work be done by staff of a different grade? What are the training needs? Who makes the decisions within the procedure? (Consideration of staff leads to consideration of organisation.)

Where is the work done? Should it be done centrally or locally? Re-allocation of accommodation or equipment may bring like or related processes together, or reduce movement of papers and staff. (This may also improve supervision and reduce the number of supervisors.) At what place may the work be done most economically? Where a service to others is involved, economy and usefulness need to be carefully balanced.

When is the work done? A time cycle of the procedure is needed. Is the sequence right? Consider the steps at all stages of the cycle to see if they could be simplified or eliminated by extending an earlier step, or by postponing it. Inspection of quality or checks of accuracy should be timed to occur at the latest possible stage in the cycle, subject to the risk of carrying errors forward within the procedure. Consider the possibility of combining several separate records into one duplicated one, raised at one time.

How often? Get the work load in detail; over a fully representative period a process sometimes has to be repeated many times to justify mechanisation. At other times the speed of providing information may justify mechanisation, although the process itself takes place only seldom. When considering this point a watch should be kept for possible repetition of the same operation.

How is the work done? This includes method, movement, equipment and supervision. How is it checked? (Most machine processes embody a mechanical check.) How

is it controlled for quantity? Can statistical sampling be applied?

How much does it cost? Are the staff cost-conscious and alert to possible savings?

The Facts Required

The aim will be to discover as much as possible about:

The purpose and objectives of the department or section.

The organisation structure of the unit and its position within the company.

Relationships with other departments or sections which may be necessary for the work.

The duties assigned to the various posts and the measure of delegated authority.

The skill required.

The purpose of each procedure in its context of the whole system; the various forms used.

User or consumer attitudes or needs; also the interests of customers and suppliers, even when they are not directly involved in the operation.

Work load; time taken for operations; frequency of operations; costs and standards of performance which may have to be adopted.

The programming of work through common service departments.

Statutory requirements and demands of trade associations and other external requirements, if any.

General Information

From the beginning of the enquiry the physical conditions should be considered, together with any possible savings from improving the layout of the work. Any repetitive job that warrants closer attention from the Motion Study angle should be noted.

Full statistics should be collected of the number of documents handled and entries made, and, if necessary, documents should be counted over a period. Statistics of throughput should cover a year or so, to show the effect of any seasonal peak load, or other abnormal activities, such as a sales campaign. A fair daily average can be gained in collecting figures for the

appropriate cycle and dividing by the number of working days in the period. Also specimen documents should be collected with, whenever possible, representative entries. Particular care is needed to check the accuracy of the figures, because if any implied criticism occurs in the report, this must be supported by accurate evidence. Any figures should be shown to the section head, and his confirmation of them obtained. Incorrect figures can often be passed on by the man at the desk in good faith but without complete knowledge.

The flow of documents throughout the day or week should be noted, and documents followed from the time they enter the office (e.g. in the mail room) to the time they leave it, since bad flow means bad output. The work should also be studied at all times of the day, from the time the department starts in the morning, around the lunch-time break and again in the afternoon. If flow is bad, accurate figures will be needed to prove it. It will also be necessary to call attention to any regular peak loads or bottlenecks. Checks should be made for duplication of work and unnecessary records or reviews.

Information from Individuals

Depending upon the way the ground has been prepared by the department head and section leaders, there may be a varying degree of suspicion and anxiety among the staff, since surveys bring with them the possibility of changes and redundancy. The investigator should aim at dispelling any doubts or mistrust with which he meets and should conduct the interview on the lines already suggested.

The investigator is at an advantage if an activity list is available, because he will then have an outline of the job of the person interviewed and will be able to raise specific points and to discuss the work with better understanding. Activity lists or their comparison have sometimes been known to cause bad feeling and should therefore be handled with care. Nevertheless, the investigator must find out what the operator considers to be the proportion of time spent on each part of his job, and check this with the information obtained from the section leader. He must encourage the operator to describe his job item by item.

When obtaining information the investigator should:

Not accept vague terms like 'I handle', 'I deal with', 'I make arrangements for', but find out exactly what is done.

Be definite, and investigate vague statements such as 'often', 'frequently', etc., in order to find out the true frequency of occurrence.

Make sure that the terms used to describe the work are understood and agreed.

Beware of imaginary policy and too easy acceptance of general statements. Unless the interviewer has actually done the job himself false interpretation is possible, and unjustified inferences may be drawn from statements made.

Distinguish between facts and opinions. Comments and opinions are useful pointers to further enquiries, or to test whether the real cause of a problem has been found, but they need investigation and confirmation before they can be relied upon.

Look out for a job of a daily routine character which the operator is so used to doing that he is hardly conscious of it, or its meaning, and consequently forgets to report all its characteristics. Likewise infrequent jobs must not be forgotten. Such minor matters may be important to the enquiry.

Look out for abnormalities or exceptions. They may point to gaps in information about the work.

Common Errors

Errors in fact-finding are caused by a variety of failings, among which are:

Failure to challenge and verify the validity of information at the time of collection.

Failure to be systematic, to sort out, consider and digest the data collected.

Failure to collect adequate data to support conclusions, or failure to reject unnecessary information.

For these reasons a critical attitude has to be maintained to any information collected.

Recording the Facts

There is a school of thought which suggests that people are disturbed by note-taking during the fact-finding interview.

But if the investigator takes care to explain how and why the notes are to be taken and invites those concerned to check them, this is rarely so. Such practice has three advantages:

It secures interest.

It enables what has been said to be checked. Many an over-statement is corrected by an operator when he sees in writing what he has previously said.

It slows up the interview, and thus gives the operator time to think.

Note-taking is largely a matter of common-sense. But there are certain methods to avoid, for instance, the writing of notes in shorthand, or in so rough a form that they have to be completely rewritten. Some people use separate sheets of paper for each point, since these can be shuffled and rearranged. To assist a later study of the facts, these pages or sheets are sometimes classified and summarised, separating facts and their sources from any inferences or conclusions which might have arisen.

Procedure charts should be drawn up as soon as possible and added to as more facts are collected. By attempting to chart the procedure, gaps in knowledge and possible lines of approach are uncovered. Operator or document movement diagrams are useful to illustrate the flow of work and to throw up any wasted movements of people or papers. These can often be drawn during the interview and checked there and then with the person responsible.

Weighing the Evidence

After collection of the facts the next step is to weigh the evidence and consider what has been said from a number of angles. The investigator might use the following check list:

Any general statement should have some implications for particular cases. Can these be substantiated as a check on the generalisation?

Is all the evidence collected based on enquiry or personal observation of actual cases or written records? Have any inferences crept in?

If the evidence is insufficient to form a conclusion, should further evidence be obtained, or should the general statement be modified? Sometimes the department

concerned might be asked to keep special records for a short time to supply the facts needed, but the cost of these records must be balanced against the value and importance of the further evidence.

What inferences may logically be drawn from the general statement? Consider these in relation to other items of evidence; are these inferences consistent with the other evidence? Are further enquiries necessary to confirm these inferences?

In collecting evidence about the normal practice have abnormalities or exceptions been ignored?

Bad Procedures

It is useful to look out for bad procedures, including:

Excessive number of stages: the result is to slow down the whole procedure. This may be the consequence of having too many persons on one procedure; the procedures may have been broken down into too many specialised operations (over-specialisation may result from a reluctance to give small items of trivial work to higher grades). Delays at each handling point are cumulative. On the other hand there may be pointless stages, where the operation performed does not advance the whole procedure towards completion. Some such operations, e.g. recording for control purposes, may be necessary; they should be kept to a minimum.

'Back-tracking', or making the procedure return too often to the same point. This may be due to failure to group related operations.

Insistence on a single procedure; standardisation for its own sake. If too many variations from standard treatment are provided for, subsidiary procedures tend to become complicated, an extra burden is placed on the person who has to decide when the variation is applicable and the possibility of error is thus increased. On the other hand, if standardisation is designed to provide for rare exceptions or for circumstances which are too varied, the procedure can become over-complicated.

Too many movements of people, e.g. to consult records. This fault is not necessarily due to layout. It may be due

to failure to attribute to the staff near the records all the operations requiring their use.

Too many records required for reference or noting; they may slow down the flow of the procedure.

Too many documents travelling along the line of the procedure. They may be too numerous where they move in a batch, if the batch is too big or too complicated so that each stage of the procedure takes too long; or where too many related documents move separately, as an indication of failure to control the flow of work and link up subsidiary procedures at an early stage. This fault is closely associated with the question of form design.

Duplicate records. Records kept at two points of a procedure, one lot of which could serve both purposes equally well if the procedure were changed.

Unused material (a variant of the previous fault). Forms or records discarded at an early stage which would save extra work if brought into use later.

Perfectionism or seeking at excessive cost to eliminate the smallest error. Symptoms may be an excess of arithmetic checks, the over-elaborate preparation of documents, e.g. typing where manuscript entry is quicker and cheaper, or not distinguishing the normal case from the exceptional one. This search for perfectionism is unfortunately all too common; the idea of the 'calculated risk', the risk which is likely to cost less than the safeguards against it, could be more widely applied.

Considering the Facts

In considering the facts gathered from an interview, the various basic office procedures discussed in a more specialised context in other chapters, should be borne in mind:

Copying

The prime considerations are to ensure that the information to be copied is available in suitable form and that the documents on which entry is to be made are designed so that an even flow is achieved. The precise method to be used, e.g. pen and ink, typewriter, duplicating machine, needs careful consideration with regard to requirements and costs.

Calculating

This may be made easier by the use of standard or specially designed ready reckoners, slide-rules, or machines. In all computing work it is worth considering to what degree of accuracy the answer is required, for it may be that an approximation to the exact result can be achieved with very much less work. Shillings and pence can usually be eliminated from cost accounts without loss of vital information, and spurious accuracy can be avoided.

Checking

This may involve comparing one document with another to ensure that they tally, or checking calculations or additional information entered. Here again special consideration is needed of how far checking should be taken, to decide whether everything should be checked in great detail or whether sample checking, selective checking or no checking at all would be adequate. In general there is too much checking in offices. A full check of all work should not be necessary and tends in itself to reduce quality by detracting from responsibility of individual members of the staff.

Sorting

This can be taken as including classifying and collating. Considerations should include the colour, texture and size of the documents to be handled, and may lead to the installation of aids, from simple sorting boxes or collating racks to punched card machines. There may be some conflict here between the desire to simplify and combine records and the need for ease of reference. For instance, over-centralisation of information on a single card which has to be referred to by various people in an office can lead to waste of time and inconvenience.

Filing

Attention should be given to the arrangement of documents for easy reference. The method adopted will largely depend on particular requirements. Before arranging for documents to be filed, it is worthwhile finding out whether the information is available elsewhere, possibly in a different form. Where reference is infrequent, exact filing may not be worthwhile.

Communications

This includes all methods, whether written or verbal, by which information is conveyed to people within the office and outside. Examples are proper arrangement of the furniture and filing cabinets and the provision of adequate telephone and (on a larger scale) teleprinter equipment if necessary. Provision of this equipment is not in itself sufficient; application and use must be generally understood.

None of these elementary processes can be treated entirely independently of the others. For example, the way in which copying is done may have an effect upon, and possibly eliminate the need for, separate computing and checking. Again, since an accounting machine has the ability to write and compute simultaneously, accounting machine 'proofs' may be accepted and thus eliminate the detailed check of each posting. The effects of the method of copying statistical information adopted on the necessary computing and checking must not be disregarded. When communications are under consideration, both ends of the process should be taken into account. A written note may, in fact, be more satisfactory than a telephone call if the recipient of the message is normally concerned with concentrated mental work or is frequently not available.

Machines

In designing a new office procedure the question of whether to use a simplified hand method or whether to mechanise has to be decided. Earlier chapters have dealt at length with the simplification of clerical work. If and when mechanisation is agreed upon, the extent of mechanisation and the choice of machine is difficult, and may involve considerable sums of money. The difficulty is mainly due to the fact that it is virtually impossible for the non-specialist to be familiar with all the possible machines for performing the basic office processes and, no less important, to the fact that selling office machines is a highly specialised art and one may be hard put to resist the blandishments and persuasiveness of the salesmen. The advantages of machines lie in their ability to combine operations; besides which they are not subject to the frailties and fatigue of the human brain. They may offer greater speed, reduction of labour, greater control of accuracy, improved legibility of

records and possibly more extensive use of the available information. Further, the rhythm of an accounting machine, for instance, noticeably imparts some of its tirelessness to the operator, who tends to work more regularly and is less liable to be distracted than a clerk. However, a machine is less flexible than the human brain and a machine's shortcomings often more important than its accomplishments. This lack of flexibility means that a machine is usually most useful where there is a large volume of routine work with few variations of operating rules.

The paramount danger which should always be borne in mind is that of confusing the advantages and facilities offered by a certain machine with the precise needs of the system into which it is to be incorporated. Salesmen commonly emphasise the features of their particular machines without sufficient regard to what the practical office procedure actually requires and it is necessary for the manager to resist this, by deciding first what a machine is required to do and then considering the alternative possibilities.

A General Check-List

The following points may be useful in considering the merits of a machine installation:

What alteration will there be in the number of staff required to run the system?

How much preparatory or additional work will be required from workers not previously considered as part of the routine? Will they need any special training?

What differences of pay will be required?

Will the requirement for specially trained operators make replacements hard to find?

What will be the cost of special stationery, ribbons, ink, etc., for the proposed equipment?

What will be the cost of maintenance?

What will happen if repair services cannot be obtained within, say, three hours?

Can the proposed system handle all exceptions which may occur? If so, to what degree will the exceptions reduce the efficiency of the new method, and what will be the cost?

What effect will mechanisation and any proposed production line techniques have upon the morale of employees? Will a reduction of morale, teamwork and interest in the job lead to a higher turnover and less production?

During installation must a dual system be maintained? How much will this cost?

How much additional help and overtime will be required during the installation period?

How much additional supervisory work will be needed for planning schedule, checking and follow-up?

What will the cost be of training present employees?

What is the unrealisable value of forms, equipment and supplies made obsolete?

How will the proposed changes fit into the long-term needs of the organisation?

Can the new equipment be used for other purposes if changes in the organisation eliminate the need for the method?

Over what period are installation costs to be regained? Will it matter if a better machine is developed before this period has elapsed? If so, should the period be shortened?

Costs and Savings

Many alternative systems can be eliminated without going to the length of a formal statement of costs. However, where one or two seem to offer much the same advantages, a careful statement of cost may be required. In any case, the costs of an office and the services which it renders are useful. When a change in organisation or procedure is recommended, the only satisfactory method of calculation is to compare carefully the existing costs with the prospective costs, although factors such as an improved service, which the new procedure may provide, may be taken into account.

If clerks are displaced as a result of a change in methods, the direct costs are immediately realisable; but not necessarily the indirect costs. Consequently, to take the full average cost of employing a clerk as the net saving to be gained per clerk displaced does not always constitute a valid reckoning. In evaluating work the full average cost of the time spent on it may

be taken; if this cost is acceptable then it is worth proceeding; if it is not acceptable but some time is used up (owing to the cyclical nature of other work) which might otherwise be idle, then it may be worth proceeding. Otherwise the expense is unjustified. A change in method that can be justified on the direct costs alone is certainly worth adopting. If not, further consideration may be required. The impact of savings in one office upon the costs of others needs to be watched.

The notable tendency of administrative departments to grow is the result of failure to keep the cost and value of office tasks under review. Managers tend to impose an increasing number of additional tasks on the hard core duties, without first comparing their cost and value. 'Once for all' jobs of any significance should be so costed, and permanent jobs should be frequently reviewed.

Considerations of Organisation

Considerations of improved methods may also lead to a need for a reorganisation of the department. There may be several possibilities, the pros and cons of which can be discussed with the departmental head or detailed in the report. Because of the individuals involved, an immediate change-over to the ideal organisation may not be justified, but this can be left with the manager as an ideal towards which to work when natural staff changes occur.

Final Review in the Section

Once the facts have been collected and organised, and considerations made concerning basic processes, machines and costs, several courses of action are usually possible. Before presenting these in report form, a day or two could be well spent in the section looking out for minor points which have not been covered. At this stage points concerning other sections or departments, or the works may be followed up and new ideas tested.

Completing Details

These should include:

Necessary consultations with machine firms (in conjunction with the Office Machinery Section, if any); careful comparisons, with test runs, may need to be made.

Discussions with the departmental head to test his general reaction to the new ideas. At this stage likely opposition may be estimated and arguments marshalled.

Preparation of staff estimates.

Exploration of the possibility of necessary motion studies being made, and designs for racks, working areas and equipment accommodation being carried out.

Making Recommendations and Report Writing

The final stage in any assignment is the one of forming conclusions — analysing the facts, subjecting the data collected to testing questions, and arriving at a solution. Impartiality must be maintained and sometimes outside advice sought. Consideration must be given as to whether the solution is an economical proposition, and the advantages and disadvantages of changes must be carefully assessed. When a solution is reached the tasks of making recommendations and writing the report follow, both of which require careful attention. Changes must not be proposed for their own sake.

Forming Conclusions

The thinking and reasoning stages of assignments cannot in practice be separated into neat and successive stages of preliminary survey, planning, fact-finding and the formation of conclusions. While the assignment is developing tentative conclusions are formed, tested and accepted or discarded, even in the early stages. Analysis, classification, verification of meaning, delineation of problems, the formation of solutions, synthesis and so on, are stages in the process of forming conclusions.

When the main examination of the work has ended, the summarised and classified information should be analysed and scrutinised so that the facts found may be related with one another in order to distinguish between cause and effect, to identify the main problems and to decide what additional information, if any, is required to resolve the problems that have now been isolated. Analysis is assisted by adopting the method recommended as a guide to fact-finding, by subjecting the data

to the questions: 'What?', 'Why?', 'When?', 'How?', 'Where?', and 'Who?' The general mode of approach must be to move from the general consideration of the problem in relation to sections of work, to appreciation of phases of work and finally detailed operations. This applies in organisation as well as in methods; it holds equally for technical and non-technical work. This questioning may involve searching tests, which if not completely satisfied will raise other possibilities for eliminating or doing the work more economically by other methods.

Absolute impartiality is required at this and subsequent stages. Prejudices of opinion, the often incorrect assumption of immediate recognition of the problem, or guesses may be introduced by the staff, but the stages of argument must be formulated and solved on a sound basis of fact and reasoning. To guard against over reliance on personal experience, a danger which increases the longer a man has been engaged in O and M work, some self-discipline is necessary. Apart from checking deductions with other men of experience, many O and M staff find that meetings with their opposite numbers in other companies can bring forth new ideas and prevent over-reliance on the practice of one man or one company. Also, few problems are completely new or different, and most of them contain elements of other problems that are known to exist elsewhere; some have already been satisfactorily solved. Thus, parallel practice and experience obtained from outside the company might well be analysed and compared. This comparison may suggest new ideas and alternative ways of doing the work, though the methods used by one organisation seldom exactly fit the practice of another.

Time should be given to the formulation in words of the actual problems which are involved in the assignment.[1] This exercise will help to indicate exactly what needs to be solved, clarify the issues and encourage precise thought. To 'challenge the accepted' is one of the most difficult things for anyone of experience to do, because it involves turning back on habits of thought, precedents and well-tried procedures; yet this persistent but 'revolutionary' attitude is essentially part of O and M.

When considering possible major changes, the main deficiencies and difficulties of the existing arrangements should be listed

[1] See page xxii.

and their importance assessed in relation to the objectives of the department or section. An assessment should be attempted in terms of their cost and of how far they are effective. Discrimination is required to distinguish between the desirability for fundamental changes in such separate matters as the main division of work between sections, the grading of posts and the need for job training. Changes in procedure may not be necessary if certain management weaknesses are removed. The advantages and disadvantages of a change must be carefully assessed; if the facts do not indicate some obvious advantages proposals for change are unlikely to survive a natural opposition.

Economy should not be carried to the point where efficiency is impaired; existing standards of service and accuracy should be assessed in relation to the cost of doing the work; essential minimum standards of service so determined should be maintained against the urge to achieve even greater savings at their expense. Precise savings are often difficult to estimate, and there are two schools of thought on the policy of giving emphasis to this measure of the effectiveness of O and M work. A small saving in each of many sections will result in a large saving; to this end a trial balance of all the various savings to be obtained from a series of minor proposals is usefully made.

The soundness of conclusions should be tested by discussion with the staff concerned, and in some instances a scheme can be tried out by arranging a pilot run on a small scale; points may then be revealed which have been overlooked and require modification to the original proposals. Consultation may well give some indication of the main objections to the proposals. These must be considered to distinguish between natural prejudice against change and difficulties which can be supported in practice.

Recommendations

If the staff concerned have been informed of the development of the assignment, the main proposals should not surprise them; and if they have been involved in the evolution of the proposals they may be persuaded to claim them as their own, and thus implement them with greater enthusiasm. If, in fact, a member of the staff has helped in finding a solution, credit should be given to him in the recommendations in the report.

Discussion should help to encourage the acceptance of new ideas and practices, but further assistance may be needed, such as:

Demonstration of equipment or of the new procedure by means of pilot runs.

Visits to other offices to see parallel practice.

Pictorial representation by charts and maps to illustrate improvement in practice, savings in movements of paper or time. Illustrations of this kind must, however, be carefully planned to avoid any possibility of a misunderstanding.

Agreement on main proposals must not be sacrificed by striving for too long for complete agreement on quite sound but less essential matters of detail; compromise by dropping some proposals sometimes pays, but judgment and discrimination are needed in deciding what may be dropped without serious loss. Considerable patience is needed to secure agreement on the findings. Disagreement usually stems from well-meaning objections by those concerned, and the causes of this should be clearly identified and weighed in relation to facts and circumstances to see whether any modifications to the proposals are justified.

The case should not necessarily be withdrawn because of disagreement; a firm stand on a sound case has been known to tip the scale at the last minute; time for reflection may reconcile those concerned to the soundness of proposals and the common sense of implementing them. In some cases it may be possible to confirm a solution with 'top' management before pressure is brought to bear; but the investigator must always remember that he will have to 'sell' his solution, whether to 'top' management, to the departmental head, who may have to accept the findings if his superiors have called on O and M, or to the operators themselves. He must however be careful not to 'oversell', but rather to present the idea that he and 'they' might be able to reach a solution between them.

The Report

In some companies most assignments require a report, even if action has already been taken, in which case the report would be adapted accordingly. Sometimes a series of interim reports is necessary before the final report is submitted. From the

investigator's point of view, a report imposes discipline on the assignment, and it is as well to remember that in O and M work a good report can make a major contribution to the success of the job and a poor report hasten its failure.

The successful report demands of the investigator skill, not only in organising the material but also in the art of writing, of communicating his ideas. From the outset, sympathetic contact must be established with the reader; therefore the tone of the report should be restrained and impersonal, and care should be taken in deciding whether and how criticism is to be voiced. The case for the solution should be stated simply, and should not be weakened by argument of any doubts which may have arisen in the investigator's mind. Questions should have been satisfactorily answered before the report is started; if the writer has not cleared his mind about the problems, their connection and relative importance, the difficulties of writing concisely and clearly will be increased and the result will be disjointed and inconclusive.

When compiling his report the writer should bear in mind the general principles of effective writing in business:

Directness and Conciseness

This is vital to all writing. A writer should come to the point without involving his readers in lengthy, unimportant detail. Digression from the main issues must be avoided, unnecessary words cut out and complicated sentences evaded.

Force

Force is acquired by the use of direct and unambiguous words, and by the elimination of all unnecessary verbiage. Such a statement as 'the meaning should be precise' is more forceful than 'the meaning should be precise and exact'. Words which are not essential to qualify or restrict the meaning of the sentence should, therefore, be eliminated. Extra force is gained when a strong statement can be put at the end of a sentence or paragraph.

Sincerity

To carry conviction a writer should write only what he believes. Readers are quick to detect a note of insincerity; their

confidence in the opinions of the author will be severely shaken if any such suspicion enters their minds.

Clarity

The main purpose of writing, to communicate ideas, cannot be accomplished unless these are expressed clearly. Clarity in writing can only result from clarity of thought; hence, adequate thought before starting to write is essential. Sentences, when written, should be instantly understandable to the reader, with the minimum of effort. Clarity is achieved by avoiding complicated sentence structure, keeping related words together and by the use of simple grammatical constructions and careful paragraphing.

Simplicity

The writer has failed in his object if the reader does not grasp the idea as he reads. Thus, he must avoid expressions or thought content which may be beyond the reader's comprehension. Simple direct statements of fact are always easy to understand; hence, the condensing of writing as much as possible will lessen complication.

Appearance and Paragraphing

The appearance of the document is also important. There should be a margin on each side of the page and the material should be divided into paragraphs with headings for emphasis. Care should be taken to maintain uniformity of layout throughout. The paragraph is the unit of composition and should be concerned with one main thought. Confusion of thought within or between paragraphs makes the theme difficult to follow and the logic of an arrangement is lost. Short paragraphs of about ten lines divide the subject well and encourage concentration of thought; blocks of uninterrupted print can intimidate the reader. A change from one section of the material to the next may occasionally be brought about by a paragraph specially written to provide the transition, dismissing the previous subject and introducing the next.

Style

Style is largely an individual matter, but when preparing documents of a business nature an attempt must be made to

conform as closely as possible to modern standard practice. A report does not provide an opportunity for the exercise of style in any literary sense, and facts should therefore be expressed and presented in a reasonably standardised way. The following general rules may help to achieve this:

Familiar words are preferable to the far-fetched and the short word to the long.

Concrete descriptions are preferable to abstract ones. Ideas can usually be communicated more effectively in concrete terms, and probably in far fewer words.

Long and involved sentences and the use of too many adverbs or adjectives should be avoided.

If possible, the writer should use the active rather than the passive voice, the transitive rather than the intransitive verb, and positive rather than negative statements (e.g. 'qualified' rather than 'not unqualified').

The rules of grammar should be observed, and a reference book consulted on any points of doubt. Good spelling is essential.

Words should be carefully chosen to express the intended meaning accurately. For example, 'compendium' should not be used if 'brief summary' is meant. Hackneyed words and phrases should be avoided; so should vulgarisms, provincialisms, foreign words, coined words and puns.

All the above may seem obvious. But the writer who makes errors, however innocently, will not be taken seriously and may lay himself open to ridicule.

Before commencing to write at all, however, thought should be given to the person for whom the report is intended, as to whether its tone should be personal or impersonal. As soon as this question has been settled decision is needed as to the structure the report should take; the following method is suggested.

The writer should make a framework of the main sections and expand this as far as subheadings and notes on the theme of each section and paragraph. The preparation of a skeleton or outline concentrates attention on the structure of the report, and helps develop the argument in an orderly way. Obviously there can be no set arrangement for everyone to adopt, but the following is a suggested basic outline:

Title.
List of Contents.
Summary.
Introduction and/or Preliminary Section.
Body of Report.
Conclusion.
Summary of Recommendations (with reference to text).
Appendices.
Bibliography.

This outline contains all the sections that may be needed in a report. In some cases the list of contents, the summary at the beginning, as well as the summary of recommendations, appendices and bibliography, may be omitted.

Introduction. The main purpose of the introduction is to define the subject and scope of the assignment. The act of definition presents an opportunity to clear a doubt about the assignment or to remove a prejudice which has already arisen. The introduction should begin with the terms of reference, or if these were not defined, with a brief description of the subject of the assignment. The statement of the subject by itself will not always indicate sufficiently clearly all the particular aspects of the assignment, nor how they are treated. The introduction should do this. If interim reports have been submitted the introduction should draw attention to this fact, and explain how the main parts of the other reports fit together. Finally, a closing paragraph may describe the arrangement of the rest of the report together with any limitations of subject matter, and define words and phrases later employed which are not readily intelligible.

Preliminary Section. This is not always necessary, but should be used when the subject is unfamiliar and needs special explanation, or when a review of the history of the subject is essential. A preliminary section is seldom necessary in a report of short or medium length.

Text-Body of Report. The report is required to state the problems found and their solutions. Relevancy and persuasiveness are important qualities, and can be tested by the writer asking himself:

Does this particular information lead to a conclusion or a recommendation?

Does it contribute anything of value to the background needed to judge the soundness of the recommendations?

Irrelevant material is confusing. When the subject and recommendations have been introduced clearly and are understood, the supporting information should be drastically cut and emphasis placed upon only those items which are really significant. The basis of a report is one of fact, concisely presented in a detailed manner, with as much and no more comment and interpretation as may be necessary to the theme of the report to make it intelligible. The facts should be arranged to point as clearly as possible to conclusions and recommendations and the data should be complete and reliable.

A report is intended to lead thought to a definite conclusion and is more convincing if no doubt of the meaning occurs in the presentation. The statements made should answer specific questions, and generalisations introduced as a prelude to comment on particular situations should be handled with care lest ambiguities are raised.

Recommendations, which must not be confused with instructions, should be presented in the same way as the facts, with emphasis on what is essential and attention drawn to what is important and what is less important. They should stand out clearly from the rest of the text, but alternative recommendations may be introduced, where the situation so demands, or to create an opportunity for the reader to associate himself with the recommendation by his own selection. Finally, unless specifically requested, methods of implementation are not normally required in a report.

Conclusion. The conclusions, already agreed in principle in the body of the report, should now be restated emphatically. No new material should be added. The conclusion is the final word — not an afterthought.

Summary of Recommendations. A summary of recommendations is not necessary in all reports; if these are developed in the text and restated in the conclusion obviously there is no need to do so again. If, however, recommendations are scattered throughout the report, a summary should be made in a separate section at the end, but details or reasons for making the recommendations should be excluded. They may be listed as they appear, or in order of importance.

A summary of findings may also be added, but this is only useful in a long report. The writer should at all times employ his own judgment about what to include and what to omit. Some people may even require a summary (giving a broad picture of the findings, conclusions and recommendations of the report as a whole) at the beginning before the introduction. These are matters for personal decision.

When the report has been written it should be carefully revised and edited. An interval of time will usually restore the writer's critical faculty.

The general principles stated at the beginning of this section must be kept in mind when redrafting, together with the necessity of using words and argument suitable to the recipient of the report. Finally, the writer must remember that although the report is not meant for posterity, reference to it may be needed some years hence and it is, therefore, in this respect a permanent record. Consequently it should be as readable, effective and clear as possible.

The art of writing reports lies in the ability to distinguish between the essential meaning and the unessential word-clothing. The writer must have the ability to marshall material in logical order and to present it in a balanced form; if attention is focused on the wrong points time is wasted and the reader understandably irritated. A bad report may well depreciate the currency of O and M.

Follow-through and Implementation

Recommendations may be accepted at various stages; many are adopted in principle without any immediate action being taken upon them. Most O and M departments have a 'follow-through' system to ensure that the next stage of implementation takes place within a reasonable time. Every company has its own policy with regard to this implementation. Some lend the investigator to the department concerned to implement the new procedure to the last detail. Others ask him merely to assist, depending on the ability of the manager and his staff; for if the management cannot undertake the task itself, O and M must introduce the new procedures, and in some cases remain until they are working satisfactorily. Some companies restrict O and M to its purely advisory capacity and do not allow it to imple-

ment recommendations at all. Any executive authority given to O and M is temporary, with the specific purpose of putting into effect certain changes in the name of and under the responsibility of the management. O and M has no responsibility of its own right.

In considering the question of implementation, it is most important to remember that the departmental head is responsible, operationally and functionally, for the work of his department. Following a survey, assistance in the installation of the new procedures may be offered and, if accepted, this would normally be given by the person who conducted the survey, the departmental head delegating to him certain functional responsibilities. But the responsibility for the department and its output rests entirely with the manager, never with the O and M man.

Sometimes the introduction of a liaison officer between O and M and management is a good idea, as it eliminates divided loyalties on the part of the O and M man if he is loaned from his own department to the department having the new procedures installed. In a large department the officer appointed may be the assistant manager. He will work in close collaboration with the person who conducted the survey, and must have been concerned with the scheme from its inception. Usually he will represent operational responsibility and the O and M man functional responsibility. Sometimes, however, the job of liaison, and the implementation of recommendations which he has made, are considered to be valuable training and experience for a young O and M man, in which case he will be loaned; but care must be taken not to place him in an invidious position.

If the O and M department is given operational responsibility during the installation, there is a tendency for the staff to rely on them to too great an extent, with undesirable results when they leave. Nevertheless, the duty of O and M is to give all assistance possible to the department staff during the installation. The man assigned should attend at the inception of the installation proper, after which he should pay a number of follow-up visits.

Planning the Installation

After the above responsibilities have been settled, the necessity arises of analysing the new procedures, breaking the

work down into convenient units for installation, and determining the sequence in which these units should be installed. It is seldom possible to commence all the new procedures for a large department on the same date. The way in which the work is to be broken down for installation requires careful consideration, lest the work of other sections, or of the whole department, be unbalanced. A new procedure is usually faster, and thus may cause hold-ups in other sectors unless the starting point is very carefully selected.

O and M must therefore ensure that the time factor, physical arrangements, staff arrangements and communications are all well coordinated in advance of the installation date.

The Time Factor

When deciding the timing of the installation the investigator should bear in mind holidays, fiscal or calendar years, month or quarter ends, seasonal trends and peak periods.

After consideration of the sequence, dates, time to obtain supplies and to train staff, a timetable for the installation should be prepared.

Sufficient time should be allowed for thorough and comprehensive training right down the line.

Physical Arrangements

Accommodation
Equipment
Stationery
Layout of the accommodation in the most suitable way to suit the flow of work.

Staff Arrangements

Allocation of staff to all duties shown on the organisation chart. Care must be taken to ensure that the correct number of staff is allocated to each group of operations. If too many are allocated in the early stages, it may be difficult to reduce the number later. A 'floating staff' provides the means of supplementing the correct number at first, where output is low and operators are not fully practised.

Procedure instructions — to act as a basis for training and also as a book of reference in the future.

Communications

Teleprinters
Telephones
Messengers and conveyors
Postal services
Transport of staff.

All staff concerned should be notified about the installation, when it will start and what it involves. A new 'remit' should be prepared for a new department and circulated by the appropriate authority. Existing 'remits' should be revised, if the installation materially alters the responsibilities of the department. Although the new procedures will have been agreed in detail between O and M and the manager or assistant manager concerned, all the senior members of the department may not be fully aware of the procedures, or of the installation programme. There may be prejudice to overcome, but by demonstration, logical argument and tactful handling, full cooperation should be obtained. Procedure wall charts are of great value in explaining to management and supervisors the nature of the new installation and its justification.

The Installation Stage

The installation stage is divided into three phases:

Rehearsing the new procedures.
Installing the new procedures.
Comparing the new procedures.

Rehearsing the New Procedures

The new installation should be rehearsed in some way, in order to reveal any unforeseen complications. In a machine trial, a demonstrator, and possibly a mechanic, should be present from the office machine company. Prior to a full-scale trial, a 'dummy-run' is sometimes used in which a few specimen documents are passed through all the operations.

The best rehearsal is usually a trial extending over a lengthy period on one section of the work. This is done by selecting a group of materials, products, customers, etc., according to ease

of segregation, while the main work of the department continues on the current procedures.

Alternatively, a period of overlap of the old and new procedures may be arranged. The disadvantage in this is that it takes up too much of the staff's time to run two procedures side by side; but it has the advantage that the new procedures can be discontinued while improvements are made.

As a result of the rehearsal, it may be found that:

Further training is necessary.

The operation of machines or equipment can be improved by motion study.

There is a need for a revision of parts of the procedures or of the installation plan.

Before starting the installation, preparation of the new workplace overnight, or at a week-end is advisable.

Installing the New Procedures

Confidence and firmness are important qualities in the person supervising the installation, but there has to be a flexibility of approach to allow for differences between plan and performance. The human aspect of this phase is important; some members of the staff may become easily discouraged when things go wrong, and suffer from the strain of absorbing and operating new procedures.

The time of installation is a test for supervisory staff, and is apt to show up needs for extra experience and training. Coordination of people and activities needs to be watched. This is often a pointer to the quality of management. The ability of the departmental staff to solve problems and make decisions on their own behalf, without leaning too heavily on O and M, will promise well for the success of the installation. A useful practice is to hold a daily conference with the section leaders and also to make a daily verbal report to the head of the department.

Comparing the New Procedures

When the installation proper begins, a process of comparing results with the original plan should be carried out. This can consist of:

Comparing the rate of progress with the prepared timetable.

Comparing the actual procedure with the proposed one.
Noting any deviations or improvisations, and their effects, and deciding whether these are likely to be permanent.
Noting any weak links in the staff.

During the installation old habits should, if possible, be eradicated. These may have a firm hold and further training may be needed.

The O and M man must always remember to give credit for suggestions or special efforts, and be ready with encouragement and praise when this is needed. In this way, a foundation for a sense of satisfaction and achievement can be laid among the operators.

The Follow-Up Stage

The follow-up stage is also described in three phases, though in operation they often run concurrently:

Checking the procedures.
Amending the procedures.
Developing the procedures.

Checking the Procedures

This follows logically on the comparison phase of the installation and consists of a formal check on the progress made. It should include results within the department, together with effects on outside departments. The check should be thorough; it should always be based on facts, though opinions may also be of value. The check should examine:

The layout of the department and work flow.
The equipment, machinery and stationery.
Communications.
Staff allocation and the work load on sections and individuals.

In routine sections output statistics must be maintained, for comparison with clerical output standards. If these standards have been calculated previous to the installation, they should be checked and any amendments made. If clerical output standards are not already available, arrangements should be made to have them computed.

Amending the Procedures

During the installation amendments are sometimes made to the procedures as originally agreed. Some of these may be only

temporary, but others may be made permanent. Before this is done they should be examined to ensure that they do constitute improvements on the original plan. The formal check on the procedures may suggest additional improvements.

The O and M man, and probably the assistant manager, will decide what amendments and improvements are to be permanent and proceed to incorporate them in the procedure record and charts. All copies of these should then be brought up to date.

At the close of the formal check a report is rendered to the departmental head, summarising the effects of the installation and drawing attention to additional improvements which may become possible after a further period.

Developing the Procedures

Any well-designed organisation and set of procedures should be sufficiently flexible to deal with normal variations, e.g. in the volume of work, works' requirements and new products. The department should be able to make such alterations to the procedures as are necessary. From the survey and installation of the new procedures and the discussions which have taken place, the staff should have come to realise that no organisation should be regarded as final, and should have been encouraged to think out and suggest more improvements.

Satisfactory office procedure results from the application of common sense, experience and some technical knowledge; to embody the required process of thought in a set of neat rules is impracticable. The O and M man is not only an investigator and instigator of new procedures, but a salesman of the whole idea of good organisation and method. A successful procedure installation or reorganisation is his advertisement, and a satisfied customer his strongest selling point.

CHAPTER VI

THE APPLICATION OF MEASUREMENT TO OFFICE WORK

The investigator, in approaching his assignment, is searching for data in two fields from which to make his assessment. The first, that of the material of the job, the machines and equipment of the office, has already been described in outline. The other, that of matching the work to the personnel and of providing information for the management on optimum output is considered here. The quality of the equipment in an office cannot alone determine its efficiency; nor can the tact and good sense of the management in organising the work of their staff achieve good results by itself.

For these reasons amongst others O and M will often be faced with the problem of how to measure work as part of measuring efficiency and of how to ascertain how work can be distributed to the best advantage, and again of how to obtain a fair share of the work from each person concerned. This chapter is concerned with these problems.

The Objects of Measurement

The manager of a large office must have a fair idea of the amount of effort involved in the work which he is supervising in order to assess the number of staff he requires, to allocate work fairly, to control output, and to gauge the performance of each of his subordinates. The O and M man will need to have an even finer knowledge of the work; for the same reasons as the manager, he must know how to compile standards. He will also on occasion require the results of measurement in order:

To compare whole methods with one another, or variations in part of a method.

To diagnose reasons for low output.

To cost transactions and thus justify their need.

In each of these cases the investigator will have to sell the

results of his measurement to his superiors, and to the operators; hence he will have to give a logical explanation of the basis of his calculations.

Incentives, which are dealt with in greater detail below, cannot be applied without measurement. The application of direct financial incentives to office work is limited, but some sort of measurement is helpful everywhere.

Measurement is also required to provide standards for staffing and control purposes, and this implicitly demands that the method should be right before measurement is made. However, in practice the discipline of detailed measurement study will often serve to reveal deficiencies not previously apparent.

Broad Measurement

O and M Departments soon accumulate, from experience, a knowledge of the approximate rate of output which can be achieved in the various jobs with which they are concerned when using a particular method; this approximation may suffice for the needs of smaller offices. Such broad figures may have been developed in various ways, none of which will probably suffice on its own as a method of assessment; for instance:

They may represent the output of a section which has been well supervised and staffed and with which the O and M Department has worked closely.

They may result from observation over some hours or days of an operator whose work is known to be consistent.

They may result from figures provided by office machine companies with adjustments made for particular circumstances.

Such methods of broad measurement may produce output standards for simple clerical operations such as punching cards, sorting documents, typing orders, invoices and simple letters, and posting machine records. These, when applied by experienced O and M men are normally considered to be sufficient for staffing and output control purposes, at any rate in the simpler clerical jobs, with which the investigator tends to be at first concerned. There is a danger, however, that they may mislead, unless they are applied by someone who knows exactly how they were established and the circumstances to which they relate.

These circumstances are difficult to describe in broad terms since they are so variable. As an instance, in a comparatively simple accounting machine operation, factors such as the content of the posting, the state and design of the document from which the postings are made, the pulling of the record, the ease of alignment, the length of posting run, all make a great deal of difference to the work involved in two apparently similar jobs on the same model of accounting machine. Further, any broad measurement figures will depend substantially on whether a good operator or an average operator was used, over what period the performance was timed, what allowances were made for rest, and so on. With broad measurement all these factors are impossible of definition in such a way as to enable the results in one place to be applied to another, unless the same investigator was involved in both. He, with the experience already gained, might be able to make adjustments to the figures calculated in one place so as to enable them to be used elsewhere with a reasonable degree of accuracy.

Some large companies have found that the broad methods of measurement are not sufficient for the following reasons:

Only a small proportion of clerical workers are occupied on one or two simple clerical jobs throughout the day. The majority of clerical workers do perhaps fifteen or twenty different sorts of work each day, switching from one to another.

Broad methods of measurement do not provide a satisfactory means of comparing one method with another when so much depends on ensuring that different degrees of skill and assiduity are taken into account.

Except in the simplest type of operations, broad measurement does not enable transactions to be costed.

A method of measurement must not only be right; it must also look right to those engaged on the work for which standards are being obtained. A fully logical basis for measurement is of great assistance, not only in the use of standards for staffing and output control, but also in the comparison of method.

For these reasons some companies have moved on to more detailed methods of measurement.

Detailed Measurement

Application of detailed measurement to clerical work has not followed the application of similar techniques in the factory. The reason for this is not, as is sometimes suggested, conservatism on the part of office managers and workers, but rather some added difficulties in the measuring of clerical work. Specialists in work measurement in the factory have rarely progressed beyond the very simplest of office work, unless they have made a real attempt to study the peculiarities of the latter and the special treatment which it requires. Those who have progressed furthest seem to be those who have specialised in office work rather than in work measurement.

In considering the application of detailed measurement to office work, there are special factors which have to be kept clearly in mind, the first of these being the difficulty of measuring mental work. Mental work occurs in all clerical operations, and may vary even with the same physical operation; such simple operations as punching cards and hand sorting involve some mental effort. The way the work is presented to the punch operator has a considerable effect on the speed which she can attain. The mental effort involved in hand sorting into alphabetical order is noticeably greater than that involved in sorting into numerical order, whereas the physical operations may be almost the same.

Those who are measuring office work must therefore understand its purpose. Only part of the work being done is shown physically, and the assessment of the remainder involves the knowledge of the procedure and an ability to judge the skill and effort which is being applied. A clerk, for instance, may look at a document for a minute or more, and anyone measuring the work must know what mental check or comparison is being made, and whether this is necessary. Some office procedures are easy to assimilate, but in other cases a sufficient knowledge may take some time to acquire. Again, all the work involved in completing a transaction is not carried out at the time when the basic operations are performed. For instance, calculation of the work content involved in receiving a supply indent and translating it into an order to a supplier, cannot be done by studying the clerks only when handling indents and orders.

Various queries, telephone calls and routine correspondence arise from this work and have to be taken into account; these may amount to twenty, thirty or even forty per cent of the work involved.

Also, the amount of care necessary to the performance of clerical operations must be carefully assessed. Errors may be expensive, but so too are the means for preventing them, and the calculation of the work content of a job must allow for a reasonable amount of care. Finally, superficially similar transactions may vary a great deal in work content. For instance, the time taken to pass a supplier's invoice may legitimately vary from thirty seconds to thirty minutes. But this might lead either to a very large sample being obtained, or the transaction being batched for separate study.

All these complications can be overcome, but they need consideration if measurement is to be applied economically. Although there are many variations in clerical work, there are equally many common elements, especially in selecting and putting away records, reading, writing, calculation, typing and machine operation. Many of these common elements can be incorporated into clerical output data capable of being combined in standards of varying types.

Techniques of Detailed Measurement

The techniques available for the detailed measurement of clerical work, which are described briefly below, were originally designed for factory work, but can be developed and applied to office work by those who understand the special factors involved:

Time Study. Time study techniques include any method of timing to a planned degree of accuracy. Actual timing of operations is modified by a rating factor to provide for variations in the operator's speed of working. Special techniques are used to calculate the incidental times to be charged to each job although they may not occur at the same time as the main part of the transaction is completed, e.g. queries, telephone calls, correspondence. An allowance for personal needs is added.

Film Analysis. A motion picture of an office operation can be taken and analysed frame by frame; as the number of

frames per second is known, times can be established. This method is used in the examination of elements too brief for ordinary time study, particularly in the comparison of methods and machines. It is a very accurate method of measurement, based of necessity on a limited sample and used only when precise detailed knowledge is required of highly repetitive operations.

Predetermined Motion Time Standards (PMTS). Research into better methods of establishing time standards has led to the development of predetermined motion time standards, of which there are several different systems. All physical movements are made up of a relatively small number of body motions. For example, the motions involved in reaching to pick up a pencil can be split up into four separate stages — reaching to grasp it, grasping it, moving and pre-positioning it, and putting the pencil point to paper. PMTS are essentially a catalogue of these motions with time units assigned to them. A trained observer can record the motion pattern required to perform a particular task; when he is satisfied that the motion pattern is correct, he can assign the right time values from the catalogues, thereby producing a time standard for the operation. The use of PMTS by itself is dangerous in office work, since no allowances are made for mental effort; but their use by a properly trained man can produce valuable results.

Standard Output Data. Output data may be developed which is applicable to common elements of clerical work by one of the three techniques given above. This data may be detailed, but its use can be taught easily to O and M staff, who can then translate the data into standards which are easy and quick to apply. Some consultants in the United States and elsewhere make wide use of data of this type, and it is known that one company in this country has already developed data to cover about thirty per cent of its clerical work and is increasing this figure. This company claims that this data, being a by-product of measurement studies made for particular purposes, has cost little to produce;

the compilation of similar data is now part of all such studies.

The first two of the techniques described above involve separate study and measurement; the latter two are techniques of synthesis from existing data. They are all designed to yield standard times for tasks, i.e. average times that would be taken by an average operator, suited and accustomed to the task, working under normal conditions, without undue fatigue.

Introduction of Standards

When standards have been determined by the use of detailed measurement techniques, their successful use depends essentially on how they are introduced. The make-up of the standards should be explained to the supervisors and the clerks who are to work to them, so that they appreciate that these measures are soundly based and are fair. They should be told that the adoption of standards implies no criticism of their work, but is an honest attempt to assess the work load accurately so that the correct staff level can be set, and to provide information which will allow the staff level to be varied to match the work load.

Activity Sampling

One further technique, not yielding standard times, but nevertheless used in the field of clerical work measurement, is known as activity sampling, work sampling, or random observation study. This is used as a means of assessing the proportion of time which is spent on a particular type of work, and can serve to indicate what is likely to repay more detailed investigation. These studies can also give useful information on the incidence of the level of loading at various times of the day. Activity sampling consists of making instantaneous observations at random intervals of what each operator is doing. The number of observations depends on the degree of accuracy required and is decided by a statistical formula. The observations should be taken over a representative period. The technique is most easily applied to machine work, to the questions of whether a person is working or not, and on what job, and is clearly applicable at the moment of observation. The effectiveness with which people are working and the tendency of clerks to spread out the work they do, if properly loaded, are not taken into account.

Standard Data

It is regretted that no standard times for clerical operations are published in this chapter. This is partly because training is required before standard data can be successfully used. A further reason is the difficulty of defining and relating operations for which standard times can be quoted without ambiguity; this also serves as a warning against uncritical use of data obtained from any outside sources. As an instance, in one firm times were established for a task originally defined as 'Separate 4-Part Purchase Order Set'. The clerk who had to do this received the sets sometimes with three sheets of carbon interleaved, sometimes with a requisition attached by paper-clip, sometimes with both, sometimes with neither. The time for the most complicated version was double that for the simplest. With these variations within one firm for an operation not unreasonably described as 'separate 4-part purchase order set', the usefulness of a single time figure to another firm whose order set could be different in size, construction, etc., is obviously non-existent.

Incentives in the Office

Schools of thought in this country are divided on the policy of paying direct financial incentives to clerical staff. This section sets out some established criteria for incentive schemes together with some advantages and disadvantages claimed for them, and illustrates three schemes currently operating in the offices of different firms, with somewhat different purposes.

Criteria for Selecting Activities

The following criteria have been established in different companies for determining which fields of office work should be put on incentives:

There should be a fairly homogeneous office group.

The work performed should be of a repetitive and routine nature.

The group should have a supervisor receptive to the idea of incentives.

The work must be readily measurable.

The quality of work as well as the quantity of output should be capable of control.

The procedures should be reasonably static.

Characteristics of Incentive Schemes

The following characteristics are desirable in all incentive schemes:

The work on which the incentive is paid must be reasonably accurately assessed.

The scheme must be easily understood by the employee.

The amount of the financial incentive should be large enough to be appreciable, but not too large in relation to the basic rate of pay. From ten to thirty-five per cent of the basic rate constitutes the range usually felt to fulfil these conditions.

The incentive should be applied either to the individual or to a small group working as a team, so that the benefit received closely relates to the effort expended.

The incentive payment should be made as soon as possible after the period in which it is earned.

Practical Difficulties in Applying Incentive Schemes

A number of practical difficulties arise in attempts to apply incentives to office work:

Knowledge is imperfect of how far clerical work can be measured.

Much clerical work is difficult to measure; this makes measurement expensive.

Flow of work to the worker is difficult to maintain.

The integration of measured and unmeasured work must be attempted, but unmeasured work may occur at any time and staff are often switched on to special work.

The quality of work performed is difficult to check. An additional checking operation might be involved. Often, too, quality is difficult to assess, e.g. the way in which letters are despatched.

Advantages of Incentive Schemes

The advantages claimed by the protagonists of incentive schemes are as follows:

Incentives usually result in improved performance.
The employee gains, since rewards are related to effort.
The firm gains, since the amount of the incentive payment is normally less than the value of the increased output.
The interests of the clerical worker are joined with those of the employer, and cooperation develops within teams (when paid as a group).
The minimum of supervision is required.

Disadvantages of Incentive Schemes

Critics of the schemes cite the following drawbacks:

A lack of flexibility may result. Much office work is subject to change, and procedures and organisation should be under continuous adjustment to meet changing conditions.
The segregation of people into homogeneous units is not always easy to organise.
The work of some clerical staff cannot readily be measured at all. The opportunity given for some staff on incentives to earn more than others working equally hard may upset relations and the salary structure.
The recording and checking of output and quality, and the calculation of the incentive payments involve extra work and therefore extra cost.
Accuracy has been known to suffer when extra output is attempted.
Possible discontent when work and incentive fall off.

Differing Opinions

Any impartial assessment of incentive schemes is extremely difficult to make. Where they have been applied and improved performance has resulted, the benefit that has resulted may have derived from the incentive or at least in part from the measurement of the work. Some firms which have installed incentive schemes in parts of their offices are well satisfied; others feel that the goodwill of even junior levels of clerical staff might be sacrificed by an improvident application of incentives. Some large firms are understood to have discontinued incentive schemes for office workers because of the lack of flexibility that resulted in their office organisation.

Since incentive schemes necessarily entail measurement, the best way for a company to obtain convincing evidence would be to apply measurement first, without incentives, and to gauge any benefits that result. The subsequent application of incentives would then permit distinct evaluation of any extra benefits brought about by their introduction.

Examples of Incentive Schemes

There are wide variations in the types of incentive schemes that firms have tried. Three different schemes are described briefly below.

Scheme 1

In one particular company the decision to offer an incentive was taken in advance of working out the details of how the incentive was to be applied. The decision took the form of three instructions — to stop recruitment, to dismiss no one as a result of this decision, and to appoint a small committee consisting of the office manager, one O and M man and representatives of the staff to work out how the decision was to be implemented.

The committee itself decided to make an inventory of the work done in the office and to invite staff participation by recording the work done each day by nature and time, the number of times individual operations were performed, and idle time, if any. At first the existence of idle time was not admitted, but within a few months, a critical examination showed that considerable time was being wasted, mainly through:

- Excess complements based on peak requirements plus a reserve for illness, etc.
- Inefficient working methods and irregularities in the flow of work.
- Alibi records due to lack of trust between staff or between departments; unnecessary records; controls (some being repeated).

Because there was no work measurement or performance control, many clerical workers had the habit of spinning out the amount of work available each day to cover the whole of that day. Managers and heads of departments, not realising

this, did not believe that any time was being wasted. When work increased and their demands for additional staff were questioned, they pointed out that all employees under their supervision and control arrived on time at the office and were at their desks all day busily engaged in the performance of their work.

A preliminary investigation, made in close consultation with managers and staff, soon made clear to all concerned that:

An important proportion of office work consisted of routine duties.

By the adoption of a steady working speed in the execution of these duties time could be saved.

Unless absorbed by an increase in the quantity of work, the time thus saved should be reported as 'idle time'.

As soon as the principle of a steady working speed had been adopted, the committee set to work on the determination of standards. Without using a stopwatch, but again by discussion, persuasion, experimenting together, or giving an example, the committee soon managed to introduce, if not a scientific 'standard time', at least an 'agreed' time for each operation. In an amazingly short time the staff began to carry out their routine duties in the 'agreed' time, and 'idle time' began to be reported in increasing quantity.

After two months the position was as follows:

As a result of normal labour turnover and following the decision not to engage new staff fewer clerks were employed.

More work was being done, some of which could be measured in terms of man hours by making use of agreed times per operation.

Idle time reported in several departments proved the existence of a reserve labour force.

In view of this promising start, and in recognition of the cooperation of the staff and as an encouragement to further efforts, an incentive was paid from the third month. Pending the development of a suitable formula, the amount of the incentive was provisionally fixed at 10 per cent of basic salaries, payable on the 15th of each month in respect of the previous month.

The 10 per cent incentive, the cost of which was originally

most certainly in excess of savings already obtained, remained in force for two years, when a reliable estimate, if not an accurate calculation, could be made of the reduction in labour costs. As a result the percentage was increased to 13 per cent of basic salaries; it has since risen to a level which varies from approximately 18 per cent to approximately 24 per cent.

At the outset it was not always possible to differentiate between savings obtained through modernisation or mechanisation of office procedure and those resulting from the efforts made by the staff. After some years this has become possible, and the incentive is now considered a just and equitable compensation paid to the clerical worker, not so much for working faster as for carrying out his task at a steady working speed and for having become time — and therefore cost — conscious, and for giving active support to the constant effort to increase productivity.

In retrospect certain conclusions have been formed, which are that:

The amount of routine work in an office is far greater than is often believed. In offices of industrial and commercial concerns from 60 per cent to 80 per cent of the work is estimated to be measurable, on condition that the yardstick used is not too precise.

The time spent in the various departments on collecting the basic information periodically required does not as a rule exceed a few man-hours per month. Three employees in O and M are employed in recording and summarising the work done by some one thousand office workers.

Prior to the introduction of the incentive plan, an average of from 70 to 75 measured units of office work was produced, compared with 100 units representing an estimated potential, which could involve no risk of excessive physical or mental fatigue. After the introduction of incentives, the index of production soon rose to this norm of one hundred units and is usually maintained at approximately this level, but during peak periods it has risen to 120 to 125 without adverse influence on the quality of work produced. The increase in production is one of at least 30 per cent to 35 per cent

and a possible 60 per cent to 65 per cent. The incentive averages approximately 14 per cent of gross salaries.[1]

Work measurement and the preparation of standards are serving a dual purpose. They are essential for the development of the incentive plan. In addition they have supplied the basic information required for preparing and carrying into effect a far reaching programme of office reorganisation. In view of this the gross amount of savings obtained through increased productivity is to be compared with the total amount paid as incentive plus the total cost of the O and M departments. A modest estimate works out at a gross payroll saving of 40 per cent, from which should be deducted 14 per cent paid as incentive and 4 per cent to cover the cost of the O and M department, leaving a nett payroll saving of 22 per cent.

There are in this company, and in most others, office jobs and office operations which are difficult to measure and for which no reliable standard can be set. The presence of a commissionaire or a receptionist is required throughout the working day, although there may be few messages to be delivered and no visitors to be received. Private secretaries must always be at work especially when the officials for whom they work are away on a business trip. The application of standards to that part of their work which is measurable would probably give a lower level of productivity. Should they therefore be excluded from the incentive plan? This question was put to the staff, through their representatives, who unanimously decided that the whole of the staff should participate in the scheme, and recommended that these and similar functions be pooled wherever possible in order to reduce idle time to a minimum.

The incentive described has helped first to control, and subsequently to arrest an expansionist trend in office organisation; in this company the trend has to some extent been reversed. Theoretically measurement like this can be done

[1] The incentive is not paid in respect of Christmas and holiday bonuses. This explains the difference between the basic percentage of 18 to 24 per cent and the average cost of the incentive in relation to the gross amount of payroll.

without an incentive, but the experiment described has shown in practice that an incentive has proved to be, at the very least, extremely useful by ensuring that the staff participate in the benefits of higher productivity.

Scheme 2 — Offset Litho Printing Machines

This bonus incentive scheme was applied to fourteen Offset Litho Printing Machine operatives over the period of one year. The scheme was based on the actual time taken to carry out the job, compared with the Standard or Allowed Time for that work, a bonus being paid on the time saved. Operatives recorded on their work sheets details of all the work done, including any excesses, such as lost time; these work sheets were used to provide control data for management.

Preliminary Method Study work had indicated that the layout of the process and the work places required modification. Accordingly, when the best methods had been evolved, and the rearrangements were in hand, including the modification of work places, time studies of all the work were made, and from these latter studies work values were established for the productive work, in two separate categories:

Actual printing.

Non-productive work such as make-ready, machine cleaning, colour changes, etc.

Work values included allowances for rest and for unobserved contingencies. Precise details of how the values had been set up and the range of work they covered were set out in a work specification, which was discussed with the operatives before the application. This work specification gave an example of bonus calculations, and set out the precise conditions which would cause any change to the values.

In practice each operative completed a daily work sheet on which he recorded the following data:

The quantity of productive work completed, and whether this was measured or not.

Details of all non-productive work carried out.

Details of all lost time, and the cause of the delay.

These work sheets were checked by the foreman each day, and handed into the control office, where the bonus calculations were made and the Management Control Sheets computed.

The bonus earned was notified daily to operatives, the control sheet also being presented to management daily.

The work values were such that an average operative could earn 80 standard minutes in an hour, and when this was achieved it was referred to as a '100 performance'.

$$\text{Performance} = \frac{\text{Total credits}}{\text{Attendance minutes}} \times 75$$

e.g. 100 Performance $= \frac{80}{60} \times 75$

Total credits = standard minutes of measured work (productive and non-productive) + minutes of unmeasured work, lost time, etc.

Minutes saved = Total credits – attendance minutes

Bonus earned = Minutes saved × Bonus Rate.

The level of bonus paid was such that an operative working at a '100 performance' rate earned a bonus which was equal to one-third of his basic rate. Bonus was only paid for work which was of acceptable quality, and no additional bonus was paid when the rate exceeded a '125 performance'. The results of the experiment are tabulated below:

	Anticipated	*Achieved*
Increase in operative productivity	75%	111%
Increase in departmental output	67%	86%
Production and Direct Labour saving	35%	45%
Increase in operative earnings	15%	16%
Labour saving per annum	£4,300	£5,580

Scheme 3 — Comptometer Section

The introduction of an Incentive Bonus Scheme for Comptometer Operators followed the reorganisation of the Payroll and Cashiers Department, and the grouping of all comptometer operators in one section, the most notable feature being the transfer of operators from Stores and Supply Department. The comptometer section provided a service to all works departments, but its main task was the evaluation of Labour Costs and associated accounting functions.

This scheme, introduced in 1946, was based on experience gained at another of the company's works, bonus earnings being calculated on the time saved, i.e. the difference between actual and standard job times. Standard Times for routine jobs

were established over a period of six months; during this time, four experienced operators from the other works assisted the operators who were new to the scheme. Examples of the standard times which include allowances for personal needs, etc. are given below:

Category	*Operation*	*Time in Minutes Per Inch*
Piecework Bills	Calculate	43
	Check calculations	34
	Total to gangs	22
	Check total to gangs	17
Time work Bills	43 shop	43
Weekly labour	02, 23, 36, 65 shops	217
costs spread	Remainder	64
to jobs	Balance Bills to cards	12
Foundry Notes	Calculate weights and value	67
	Extend, sort and clip	64
	Add clippings (sub total)	20
	Grand Total	6
	Summarise and make copy	23
	Extend Foundry	155
	Check Foundry	138

For most routine jobs times are as set originally; however, when changes in routine occur, new job times are established. For new work, or for jobs performed on single occasions only, average earnings are paid.

Comptometer Operators were in three grades, to whom the following basic rates of pay and bonus scale were applied:

	Basic (Weekly) ($39\frac{1}{2}$ *hours*)	*Bonus (Hourly)*	*Average Weekly Bonus Earned*
Senior	46/- @ age 15	9d per hour	50/-
Intermediates	rising to	8d per hour	27/6d
Junior	139/6 @ age 21	7d per hour	15/-

Promotion from one grade to another was based on quality of work, and not on length of service. The total strength of the section was twenty, numbers being roughly equal in each grade. There was a Working Section Leader to each grade responsible for allocation and the general flow of work, with one Supervisor in overall charge. The Supervisor and Section

Leader received a bonus based on the overall average for the section.

The procedure was as follows: Supervisors measured the work, evaluated the standard time, and recorded this against the operator (a note also being made of the time of issue and completion, thus enabling a check to be made on actual time taken compared with the standard for the job). At the end of the week the total standard time for the jobs allocated was compared with the actual clocked hours, thus arriving at the time saved, which when extended at the appropriate rate, yielded the bonus payable for the week, e.g.:

Total Standard Hours	—	61½
Clocked Hours	—	39½
Hours Saved	—	22

Senior Grade @ 9d per hour = 16/6d.

The Quality of Clerical Work

This section must, by the nature of its subject, refer to many other parts of this book, for poor quality work in the office is a reflection of many faults — poor methods, bad form design, unnecessarily complex procedures, bad lighting, etc. The subject is the same but the aspect is specialised to quality, good and bad.

Although all errors are undesirable, it may not be an economical proposition to eliminate them all. By implication, therefore, management must be able to distinguish between important and unimportant mistakes. Action can first be concentrated on avoiding those errors which might lead to serious loss or inconvenience. For example, on a purchase order a minor typing error in the supplier's address is likely to be much less important than a mistake in the quantity.

Why Mistakes are Made

Some mistakes are made in all human activities, and clerical work is no exception. The kind of error which arises from faulty judgment would be outside the scope of this book, for example, the inaccurate assessment of several conflicting factors determining a business decision. We are here principally concerned

with those mistakes that represent the direct result of faulty operation of a routine, in which the opportunity of exercising judgment is, or should be, small. These errors are caused in many ways, and a combination of causes is usually responsible for the mistake, the principal one being difficult to identify and correct. However, many errors are made for four principal reasons, which are not exclusive types of mistake. In practice all of the following may well be involved:

The methods employed are clumsy using operations which are conducive to error, or materials of poor quality.

Staff are badly selected or insufficiently trained and instructed.

The clerk or machine has failed to carry out instructions, or maintain an expected standard. This failure may itself be caused by a poor working environment.

There has been faulty distribution of duties and work.

The usual way of detecting — rather than avoiding — mistakes is to check the work wholly or in part, once or several times. For example, calculation work is usually checked by duplication of effort, by another person doing the job a second time, and comparing the two results; copy typing is normally checked by calling over against the original; a punched card machine operator will check that a batch of cards with a common hole has been sorted correctly by holding the pack up to the light or 'needling' through that hole. Checking and the correction of errors account for a substantial part of the work of most offices. In addition to formal checks designed to find errors at each stage of processing, 'unofficial' checks are often instituted. These are imposed either because the routine check is inadequate, or for reasons of making doubly sure, or because the supervisor is applying some higher standard of accuracy or appearance than was originally thought necessary. A demand for accuracy occasionally leads to the maintenance of records primarily to provide a check on other records.

A survey of the quality of clerical work has, therefore, a dual purpose. Firstly, to raise the standard because too many errors are being made, and secondly to reduce the amount of checking once that higher standard has been reached. When the current standard is thought to be adequate, the aim may be only to cut the checking.

Where Mistakes are Made

Improvement of quality will almost certainly demand changes in method. Therefore the O and M man would be wise to regard quality as one facet of the clerical procedure survey and not as an exercise on its own — even though it may begin as such. In all methods of work he should devise his systems so that he can reduce the possibility of mistakes and cut down the volume of checking without sacrificing standards. He should therefore be familiar with the clerical processes where mistakes are frequent.

Transcription

Copying is a most common source of error; the chances are multiplied if the forms are badly designed. If the eye has to search for the next piece of data to be transcribed, or if the entries are cramped, vague, or difficult to read, errors due to misreading or genuine misunderstanding are likely. Errors of omission are common when information has sometimes, but not always, to be copied on to one part of a form. Figures are prone to transposition even when no calculation is involved — for example, when copying code numbers. An error of plain language may be detected because it is obviously wrong, but a coding mistake can continue throughout a system until the information is decoded — and may not even then be found. The longer the code number the greater the chance of error.

Calculation

This work is generally such a fruitful source of mistakes that it has to be checked completely. When too much mental arithmetic is demanded, fatigue leads to mistakes. The condition of the basic data is important; when figures are not clear or are badly set out mistakes will follow; once again form design can play a major part. Even so, errors are made which good methods cannot prevent. Sometimes the eye transposes figures and adds them correctly to give a false total; at other times there is a faulty association of symbols resulting in a false cast. Some people are much more agile and accurate in dealing with figures than others (as an art, mental arithmetic agility is dying).

Filing

The process of filing papers can range from the simple to the complex. It is one thing to arrange invoices in strict numerical sequence where the number is plain and the documents are of uniform size; it is quite another to file correspondence under a subject index when the person doing so has little or no knowledge of the subject matter. Alphabetical filing is more difficult than numerical, and the decision may be left to the filer as to which of two names in a title is the indicative one. Furthermore, different people may not make the same decision on separate occasions. If there are four firms called 'M. C. Jones' then the possibility of error is correspondingly high.

Coding

In addition to faulty transcription, the coding of information produces further errors. The most common is the misinterpretation of the plain language description, particularly if the case is marginal. Decentralised coding is prone to this kind of mistake, which may be quite random; on the other hand, mistakes made where the coding is centralised are likely to be more consistent. Compilation is of vital importance; in particular, the code should not be unduly detailed and, above all, categories should be mutually exclusive.

In all these processes the routine can be further hampered by an indifferent working environment. Failures in concentration may result from undue noise, indifferent lighting or bad layout of the working area. These matters form the subject of a separate chapter, for they affect matters other than the quality of clerical work, but although a poor working environment can contribute to errors, the morale of the clerk and the calibre of supervision and leadership represents the supreme best. It is management's responsibility (and, indeed, self-interest) to make sure that individuals possess enough specific knowledge to enable the job to be performed to an acceptable standard, and enough general knowledge of the business for them to understand the significance of their own tasks. This applies particularly to those jobs on which the employees' own work will impinge. Adequate training and instruction are essential. That managers do not always state clearly to clerks what is expected of them is demonstrated by the poor appearance of much written work.

Inferior reproduction and bad layout may not be classed as errors, but they can subsequently cause them. For example, the junior girl who is working a duplicating machine may never have been given proper instruction on how to operate it. Work may be slipshod; both time and paper are then wasted, and the system may be blamed unjustifiably. Operational errors can also be mechanical, due to an insufficiently serviced or faulty machine, or to the use of inappropriate or unsuitable machines.

Improvement in Quality and Reduction in Checking

What practical steps can the investigator take to improve the quality of work and reduce the checking in an office? Such a programme should ideally consist of four stages:

Defining the process.
Recording the errors, and studying their cause.
Improving the standards that determine the quality of work.
Reducing the checking.

Defining the Process

An exact analysis of the process is necessary, including all the checks, both official and unofficial, which are made. This would be similar to an analysis for method study, but greater detail may be required on operations where errors commonly occur. Records which seem to exist primarily for the purpose of verifying other records should be noted and queried. The method of checking should be noted in detail, since changes might reduce its cost or improve its effectiveness, and any later modification of checking is likely to affect the procedure.

Recording the Errors

Checking staff may be asked to record errors over a period on a special form. Information is required as to:

The time at which work was done — to establish any variation in the frequency of errors over the day.
The identity of the operator — to ascertain if there is any correlation of errors with age, length of service, education, etc.
The part of the document in which the error occurred — to test the adequacy of form design or methods.

The importance of the error.
The nature of the error.

Such data will yield information as to the incidence of mistakes and the current quality of work. An analysis should give a guide to the corrective action needed.

Raising the Quality

The investigator should aim to eliminate the common causes of error by simplifying the method, by changes in the environment, or by applying psychological or financial incentives. Of these, work simplification is usually the most fruitful, although both the others have their place. Incentives and standards have been described in a separate section, which should be referred to when approaching this problem. A number of examples of method changes which can contribute to a higher standard are given below:

By eliminating or making the transcription of data automatic. By using address plates, pre-punched cards, or pre-prepared masters, relatively static data can be recorded and reproduced at will without the need to reconcile or check detail. Provided the correct plate or other record is selected the information is certainly correct in detail.

By controlling fluctuating additive data as variations from a standard. For example, predetermined control totals can be set up for pay and analysis routines into sections of convenient size. After applying the variations, both temporary and permanent, for the period, the payroll can be balanced to them. The risk — and burden — of processing repetitive deductions can be further reduced by dealing with them as a block figure with controls for each constituent item.

By approximation, or elimination of unnecessary precision. Final figures should not be expressed to a degree of accuracy unjustified by the original data; figures should not be calculated to a greater degree of accuracy than is necessary for the use to be made of them. In cost allocations 'rounding' original charges to the nearest pound, can save time and effort without seriously affecting the resultant accounts. As an example of many variations of the principle of approximation, in general

stores issues, all issues over ten shillings in value may be rounded off to the nearest pound; all issues under ten shillings may be priced at a predetermined constant amount which takes into account any bias in the higher ranges. Another method is to allocate the issue of low value stores to an overhead account, and avoid the pricing of the requisitions. Cost or sales codes should be examined to see whether they are unnecessarily complex for the uses made of the summarised figures. In general, discrimination in the amount of detail recorded can reduce the probability of error.

By helpful form design. The earlier section on this subject has indicated the extremely important part that form design can play in improved methods. Where transcription cannot be avoided, careful design will make copying easier and less liable to error.

By using ready reckoners. Wherever calculations are repeated this equipment should be considered.

By the use of check digits for checking calculations. This is particularly suitable when transcription is to a punched card or tape as material for a computer or calculator. For example, a check total can be fed in to test accurate machine reading of the punched data.

Reducing the Checking

Intermediate and duplicate checks may be avoided by selective checking, or by sample checking, the first of which ought to be inherent in the method of simplification. For example, the accuracy of both calculations and copying can be tested by a mathematical check of the figures on the copy. Selective checking presupposes that errors throughout the process are not usually of equal value. Attention should be given to that data which is vital and should be fully checked. The checking of all purchase invoices can be reduced by restricting the arithmetical check to those above an agreed value, for random errors in the arithmetic of the unchecked items tend to cancel each other out. Sample checking can be used as a means of retaining control over quality, to ensure that a deterioration is quickly detected. It can be applied in the absence of any other test if the work is normally of acceptable standard, or after a

Normal check if there is some doubt that the latter is fully effective. Normal sampling techniques are used, and some expert advice on the choice and size of sample is normally advisable. Finally, quality is difficult to improve if multiple checking is retained. The existence of a check tends to detract from the original operator's sense of responsibility for the quality of his work — a sense that should be encouraged.

In conclusion, what might be described as elementary office management can play its part in maintaining the quality of work and minimising mistakes. If frequent peaks and troughs of quality are the rule, then errors will be difficult to eliminate. If the flow of work to an individual operator is erratic, then he or she cannot achieve that steady rhythm which reduces mistakes. Fatigue is a likely cause; the good manager must realise this and do his best to avoid the rush of work which leads to it.

Job Analysis

This section is concerned with Job Analysis, and the various uses which can be made of this particular technique in an O and M investigation. Since the various terms used are liable to misunderstanding, the following definitions are given:

Job Analysis. The breakdown of the job into its various component parts, e.g. tasks, duties, relationships and responsibilities, entailing the detailed study of this breakdown and all that is involved in it. The method of analysis will depend on its ultimate purpose.

Job Description or Specification. A tabulation of the various duties involved in a job, usually including other items of information which have been extracted during the analysis.

Job Evaluation. The determination of the relative values of job, which can be used as the basis for the construction of equitable salary or wage levels or ranges.

Merit Rating. The determination of an employee's personal ability. It must be stressed that Merit Rating is concerned with the individual performing the job, whereas Job Analysis, Job Specification and Job Evaluation are concerned solely with the job itself.

Uses of Job Analysis

Although this chapter is primarily concerned with Job Analysis as a technique of O and M it is important to be aware of the other uses to which it can be turned, and to realise the wider implications of this particular type of study. The various uses of Job Analysis are:

As an aid in the study of methods.
To assist in the grouping of related tasks and in the clear delineation of responsibilities.
As a basis for Job Evaluation and subsequently salary and wages administration.
As an aid in determining the type and quality of staff required.
As an aid to planning career development.
For training purposes.
As a basis for personnel records and statistics.
In conjunction with Merit Rating, to ensure that staff are being used to their maximum ability.
In conjunction with Merit Rating, to assist in determining which staff are best suited for promotion.
To fill in the details of the structure of an organisation which is outlined on an organisation chart.

It will be apparent from this list that Job Analysis can be performed as an aid in an O and M investigation or to assist Personnel Administration. Since a survey of this nature may involve a great deal of effort, the basic information derived from the study should be used for as many purposes as possible. The basic analysis carried out in O and M work is closely related to that carried out in a Job Evaluation survey, and close liaison is desirable between the O and M and Personnel functions.

Job Analysis and Job Description

The scope of a Job Analysis study and the amount of detail required in it will depend on the use intended for the analysis. In all cases it will be necessary to determine and list in the Job Description the various duties involved in the job. Usually the percentage of time spent on each duty is estimated and listed. The duties may also be classified into 'routine' or 'daily', 'periodic' and 'irregular' or 'infrequent'.

In addition to a description of the various duties involved in the job, it may be necessary to study all or some of the following factors, which may be required for the job. These may also be used as the basic factors in a Job Evaluation Scheme. They are here listed, together with examples of some of the questions which the investigator might ask in this regard:

Education — the basic scholastic requirements. Are staff being used of the requisite educational standards? Are they finding the job difficult because of inadequate education? Are highly educated personnel being wasted by performing routine clerical jobs? Can work be reallocated between jobs to achieve this balance?

Training — the formalised training required. Is efficiency being impaired by inadequate staff training? Would a formalised training programme be profitable?

Experience — the length of experience required, and in what types of work. Have staff sufficient experience? Are experienced personnel being wasted?

Mental Effort — the degree of mental effort or concentration required in the job. Can the amount of mental effort be reduced (e.g. by introducing machines, or other office aids such as ready reckoners)?

Complexity — the complexity of the job. Can the job be simplified? Can less experienced staff be used if it is simplified?

Initiative — the initiative, original thought, or ability to make decisions required. Are decisions being made at the correct level? Has delegation of authority been carried too far, or not far enough?

Supervision — the number of employees supervised. Is the span of control too wide? Is the ratio of supervision to operatives correct?

Responsibility — the responsibility for cash or equipment. What would be the cost of any errors made? Are there sufficient, or too many checks?

Confidential Information — the access to confidential information regarding the company or other employees. Are security measures adequate? Is the information really confidential?

Contacts — the contacts involved in the job. Are these

confined to the section, or are they with other departments or companies? Do the contacts involve discussion or persuasion? Are the best methods of communication being used? Is there too much 'committee' discussion?

Working Conditions — the factors which may impair efficient working. Is the work affected by noise, fumes, dust, dirt, etc.? Can these conditions be improved? Are the working conditions restricted in any way? Can the office layout be improved? Is there any pressure involved? Is this pressure constant or subject to peaks? Can these peaks be eliminated? Does the job require close visual attention? Is the lighting up to standard?

Job Evaluation

Job Evaluation surveys are usually carried out by trained Job Analysts who either belong to or are attached to the Personnel Department. In small companies these surveys could well be carried out by O and M working in conjunction with the Personnel Department or, where the latter does not exist, with line management. In some companies Job Evaluation work is used as a training ground for future O and M personnel.

The logical sequence is for Job Evaluation work to follow O and M investigations. The Job Analysis work carried out in the O and M investigations can then be readily used for evaluation purposes. Otherwise, if Job Evaluation precedes O and M studies, the subsequent changes in methods and job contents could well mean considerable re-evaluation.

Job Evaluation is a specialised subject, outside the scope of this book, but a brief description of the principal methods used may be helpful. They are as follows:

Ranking. The Ranking System merely involves the direct comparison of one job with others to determine their relative value or importance, i.e. rank.

Factor Comparison. The first step is to draw up a Job Evaluation Scheme or Factor Manual which consists of a number of Factors (such as those described above). The evaluation is carried out by comparing jobs, factor by factor, to determine their relative value and importance.

Points. The Points System is the most detailed and accurate

system and is probably the one most commonly used. As with the Factor Comparison Method, a Job Evaluation Scheme and Factor Manual is drawn up, consisting of various factors which are further divided into degrees. A weighted points system is then applied to each factor, depending on the type of survey being carried out (e.g. shop floor labour, clerical or managerial). The evaluation is carried out by analysing the various factors and determining which degree of each factor is applicable. The appropriate points are awarded to each degree and the total points value for each job calculated. The jobs are then ranked in points value order.

In all the above methods, the object is to determine the relative importance of jobs, which can then be positioned on the wage scale or grouped into salary brackets. The wage or salary arrived at is the basic rate and does not include merit awards.

Job Evaluation can be used in conjunction with Merit Rating to determine the abilities of employees relative to the requirements of their jobs. In this way a useful estimate of the potential of staff can be obtained.

CHAPTER VII

THE MANAGEMENT OF O AND M WORK

In the preceding sections and chapters of this book some details of the work of O and M have been discussed, together with the methods by which it is carried out in a number of companies. We now pass from the content of the work to the direction of O and M from above, and to a description of the mechanics of the management of staff and day to day work. This chapter is divided into five parts: setting up an O and M department; selecting and training staff; managing; the place of O and M amongst other headquarter's services; and finally, the need to justify the work in terms of results.

Setting Up O and M

Starting this work for the first time presents a variety of problems. Seldom can any company copy what another has done with much hope of success, since though that pattern is working quite well, it does so under different conditions and in a different organisation. In the nature of things each company will set up its own department differently. Top management will have their ideas on how it should be formed and the place it should take; a department head will have his own ideas on how to run it; each company will require different services from it; and these forces will help form a unit different in some respects from that in other concerns.

In some companies O and M will not be formally constituted at all, but will just evolve. Probably an established department in the office or factory will develop some sort of efficiency service. For example, this may result from the allocation of staff by the accounts department to study efficiency as part of an audit or as a separate activity; or as a result of calling upon the work study unit from the factory to look at an office machine installation, from which its activities may spread to other office territory. In this evolutionary approach O and M develops

from some other activity after having gained some experience. If and when this occurs, the staff in question are usually hived off from their original department, renamed O and M, and put under the director of administration, or his equivalent.

When an entirely new department is started it is bound to differ in various particulars from those of other companies. Nevertheless, certain fundamental questions common to all will be met. These may be grouped together under the following headings:

Sponsorship.
The Power of the Unit.
Selection of the Executive to whom O and M should report.
The Climate.
The Commencement of Operations.

Sponsorship

The importance of authority is great, and if the project is to flourish and be accepted and respected from the first, the department, although itself advisory, must be set up authoritatively — under, say, the director of administration, the chief accountant, the commercial director, the personnel director, or the managing director. The actual official does not matter, provided his authority is explicitly extended to the unit.

Consideration of some examples may help. In company 'A', an O and M department started as Office Services under the office manager, who himself came under the chief accountant; wherever Accounts had authority their O and M shared such authority, sometimes beneficially, sometimes not. In company 'B', the department started off with full authority under the commercial director and gradually gave up that authority in order to take advantage of the potentially good relations enjoyed by the adviser. In company 'C', where the work was mostly factory-paper methods, latterly changed to office methods, an administrative management department still reports to the managing director. In company 'D', the O and M unit was largely intended to study and improve upon methods of management, and quite rightly therefore the department was started and has remained under the general manager (administration).

In each of these cases some authority was gained at the start

by virtue of the power held by the executive to whom the new department reported, but the remaining authority has since been gained by the staff themselves through the merit of the advice and help they gave to other departments. It is important that O and M should come to be seen as a service to other departments, and not as an imposition to be borne.

The choice of the function with which it is to associate, particularly in the initial stages, is less important than the choice of the head of that function. Therefore, if there is a strong commercial director — not only in that his function is strong, but in that he is an executive of strong and promising personality — he may be the right patron; alternatively, a strong accountant, or any other executive, could be chosen who will use his influence to get things started. An executive whose duties take him into most parts of the business has an obvious advantage over some others. Patronage, however, must be temporary. O and M must stand on its own feet as quickly as possible.

The Power of the Unit

How much power should the O and M unit have, both of its own right, and also indirectly from reporting upwards? The problem is one of equating authority with responsibility. A line executive's job is to get his work done. Therefore, if a service or agency is to be given the power to tell an executive how to do his job, but is not to be held finally accountable, the executive is given a useful alibi if things go wrong. If, on the other hand, the service has no direct authority, how can unreasonable opposition be overcome?

Some companies overcome this difficulty by giving the unit executive responsibility in specific important instances, and for a limited period. This is defensible when a fresh activity is being planned — particularly where new and complicated techniques are involved — since O and M may know more about the new routine than any executive, and should therefore accept a responsibility which will be handed back when reverting to its orthodox role. In one company, O and M has executive authority for sanctioning changes in departmental establishments arising from the development of clerical work measurement and financial incentives.

Despite these exceptions, the department should normally be advisory only; this means that, having no authority of its own, O and M must convince the appropriate managers that the proposals suggested by the service are not only acceptable but necessary. Acceptance can spring from several factors — conviction based on logical argument; genuine trust resulting from a past record of good advice; even agreement based on discipline or loyalty. Proposals must not be accepted under duress, for they may then well be practised with a reluctance which will probably result in their being discarded.

The problem of rejection of, or passive resistance to, good advice tendered by an O and M unit possessing no authority of its own is a very real one. O and M must expect to find its views challenged, should welcome a sensible and vigorous defence of current practice, and must not attempt to wield authority to enforce acceptance of its advice. The number of cases where there is complete deadlock should be small; but each one is in itself a criticism, since differences should never be allowed to develop to such extremes.

Selection of the Executive

As already suggested the precise place of O and M in the company will depend upon the duties assigned, and on the relative importance of executives available. If, for example, the general effectiveness of the executive machinery is to be reviewed the authority should proceed direct from general management. The advantage of reporting to the managing director, chief executive or general manager is that he is responsible for general efficiency, and being freed from departmental duties, should be able to ensure that the most suitable activities are studied. He should also be in a position to arbitrate when recommendations affecting senior staff meet with resistance. The disadvantage is almost solely one of time. Naturally, if activities are to be limited, the need for reporting to general management would diminish. For example, if the department's 'remit' was

> 'to review and improve the efficiency of organisation and methods of clerical work by giving advice on the way improvements could be made and helping in the planning and design of new work',

then the service might well be made responsible to a manager

whose function embraced the majority of the clerical work. Alternatively it could report to a small committee whose members collectively held the same responsibility.

If a company finds itself large enough to set up O and M, the problems are likely to be sufficiently diverse to warrant the service being an agent of general management. Also, expansion may result in departmental objections which are mutually conflicting and inconsistent with the best interests of the business as a whole, since the policy most favourable to one is seldom most favourable to all the others. Conflicting practices arise which can only be reconciled by impartial appraisal by some agency free from any sectional interest. If this is to be made by O and M, it may be unwise for the unit to report to an executive responsible for one particular function, however highly he may be placed in the organisation.

Plainly, management's intention for the career of the O and M service should offer the prime indication of the person or office to whom the unit should report. If this intention is vague the development and usefulness of the service can be hindered or stopped. The unit should be so constituted as to enable it to gather skill and experience; management will soon trust and use it on more complex problems. If the intended use changes, responsibility for O and M may also have to be changed.

Outside consultants usually report to the Board, the chairman, the managing director or some particularly highly placed executive whose power and influence can ensure that responsible recommendations are implemented.

The Climate

Great care must be taken to avoid creating any unnecessary resistance to the O and M service. Many managers will have been too fully occupied to study records and methods objectively. Thus, unless they are conscious of the obvious inefficiency of some part of the machine, of delay in results or of the antiquated character of some method, they may be quite content with the existing state of affairs. Their interest may, however, be aroused if they feel that increased efficiency in their department would register to their own credit; they may be delighted if they are reasonably sure that reorganisation will lighten their own work. But if these advantages are not apparent

their cooperation may be only tepid. The strategic placing of the new group, the authority which it is given or lent by virtue of the power of the executive, and the decision as to whom it will report, assist greatly to encourage the service; but positive and spontaneous support may still be required for the successful launching of the enterprise.

Consider the actual case where a managing director wanted to set up an O and M service, but was fairly sure that some of the older members of the staff would not approve of it. He considered that there would be an advantage in bringing the opposition out into the open and 'stealing their thunder' before they had time to organise. He therefore created a committee, of which he was the chairman, featuring both progressives and reactionaries, whose terms of reference were to consider how an O and M unit was to be employed, its scope, duties and methods of work. At the end of the first meeting, which had accomplished little, he informed them that he had decided to send the head of O and M to another undertaking for a year to be trained and apprenticed, so that on his return he would command a hearing. Shortly before the year had elapsed he recalled the committee, and suggested that to overcome the difficulties encountered at their first meeting the head of O and M should, on his return, be given the duty of preparing a report outlining his proposals for the terms of reference and methods to be used by the new department. When the report was made it did not take long to discuss, and most of the recommendations made showed such obvious common sense that it was rapidly agreed. Any questions concerning the working of the department during the next five years were immediately referred to the agreed report, to which there could be no objection unless circumstances had since changed.

In another example, the Board of a company had decided on a wide programme of reorganisation to catch up with developments that had taken place in other countries during the war years. An O and M unit was created to act as the agent of the Board in implementing the various proposals for reorganisation. This gave them a very good start, particularly as they learned to temper the great authority of the Board with considerable discretion and so meet any temporary objections expressed by those affected.

In order to perform its function effectively, O and M must have a position of respect if not authority, sufficient in itself to open doors and secure careful attention for its views. Those in the department must be able to sell their services and never have to impose them. But too much authority at the outset may present dangers, and has been known to lead to failure. As an example of this, a company employing very large numbers set up an O and M department under work study, who had already made a reputation for considerable reductions amongst operational staff. This new group was thought to be another example of efficiency through staff economies. O and M, christened 'The Razor Gang', became the victim of non-cooperation and after some months was disbanded.

In another example, a city corporation, in common with other local governments, set up an O and M unit under the Finance Committee, where members were 'out for blood' in the form of financial savings. This is a parallel case to the last, but because of the extreme care taken by the Clerk of the corporation the new department did not share the fate of that mentioned above. The Finance Committee had ordered O and M to show a saving within three months which would exceed its own payroll and expenses. The Clerk concentrated their activities on supply services. A particular service required a drastic overhaul in its outside contracts, and the staff of the corporation generally agreed that the economy achieved was excellent and the cuts in expenditure were justified. The Finance Committee was satisfied, and forgot about the new department for about a year, during which time it was able to build up a reputation for careful and helpful advice without antagonism.

The Commencement of Operations

Finally, the new department must make a good start. The method of launching a new manager and his staff may present a problem, even if they are already known and respected, and are not likely to make mistakes on their first assignment. Some preparation, such as the creation of the committee mentioned above, may be necessary. The executive who is responsible for the new service might explain to his colleagues what he requires from the new department. He must somehow then procure an

invitation for O and M to come and attempt a job — but great care will be needed to ensure that this first assignment has not already defeated the management. Preferably it should be a job which is almost certain to yield some saving in effort and work — rather than staff — which can then be publicised to encourage other offers of work, if possible of a similar character. The main task of the new department is to acquire a reputation of being helpful. This will depend on:

The choice of the assignment.

The handling of interviewing.

The goodwill of the department serviced.

A further useful activity may also be assigned — that of drafting a list of duties for each department for approval by the managing director. This gives a useful responsibility direct to the managing director, and puts O and M in the picture on matters affecting changes in organisation, and possible duplications. In some companies the department is also given certain executive duties, for instance that of serving on a staff committee appointed to approve new posts. This work has two obvious values, the one, already mentioned, of putting O and M in the picture, and the other of bringing it before the attention of management generally. It is usual for some committee to consider all increases in staff, and in one company O and M provides the secretary to that committee, and is thereby enabled to keep a finger on the pulse of the organisation. In another company O and M is put operationally in charge of Central Office Services, accommodation, typing, filing, etc.

The department should quickly be recognised as being not only a service to other departments, but also in itself part of the management. Thus it may be concerned with standards of performance, and similarly with standards of accommodation and establishments. If this work is well done O and M may become a useful arbiter in addition to being a valuable help in organisation, management, or matters of procedure.

Conclusion

Little will be gained by copying what someone else has done, for each company will set up its department differently. How, by whom, and under whose auspices it is set up depends upon

the individuality of the company concerned, the resources it possesses, the availability of staff, the background and training those staff have already had and, to a lesser degree, upon the proportion of management to workers. The important thing is to set it up with indirect authority, possibly under general management, who can in extreme cases be called upon to act as a referee. Each company will require different services from O and M; needs are bound to differ. Some will want advice on organisation, some on management, some on methods. A very few will shift the emphasis from one to the other. And each O and M will have its own period of trial and error. The nature of the department in each company must again depend upon the scope which is to be permitted for O and M.

An O and M service should be advisory and should have no direct authority of its own. Otherwise it simply becomes another executive unit superimposed on the existing framework. Such action will bring to the surface all the human problems of divided responsibility. There may occasionally be a case for giving direct authority for a limited period to achieve a limited objective, in particular, where new techniques or new work is involved. Even here the disadvantages may well outweigh the advantages. The personalities, experience, ability and acceptability of the O and M staff are, in practice, of greater value than any indirect authority however highly placed. The principal object is to give good advice, and to get it accepted willingly and cheerfully.

Selecting and Training Staff

A question which immediately follows the decision to set up an O and M department, is that of staff. What is the best way to go about recruitment? Should the staff be drawn from inside the company or not? What are the qualities to look for in an O and M candidate? How shall he be trained? These are not easy questions to answer, for recruitment has been and still is difficult, and there are as yet no really practical training facilities available. Most O and M departments have staff who have had experience in some other company and to this extent the situation is good, for a variety of experience is of very great importance in this work. Obviously where mechanisation is

employed for the first time no inside staff can be expected to have experience of value. Later, as developments take place using automation and electronics, the emphasis on training inside staff becomes very important. Apart from this not all companies necessarily have people suited to this work available for transfer. In the smaller company a case could be made for appointing consultants to launch O and M on its first assignments and to train the staff.

Recruitment

Any company starting O and M work has these questions of recruitment to face. Once the service has become established it becomes, though never easy, less difficult. The chief problem is to find the right person to launch the service and keep it on the right lines, for the man who runs it may need to be of a different calibre from those he recruits.

The advantage of the outsider for the job of O and M manager is that he is less likely to be blinded by his own experience. He may be able to see the organisation completely impersonally, impartially and dispassionately. On the other hand, he is unlikely to know the company background and atmosphere. He may go too far and too fast. He may want to slash procedures or organisation that have become hallowed by tradition. The Chinese philosopher, Lao Tzu, is quoted as saying, 'Govern a large country as you would cook a small fish — slowly, gently', and this equally applies to the new O and M man, especially if he has been brought in from outside. One of the advantages claimed for the man from inside is that he is unlikely to chase half-baked ideas — one of the accusations against the outsider. He may, however, suffer from the limitation that he works in blinkers on matters where much is taken for granted, and therefore lacks the inquisitiveness to challenge accepted practice.

The main factors likely to influence the choice of personnel are the work to be done and the qualifications and personal qualities of staff available. In the first instance choice will be influenced by such things as:

The terms of reference of the O and M unit; whether they are to be largely O or mainly M.

The present size of the unit and availability of experts.

The kind of O and M or other experience needed (this requirement may change).

The length of time to be served in O and M.

For the most part selection will be made for what is called general practitioner work — the object being to recruit a man whose personal characteristics will respond to general training, even though specialisation may be necessary later on. Sometimes, however, staff may have to be selected with specific and relatively narrow objects in mind. For example, a varied experience on punched cards or other integrated data processing techniques might be required. The more important personal qualities of such recruits are:

An analytical and constructive mind which is interested in problems, their isolation and solution, combined with the ability to express ideas clearly.

Curiosity, powers of observation, sound judgment and abundant common sense.

Resolution and controlled enthusiasm; the ability to persevere in the face of difficulties, to study detail without loss of interest, and to wait a long time for results.

More than ordinary tact, a sense of humour, persuasiveness and social acceptability.

Imagination and initiative, with an ability to work as one of a team.

A degree or other professional qualification as some measure of the training of the mind in thinking and dealing with ideas.

An interest in other people and a sense of fair play.

An interest in productivity, efficiency and modern methods.

An interest in things mechanical without the urge to mechanise for its own sake.

The right personal qualities are often more important than previous training and experience. Lack of experience can sometimes be remedied, but failure of the human touch or of behaviour cannot.

Training

The small size of many O and M units makes training on the job difficult. To become a good practitioner in his own company the new recruit requires knowledge about:

Company background — purpose, organisation, personalities, and general practice.

Management — requirements, policies and controls.

Clerical work — present organisations, common clerical procedures, supervision and control techniques.

O and M work — possibly the contents of this book.

Until practical O and M training is established some help may be gained:

By attachment to a well-established service in a larger concern.

By attending full or part-time courses run by local authorities, industrial consultants or by other companies.

By training courses run by the manufacturers of machines and equipment.

Periodic training courses on general or specific subjects run by the unit itself can be helpful. These are not easy to initiate and harder still to prepare. On-the-job training comes best from senior men passing on their experience and knowledge to others. The 'apprentice' method is widely used. For example, an experienced man might run a team of which the novice becomes a member. In some departments which implement their own advice new staff are employed on the work of implementation of someone else's recommendations. Alternatively, an attachment might be made for a specific assignment and a transfer effected to another senior man when that job is finished. If the unit is geographically scattered, the novice can be moved about to gain experience of local problems. Always, however, a senior man should be guiding and teaching each new man, for training is a continuous process. Some companies call all departmental staff together periodically to hear how different assignments are progressing and to learn from one another.

Other sources which should not be overlooked are:

Textbooks and magazine articles.

Professional institute meetings.

Visits and informal contacts with fellow O and M men in other companies.

Dissemination of case data within the O and M department itself.

Apart from the training given by O and M to its own staff, an additional duty often imposed is one of helping the management

to keep organisation or methods and general efficiency constantly in mind. Many large companies now hold annual management conferences, or even residential management courses for senior members of their staff. In several of these cases the O and M Department, although behind the scenes, is heavily used to prepare the subject and to write the briefs for lectures. Some companies feel that proper training in personnel management and in organisation study is an essential part of the development of any manager. Thus, any good O and M department should provide for a fair number of trainees staying for two or three years only as part of their management development. This assumes that the broader issues of organisation are included in the O and M 'remit'. Most of the success of this work will depend upon the personal character of the head of O and M and, a point already stressed elsewhere, on his being obviously recognisable as part of the management himself.

The Career Question

How long should a man stay in O and M? Should the work offer a career in itself? Implicit in the personal attributes and training is the possibility that a successful O and M man is likely to be a successful manager.

The departmental manager must always be prepared to release members of his staff to other parts of the business. The urge for movement will come from outside as well as from the staff itself. Experience so far suggests that only the specialists in machinery or equipment want to stay in O and M for the rest of their working lives. But any stay must not be too short. Two or three years is not really enough. The optimum period is between five and fifteen years depending on the individual and the business, but there will of course be exceptions.

To sum up, recruitment becomes less difficult as O and M matures. A judicious mixture of men from inside with new blood from outside may be helpful (the latter should always be given a prior period of general instruction in company objectives and background). At all times, great care must be taken in selection, firstly because relatively few possess all the qualifications desired, and secondly because a wrong choice can upset other departments and the O and M department itself. The

door should be kept open to permit the transfer of staff in and out of the department.

Managing O and M

The day-to-day organisation and management of an O and M department should be delegated to one man. His main duties are:

Receiving and arranging for new assignments; arranging terms of reference and the boundaries of assignments.

Making surveys, planning, programming, controlling the assignments, dealing with difficulties; himself taking on major assignments.

The continuous lookout for specialist knowledge of organisation, management, office methods, machinery and equipment.

Encouraging, managing his staff, and giving them any necessary support.

Training new staff.

Managing the Work

Receiving and Selecting Assignments

What is the most fertile field to cultivate? Should it be that offering the greatest potential savings, or the improvement of the service provided by the office? Savings may well materialise as a result of an improvement in office service. Thus accounts may be collected earlier, or management decisions may be facilitated. Office assignments should therefore be directed towards the service as much as towards savings, but there will be occasions when both can be combined.

Assignments will come from three sources — from top management, from departmental heads or others, and from selection by O and M. Various reasons may motivate a request from management for an enquiry, and some of these may be:

To work out organisation or methods for a new job.

To reduce costs, or to make the work of its management easier.

To prevent or reduce errors, or to improve the service.
To 'put out fires'.
To tighten up security.
To speed up information to management.
To reduce demands for staff with special skills.[1]
To provide information in a neat and legible form.
To test new machinery or equipment.

As soon as a new O and M department has made a name for tactful and helpful service, work will flow in. In many cases a satisfied customer will tell his colleagues about the service he has received. Whatever the source, the demand for service may exceed the supply available, and requests for assistance may be received on matters which are either not within the province of the department or relatively simple problems which should be solved by local management. O and M should not do the work of executive management and any tendency towards this should be checked at the risk of temporary unpopularity. Difficulties can sometimes be avoided by discussing problems with the management concerned, suggesting that if they put up proposals, O and M will help with comments and suggestions.

As soon as the order book for assignments shows signs of permitting a choice of work, this opportunity should be taken. Experience shows that the most attractive assignments in terms of potential savings are likely to be difficult to investigate or improve. Much will depend on the skill and training of the O and M staff; at first they may be better employed on simpler jobs, though the savings are correspondingly less. If managements are not ready to decide on the nature of the early work, form design can serve as a point of entry, because of the economies possible not only from redesign of the forms, but of the methods behind them.

The best place to start an assignment is difficult to determine. The decision will have to be based on:

The experience of the staff available.
Knowledge of weak points in the organisation.
A survey of extravagant activities where savings are worth having.
The readiness of a particular executive or department to take stock of his or its own efficiency.

[1] See also 'Job Analysis'.

Assignments also arise for other reasons. For instance, a new technical development in which the company is interested may suggest a survey being made, to see if it has a suitable application in the business as a whole. New work can also arise directly from domestic responsibilities. Some O and M units have to approve all demands for office machines. By doing this, they obtain advance knowledge of new projects. Similarly, some departments are given executive control over the design of forms and the initiation of new forms. Either of these duties may become time consuming and may therefore have to be avoided. Apart from new work, past assignments should be followed up by periodic audit, or by association with another department in a permanent consultative capacity.

There is no hard and fast rule for selecting assignments. Depending upon how and why the department was set up, these may come from any quarter. Higher management may wish to draw up an outline programme of work in consultation with the appropriate executives, and leave the timing of the individual jobs (within broad limits) to O and M, but this complete review of the business does not often take place.

Planning, Programming and Controlling Assignments

Every assignment needs to be planned in some degree. The preliminary survey provides an opportunity for sketching out the shape that the assignment will follow, and for planning very broadly the number of staff who will be required and the amount of time that will be taken. Because assignments are concerned with some work that was not originally foreseen and covered in the terms of reference, any planning or programming has to be elastic. Some companies use Gantt charts for planning assignments in detail, because the existence of the chart serves to encourage objectivity. Others use weekly or monthly meetings of staff where the development of assignments is discussed; these have a further value of permitting the re-planning of assignments as new difficulties arise.

The director or executive to whom the department reports may require periodical reports, orally or in writing. Preparation for this session requires a review of the progress of major assignments, and provides an opportunity for the department head to keep all assignments under control. The degree of control will

be similar to the degree of planning possible. This must be flexible because of the variety of methods, management or organisation problems that arise during a major assignment.

Completion dates of stages of the assignment and of the whole assignment should always be estimated, and at control meetings help can be given by attaching an extra man at certain stages where detailed work is falling behind. The section on 'Conduct of the Assignment' has suggested a number of stages which will form control points.

Every investigator is recommended to plan his own work, even if he does not have to submit a plan of that work to his chief. So much time can be spent on chasing red herrings or drafting and redrafting recommendations that the existence of a plan is valuable as a means of self-control.

Whereas all O and M staff must be fully convinced of the need to do their work thoroughly, they must also be constantly aware that the O and M service is expensive and that they must not embark upon unnecessary surveys or other unjustifiable expenditure. Some companies cost each assignment very closely; others make no attempt at detailed costing because of the imponderables that are involved, but review each assignment in the attempt to ensure that the department is still doing a worthwhile job. Another section deals with the justification of the O and M service.

O and M, like most advisory services, will sometimes find difficulty in getting its advice accepted. Every attempt should be made by the department manager to keep in touch with whoever called for his help, in order to maintain interest in the problem and its solution. Despite this the occasion will arise when the advice to be offered is seen to be unacceptable. The O and M manager will then have to decide whether to withdraw, or continue the assignment to the point where recommendations will be made that he knows will be rejected.

Dissemination of Information

The management of O and M should keep outside staff informed of company developments that may affect organisation, and in addition let them know about new developments in O and M experience or equipment. Some reference has already been made under 'Training' to the need for drawing

attention to useful magazine articles and books; a worthwhile service to be provided by the O and M headquarters is that of 'digesting' publications to save the time of the staff. This can be covered by including an item on the agenda of departmental meetings referring to 'recent publications of interest'; another useful item is 'recent developments of experience'. Staff are asked to draw one another's attention at the meeting to anything interesting or practical that they have encountered.

Encouraging and Managing Staff

As already suggested, O and M staff often find themselves working under unfamiliar conditions. Whereas previously they have worked under fairly close supervision, when they come to do assignment work they may be on their own. The manager of O and M must, therefore, give considerable time and thought to backing up his staff. He must arrange for team leaders to see them on the job at least once a week, to discuss problems of work that have arisen, and to intervene where necessary. Any complicated or technical assignment tends to develop in the investigator some personal bias which will need to be removed from any recommendations that have to be made. The O and M manager has to do this, with the agreement of the investigator that any alterations are still supported by fact.

Most O and M staff carry between two and four different small assignments simultaneously. This prevents a man from stagnating in any one of them, and covers dead periods when the man to be seen is on leave or too busy. Too many different assignments can strain an investigator badly and this point, of range of attention, must be watched.

There is little further general advice that can be offered except that the closest personal contact must be kept with staff during assignments, particularly with those at a distance It is necessary to mix with the rest of the team; consult colleagues and chief, and thus prevent the personal difficulties that arise from the over-exercise of critical faculties and from working alone. It is likely that control can best be maintained when the senior men in charge of assignments are given the maximum freedom of action and are asked to do the minimum of formal reporting. It is usually better for the manager to seek out the project leaders and discuss the projects, rather than that they

should be required to report formally to him. O and M work demands resourcefulness and common sense; these qualities should not be called in question by an undue emphasis by the manager on formal control.

The Place of O and M

Where does O and M come in the management hierarchy? It exists not only as a management tool — as an agent of top management — but also as a service for managers, auditors, or others who need it because they have not themselves the time or the necessary expertise. This dual purpose of agent and service makes the position difficult. In some companies it is all agent, in others all service, but somehow both roles need to be combined. There are widely differing views not only about the content of O and M, but also concerning its relationship with other techniques concerned with improving effectiveness and efficiency. Before it can do this properly O and M must itself be efficient, achieve coordination with other departments who have an interest in efficiency, and solve its own problems.

What precisely is this efficiency, and how can it be assessed? Unfortunately, it has no exact meaning except in the world of mechanics or physics. There is personal efficiency, technical efficiency, managerial efficiency and so forth; and over and above these is the efficiency of an undertaking seen as a whole. The underlying concept is that the output is somehow to be related to the input; but this is all very difficult to define, and even more difficult to measure. Efficiency is, in fact, a state of affairs, not to be sought for by itself, but a by-product of correct action in all the relevant fields.

Efficiency, whatever it may be, can hardly be subjected to audit, or assessment in the ordinary sense, yet this must be done if large scale undertakings are to be assisted by setting up an internal agency or agencies charged with this responsibility. The greatest value to be derived from efficiency studies is the promotion of a state of efficiency-mindedness. Efficiency is only really produced when it becomes an attitude of mind in every single person concerned with the undertaking. Like liberty, it is one of those conditions of affairs which can be assured only by eternal vigilance, and is not something that can

be produced once and for all by the formulation of rules or the introduction of new methods.

It is unwise and wrong to deal first with the efficiency of those responsible at the higher levels, on the grounds that errors of staff administration, for example, have an important effect on personal efficiency throughout the whole company. Obviously there is the temptation to say that if only these matters can be put right everything else will come right of its own accord in due course. In spite of this temptation, an efficiency study should begin lower down. Its first task is to ascertain facts, not to argue about the workings of policy. Of course, if manifest and serious inefficiency continues at middle and bottom levels, it may be due to inefficiency of policy at the top, and drastic action may be indicated.

The departments concerned with this work may be from one to five in number, according to the size and complexity of the business; because this book is concerned with O and M this is taken first. The five, together with an outline of their usual functions, are given below:

O and M

The examination of the structure of the organisation under review. The studying of administrative and clerical procedures and methods, office mechanisation and equipment, office layouts and working conditions.

Work Study

Systematic activities concerned with the investigation, recording, measurement and improvement of the following work factors:

What the operator does.
The machine and equipment used.
The materials.
The working conditions.

Operational Research

The scientific approach to, and analysis of, problems in an organisation to provide management with information for obtaining its most effective overall operation.

Internal Audit

Sometimes only an arithmetical check of all accounting records for internal control, but sometimes widened to cover:

Reviewing and appraising the soundness, adequacy and application of accounting, financial and operating controls.

Ascertaining the extent of compliance with established policies, plans and procedures.

Ascertaining the extent to which company assets are accounted for and safeguarded from losses of all kinds.

Ascertaining the reliability of accounting and other data developed within the company.

Appraising the quality of performance in carrying out duties assigned.

Personnel

The recruitment and interviewing of staff, their maintenance (which includes allocation to work, job analysis, training, welfare, etc.) and their leaving, either with pension or otherwise. The link with efficiency for Personnel is on Job Analysis, on work load and manning, and on training. Frequently it is for O and M to tell Personnel the precise nature of the work to be done, and then for Personnel to provide the staff to do it.

Qualities Required

To distinguish accurately between the duties of O and M, Work Study and Operational Research may be difficult, but the differences between them may emerge more clearly from a listing of the qualities of staff required for each.

O and M

The O and M man must have as wide a knowledge as possible of office methods, equipment and machinery. Proven practical experience in the problems of office organisation and administration is desirable, and junior staff must at least be sound in theory. His standard of thinking should be as good as or better than that of the man whose job he is studying.

Work Study

The Work Study man must be experienced in production engineering, since the study of manufacturing operations will form the main background to his work. He must be well trained in method study and work measurement.

Operational Research

The Operational Research man must be trained in the scientific or technical field in which the department is to carry out research. In the steel industry for instance that means physicists, metallurgists, chemists and engineers supported by mathematicians and statisticians.

(The work of auditors and personnel staff is now so well known that no definition of their good qualities is necessary.)

The Work

In a very large company where numerous efficiency departments have been set up, or have in some way emerged from other sections, various problems will arise, most of which come back to the question of coordination. The problems are of apportionment of the work, of its separation, specialisation, and duplication.

Apportionment of Work

The nature of the work or of the problem presented would, one might suppose, be a sufficient guide to suggest which department is the best equipped to deal with it. Obviously a problem consisting fundamentally of the assessment of the repetitive performance of human beings is a job for the Work Study Group. The approach cannot be scientific and exact in the way that physics is exact — the field where Operational Research excels. By the nature of the approach and search for optimisation OR pays less attention to human factors than do Work Study and O and M. In this case of assessment the assignment should be placed according to the nature of the work involved. But this is not always easy to decide before commencing work, and any transgression into another section's territory during an assignment should be avoided. The proper approach is to call in the appropriate section to deal with the work in question as and when it arises.

Frequently the restriction of areas of operation to precise boundaries is difficult. There are certain to be transgressions, particularly as far as the Operational Research Department and the Work Study Group are concerned when both are operating in the factory, and again between the Operational Research Department and O and M when dealing with administrative or office problems. As a general guide, the essential difference between the Operational Research Department and the others is that the problems they deal with are usually broader in scope and more mathematical in character.

Some form of temporary agreement can be usefully arranged until such time as a formal solution is found which will overcome these difficulties. This should perhaps be something along the lines mentioned above, where each department coming upon some part of a problem not strictly within their scope, calls a halt and passes on that part of the investigation to the other department, which afterwards reports back to them. For example, when Operational Research becomes involved with the organisation of clerical work it should ask O and M to deal with this. Likewise, the Work Study Group or O and M faced with a problem beyond their scope should not hesitate to call in the assistance of the Operational Research Department.

Evolution of Additional Services

It may so happen, and in some large companies probably does, that sections such as O and M, Work Study and Operational Research are established at different but fairly close times, and usually the first to arrive takes the natural lead in guiding the other two as and when they start. While they are all fairly new, and while they are small, it will be, or should be, easy enough for them to work together well and helpfully. When they grow larger this informal cooperation becomes more difficult, and the risk of interdepartmental friction, duplication of work and time-waste with consequent adverse publicity, is likely; adverse publicity can be a real threat to the esteem in which the departments are held. Again this is a question of coordination.

In other companies efficiency departments may never be really 'set up' at all, but hive off from some other department

which has enlarged itself to include further duties. This may be the case with Operational Research and O and M which sometimes grow out of Work Study. Frequently it is the case with the audit department which is the parent of some other services. Indeed the activities of the management auditor have much in common with those of the O and M adviser, except that the internal auditor's duties end with reporting on the facts he has discovered, whereas the object of an O and M investigation is to review organisation, methods, and procedures with the object of improvement. The management audit highlights lack of control, weak procedures, lateness, inadequacy, and inaccuracy of management information, and the existence of any such state of affairs is clearly a reason why an O and M investigation should be conducted. Close liaison between O and M and Audit is therefore essential; because of this at least one company has combined internal audit with organisation and methods under the title 'Systems and Audit Department'. This is perhaps an unusual arrangement of departmental responsibility, for in a large industrial group internal audit usually operates separately from O and M. The practical organisation of this Systems and Audit Department is as follows.

Staff are divided functionally between those engaged on Management Audit, and Systems Investigations. Staff are of good quality and ability, because the audit staff are not merely conducting routine checks but are expected to discover inadequacies in the procedures they review, which will provide the starting point for systems investigations. The objects of the audit are to review the established systems and procedures and to ascertain that the internal control is efficient. Reports are submitted to the Systems and Audit Manager who considers among other things, whether a system investigation would be justified. Systems investigations may also be commenced as a result of requests from other departments, and priority is given to those which are likely to result in the greatest efficiencies and the largest benefits and savings. Preliminary discussions on the scope of the forthcoming investigation are held between the Systems and Audit Manager, the Auditor, O and M Adviser, and the manager of the department concerned, and clearly defined terms of reference are drawn up of the scope of the investigation.

Separation and Specialisation

The question here arises, should such a state of affairs be temporary or permanent? Should the original department relinquish its new branch when this has grown big enough to look after itself? Frequently the approach will need to be specialised in the works, in the office, or in some other function, and the impossibility of one department being able to deal with the whole service is evident. To obtain a really efficient 'efficiency audit' the management must provide staff versed in very many techniques. The case is clear for some specialisation, if not for separation, but interchange of staff and joint training could save the growth of too many departments.

Coordination

The conclusion arrived at is that the same officer, auditor, research man, etc., is unlikely to possess all the experience and the skills for all the different techniques required. For the same reason, no single department could cope with all the requests likely to be made upon it. There are very many points at which efficiency ought to be studied in a large enterprise, and no single investigating staff, however large, could be set up to deal with them from the centre, even if the problems were not so diverse and difficult as to prevent the emergence of such an over-specialised monstrosity.

On the other hand, coordination is essential, and some form of grand strategy must be developed. If this is not done at a fairly early stage sections will be straying into each other's territory, possibly resulting in two or even more of the sections investigating one problem, even though the sections concerned may be interested in different aspects of that problem. This in itself might lead to clashes between the sections, who are following their own lines of thought; to a waste of the time of the operator who has to submit to two or more questionings or assist with two or more calculations; also to loss of reputation.

Obviously, therefore, guidance and instructions are needed by the different sections, and the set-up as a whole must be kept in view, the whole being the efficiency of administration. How

shall this be done? There is no doctrine which suggests that any one of the separate functions mentioned is the best for governing the others. They are all slightly different and all require different abilities. The real problem in most companies is how to coordinate them rather than rule them, remembering that the relations should be extremely close between all. Apart from the need, therefore, for the heads of all the separate departments to be cooperative, there will have to be some formal relationship at a higher level. This central control is usually at a point above the individual departments or sections. It must, indeed, be in the hands of the ultimate authority concerned with the policy of administration. This means that this authority will have a specialist staff for this purpose. The coordinator may be a director of administration, or the executive under whose auspices the various service departments have been constituted. In contrast with this reorganisation, some large companies place a different director in charge of each headquarters service and secure coordination either through a management committee or through the Board itself.

Another solution already mentioned is to form a board or committee of administration, whose members would be the heads of the various efficiency departments concerned. They would have a joint authority and would meet for the purpose of deciding current and future work, the best approach to adopt, and the best apportionment of the work. A director or the head of the largest department might act as chairman of the board or committee, or the rotary method might be adopted whereby each departmental head would be chairman for a fixed period. When coordination is achieved in this way, the chairman usually reports direct to the Board of Directors. Sometimes, to achieve even greater cooperation representatives of each department are seconded to the others in turn. A representative of Work Study, for example, might work for a time in the O and M department.

But whatever the solution of the problem of coordination may be, there must be a correct emphasis on performing any one of these services in a businesslike way as part of the management, and not in a specialised professional way. O and M does not exist for O and M's sake; it will only continue to exist if it is worthwhile, and pays its way.

The Justification of O and M

Any company with an O and M department must from time to time question whether it is worthwhile to maintain this service in addition to other management service departments, such as Accounting, Internal Audit, Work Study, etc. The costs of running O and M may be heavy. Obviously, therefore, every company will agree that some evaluation of the service is necessary, together with a check on cost. How is this to be done? The following are six different ways in which this is known to have been accomplished, and doubtless there are others.

In one company all headquarters services are studied from time to time by a committee whose members are drawn from the other headquarters services (each service represented is, in fact, so studied in turn). As far as O and M is concerned, this committee looks at its expenditure, tests the results obtained from the services given, and recommends whether the service should be extended or contracted.

In another company O and M itself prepares for every completed assignment an analysis of costs incurred and an estimate of actual savings to be effected. Provided that the ratio so obtained is treated as an index rather than a measurement, and provided also that too much time is not spent on these analyses and estimates, something like this could be of use everywhere. One of the objections is, of course, that savings are of two kinds, the short term and the long. Savings may be effected in a short term, but a year or so later conditions may have changed and the new system may, in fact, be more expensive than the old.

A third method is for the head of the unit, or the team leader, to draw up an unofficial balance sheet of the time of his staff, and in rough figures form an estimate of benefits and an estimate of savings. This is done after the preliminary survey. Estimates like this are usually either too optimistic or too pessimistic and the departmental head or section leader, realising this, should publish nothing of what he obtains by way of comparison. Nonetheless, part of his duty is the need to be con-

stantly on the watch against 'O and M for O and M's sake'.

In some companies the auditors endeavour to make an assessment of the value of headquarters services. This may be done by outside auditors or inside auditors; the approach is perhaps similar to that outlined in the first of these proposals, where other headquarters services set up a committee to do the same work.

A fifth way of keeping a check is for the director in charge of administration of O and M to satisfy himself that he has enough staff on this work, and not too many. In some companies, this director will have a quarterly report drawn up on the work carried out and the possible value of it. In others this will be an annual affair to enable the director to report to the Board, but whatever the time period of the report the role will be the same — to evaluate the work performed, to estimate the future needs for this sort of work and, by association of these two, to determine the scope for O and M during the next period.

Finally, in at least one company all O and M activities are costed in detail and these costs allocated to the subsidiaries, divisions or factories concerned.

One of the dangers of treating efficiency, particularly of organisation and of management, as though it were something exactly measurable, is the neglect of any service which cannot show a profit. In some companies the help given by their O and M to other companies is considerable, though not capable of being costed. Goodwill and public relations may be helped by this sort of service, by the 'open day' to competitors and any other industry, by lectures given by O and M staff at conferences and meetings.

This sort of goodwill effort can become a heavy drain on the time and services of staff available, and this is one of the reasons why the O and M Training Council was set up, so that the nine central companies should be able to spread training over the whole country.

CHAPTER VIII

ORGANISATION

Introduction

Why should anyone take the trouble to write and, for that matter, read about Organisation?

In some large companies the management is specifically required to criticise higher organisation in a constructive manner. Indeed, the chairman would be worried if at their management conferences they did not have to answer searching questions about policy decisions and their coordination, apart from the broad divisions of activity at and near board level. Yet, some business men still believe in a species of Divine Right of direction and higher organisation exercised by one man at the head of any concern, by which duties are parcelled out among a privileged few. This belief is fast becoming outdated. It is still firmly held, and often operates well, in the smaller family business under one-man control. Larger business has had to relinquish obvious patriarchal organisation and patronage or other forms of personal control, but there is at present little guidance as to how to reorganise in a more impersonal manner, without making enemies.

The suggested approach to the study of organisation is one of simplification of structure through common sense, combined with avoidance of the use of technicality or jargon introduced for its own sake. This way of looking at the subject deliberately suggests that when we organise we do nothing that is essentially hard to understand, and that any difficulty we meet arises from the variables and complexities that attend the activities of any living organisation. These difficulties are of staff (and their relations), of the work they do (and its processes), of the decisions they make (and their repercussions) and of the inter-relation of work, staff and policy, in one working whole.

It is wise to recognise from the outset that working in a small company is different from working in a large one. The good sense, or automatic coordination in a single brain, possessed by

one man in the successful one-man business is often missing, however much it is needed, in men at some levels in large businesses, where many staff are necessarily engrossed in one small job and cannot therefore see clearly the problems of the company as a whole; many more may never have had the opportunity to take a large view of a varied scene.

The small company has few formal problems of organisation when compared with the large. Decentralisation to subsidiaries, for instance, presents no problem, but delegation to subordinates may be more difficult. Perhaps the value to the head of the smaller company in looking at the problems of the large organisation is the opportunity to study his own difficulties under a magnifying glass, with, however, the strict limitation that he can never afford the expensive organisation justified by large scale operations. He must make each member of his own small executive avoid individualism, although success attends individual capability and discretion — and this is often a contradiction in natural behaviour. Thus in the smaller organisation success attends brilliant individualism combined with the ability to see things impersonally and resist the temptation to behave like a prima donna. A conclusion to this argument is that study of large-scale organisation can be invaluable to the small company provided that those concerned can translate division of duties among people into the division of their own personal activities.

The variety and complexity of modern administration and management, particularly in large companies, are due amongst other things to competition, technical development and professionalism; this complexity is almost certainly on the increase and is hard to avoid. Apart from this, the limitations of individual managers are sometimes blamed for business complication, but these disabilities are largely caused by the organisation itself, by over-specialisation in work. Because of these complications, the intricacies of authority and relationships within any large organisation, the problems of whom to consult on what subjects, are difficult to appreciate or understand. Contradictory schools of thought and practice with regard to methods of organisation are noticeable in different companies and countries and some controversy, and indeed some remoteness, are also noticeable amongst those who teach

administration. For, in these matters, a first-hand knowledge of administrative anatomy, gained in managing a works or an office, is worth more than a body of theory or principle.

Many of those with the most experience of organisation have not the time, nor perhaps the flair, for expressing in words what they do. Others who have such a flair have not much active experience and have to base their theory more on abstract opinions and matters of principle than on practical reality. Meantime the numbers employed and the amount of administration in government and in industry, grow larger and some of the problems, of coordination and cooperation, have become considerable.

What is the answer? To encourage more experts? Or to develop a more general understanding of the sort of practical, day-to-day considerations that in real life affect, for instance, divisions of duty between different members of the staff, or the arrangement of their work? The two activities, division of duty and arrangement of work, are different, being separate parts of the work of organisation; but on occasions they tend to become confused. In a large company they may be separated under different departments, for the division of duty involves considerations such as those of power, policy, coordination and skill, while the arrangement of work processes constitutes largely a matter to be settled by considerations of efficiency. In small units the arrangement of the work is often left to the man engaged upon it, with varying success.

Several words have already been used which have developed special meanings of their own; these may need explanation, because precise meanings are required in analysing organisation.

Duties and Responsibilities

Very shortly, duties are the activities given to a man to do, and responsibilities constitute the acceptance of a further duty to report. Thus, an employee is responsible to a person, or sometimes to different persons, for his job, which is made up of various duties and activities. His responsibility takes the form of reporting, personally or in writing, on the execution of these duties, as to how far they are completed, and so on. Duties, being something to be done, or the supervision of someone else's

activities, are impersonal — responsibilities are essentially personal. Anyone organising a job of work allocates the duties amongst the staff, telling each to whom he is responsible or answerable. Duties may be redivided without altering overall responsibility if all still answer to the same chief, but a man may be made responsible to a number of different managers on different aspects of his work without of necessity changing his duties. These distinctions become important in the large organisation where a man has a single set of (operational) duties but also has responsibilities of two or more kinds, operational to his 'line-chief', and technical or functional to various 'staff-chiefs' or advisers on particular subjects of, for example, engineering, accounts, staff, or legal matters. In analysing organisation problems, the duties and their responsibilities need to be separated. Responsibility thus combines carrying out duties and reporting upon their completion. If insufficient authority has been delegated, in the shape of power to decide and to progress to completion, then the organisation for the taking of decisions is at fault.

Efficiency

This means different things in different professions and industries, and three different ideas need to be distinguished. Effectiveness, by which is meant the degree of thoroughness with which a job is performed, or degree of success with which an objective or target is achieved; economy, or the cost of that effectiveness, whether in money, manpower or material; and efficiency, which is the ratio, of the one to the other, of effectiveness to economy. These definitions suggest that on occasions someone may have been 'successful, or effective, regardless of cost' or perhaps that 'the management has been so mean that the job could not be completed effectively'. The aim of efficiency is to get the best of both worlds, as much success or thoroughness as possible with the lowest expenditure, without meanness.

If this analysis is accepted as the common sense it surely represents, the idea of efficiency itself needs to be resolved into three parts:

Technical efficiency, concerned with how the job is to be done, by definition including the machinery and the

methods to be used. This is the field of study of production and work studies in the factory, and of O and M in the office.

Managerial efficiency, covering the whole gamut of good management, i.e. the achievement of the objective with the minimum use of resources.

Personal efficiency, another element combining knowledge, personal ability and 'the will to work'.

Many cases exist where the machinery and methods have been good, the management has been fairly wise, yet because of mismanagement in the past nobody has been putting his best into the job, which has been therefore inefficiently performed. Equally, with the best will in the world, the worker cannot succeed under bad management nor compete successfully with out-of-date tools. Although these three aspects of efficiency are easily separated in thought and on paper, in real life they are intermingled, and much of the difficulty with which the analyst is faced involves sorting out which of the three efficiencies is in need of attention, whether the trouble is due to a fault in the method, the management or the men.

The submission is that the arrangement of work, or organisation with a small 'o', is largely a matter of efficiency. The arguments for and against the particular division of duties, unlike the arrangement of work, can seldom be reduced to a ratio of thoroughness and cost, and for this and other reasons duties must often be determined on personal considerations, to suit the staff concerned.

Organisation Studies

Among companies using these studies one school of thought recommends starting an organisation study at the top, by challenging and confirming or correcting the purpose being followed and the policy in force; others favour a two-prong approach, at the top through an organisation team and at the bottom by procedures, systems or methods teams.

Many assignments are concerned with organisation at the level of operations. Experience shows, however, that difficulties at lower levels frequently arise from a faulty alignment of organisation at a higher level. In consequence the investigator needs an ability to think in terms of overall organisation — from

the top, to secure coordination and ensure delegation, and from the bottom, to achieve efficiency in the arrangement of work and the grouping of people, whether they are office workers, production operatives or representatives.

Perhaps the danger of either approach is that problems arising at the top have then to be solved by 'principles of organisation' which may not yet be readily apparent and have not yet been satisfactorily established and classified. A third approach should be mentioned, which is to tidy up organisation at both the operational and the management levels so that main Organisation, with a capital 'O', at yet higher levels may be mirrored in its true light — as the divisions of policy governing a lower organisation studied and made efficient. Seen in this light Organisation, with a capital 'O', should reflect a sense of purpose and general operational tidiness and discourage too many considerations that are purely of power and personality.

The Study of Purpose

This aspect, already mentioned in the introduction, is of great importance to any study of organisation. Firstly, it promotes an understanding of what is being attempted, of the reasons for the broad policies governing main activities, together with a knowledge of the actual objectives set by the company for performance. Such a study must precede any attempt to reorganise main activities, their management or actual operations; it gives a sense of direction most useful in thinking out reorganisation. It sets the 'tone' of the business.

Secondly, it provides the occasion to challenge any purpose or part of a purpose that has become outdated. A simple example is the sales department of a company whose organisation was devised to meet conditions when the products of the company were sold direct to retailers. Gradually the company has bought up its own retail establishments and has set up depots to serve them. The organisation has not been changed, but the purpose has gradually developed into one of supplying a separate marketing company with its own chain of outlets. This is an example of an extreme case, whereas many variations of purpose are small, although the adjustment of organisation to suit present requirements has considerable benefits.

Thirdly, it draws attention to activities that should be farmed out. In most companies the primary divisions are those of subject, service or product; the middle or secondary divisions are of management; beneath these there will often be various groups of subsidiary activities, which should be examined critically. A manufacturer of paint may have a small shop making cans in which to pack his paint. This is not part of his main purpose of marketing paint, but a subsidiary one which he only supports because he always has had a can shop. When he comes to studying purpose, he finds that the cans he makes himself cost a great deal more than those he buys from a manufacturer specialising in quantity production of this sort of receptacle. Another interesting example is taken from a large gas works. This particular works found some economy in owning its own collier brigs, and barges for shipping coke. They did not have many colliers or many barges, and as a result could not afford to pay a first-class man to look after them. They decided to hand over these activities to a company that specialised in shipping and would run their water transport on a commission basis (and would own half the capital cost of their vessels). These two examples seem to suggest a strategic factor that can be used in re-examining this kind of organisation. Is any subsidiary or ancillary activity large enough to carry a staff of experts? If not, could it be farmed out to someone better equipped to manage it efficiently?

The line of organisation study advocated is one that uses a practical or factual basis; this requires a discipline or some rules of its own. It is suggested that any problem of this nature be approached in the following manner:

Start any study at the lowest level of the hierarchy with the organisation of the operations themselves.

Then see what can be done to simplify the organisation required to manage those operations.

Finally, look at the division of power and policy at high levels; but, to save any waste of time and effort, only do so if the climate at those levels is favourable to something being done which may simplify the organisation.

No survey at high levels justifies the time of those involved unless there is goodwill and active support for reorganisation on the part of at least one director. At lower and middle levels

fear of a higher wrath against resistance to modernisation may encourage the acceptance of rational organisation, but this fear disappears higher up. If the day-to-day operations are reasonably well laid out and organised, if the management can be both strong and sympathetic, if statistics and controls are limited to the essential, then the higher levels find a traditional or individualistic organisation difficult to defend.

This alternative line of study is not very different from the two-prong attack mentioned earlier. Studies are confined to matters of organisation alone, starting at the ground level, working upwards, instead of working down from above.

Constructive studies take a great deal of time and experience and demand a good understanding of the actual practical considerations peculiar to each business. Recommendations made can usually be supported by fact and example, based on the circumstances that govern each division of duty or arrangement of work; these differing circumstances will be detailed at length below. Various alternatives of organisation should be examined to find out which of them most nearly matches the requirements of work and staff. The work of reorganisation demands what might be called 'tailor-making', and requires a sound knowledge of what goes on inside the organisation. A summary of the broad lines of this approach has been attempted in Figure 32 below.

Level of Work to be performed	Ways to divide the work	Human Considerations	Delegation or exercise of Authority
Operations	Actual work processes	Working with people, with staff and the public	Minor decisions
Management	Phases of management	Co-operation, management, leadership	Guided decisions, judgment
Policy	Subject, primary function, management function	Personal equations, leadership, management	Judgment, major decisions

FIG. 32

Analysis of organisation is necessary for its simplification; study of the above chart should develop an understanding of

the considerations already mentioned. The levels of organisation shown in the left-hand column reverse the usual presentation. Operations appear at the top, as the first to be examined, and the policy or strategy level comes last. These three levels are indistinct in the smaller undertaking, but become separated quite quickly in the larger. Operations and their management are, in the small concern, often combined and in the same building with policy work. Additional levels, or tiers of authority in any national organisation are difficult to justify where delegation of management is genuinely attempted.

Organisation has (in Figure 32) been divided into three sections — the work, the staff, their decisions. To keep the chart fairly simple only some of the considerations have been shown in each of the rectangles at each level and under each column, but others are appended as notes. The common sense of the whole presentation may have its uses. The considerations at the operational level are those of the actual job itself, of the processes and the arrangement of those processes in the most efficient manner. The human considerations at that level are important but are more collective in nature, of the group, of getting people to work with men or women at their own level, and of thinking in terms of the requirements of the customer or public. Little power and authority is involved. The decisions are of a minor character, but supervision is included; many decisions are delegated to the supervisor affecting individuals or their work, and these the supervisor cannot delegate any further. He is the last in the chain of authority and has to exercise discretion, if not judgment, in many matters affecting timing of work and staff.

Divisions of Management

At the management level the work considerations have been classed in the chart as the 'phases of management'. These are — preparation, action, confirming that the work is completed, and keeping the necessary records. In the small business one manager does all this himself. When the business starts to grow first one and then another of these 'phases' is separated and staffed until, at the other end of the scale, in a very large factory, office or business, they may be subdivided as follows:

Preparation for Work

Forecasting the conditions and forces which will influence action.

Planning and replanning the work; making a programme.

(Part) Organisation; laying down the duties; preparing instructions.

Provisioning, laying in stocks of materials and making staff available to carry out the work.

Budgeting, performance and expenditure.

Execution of Work

(Part) Organisation, appointing and maintaining qualified staff.

Issuing of instructions, and their constant amendment.

Replanning operations, as experience develops.

Balancing and coordinating activities.

Progressing work ('following-through'), and provisioning as action demands.

Accounting; Recording; Controlling achievement of the plans and programme.

Not often will all these separate stages be independent of one another; anyone engaged on reorganisation at the management level will need to consider how much further elaboration is necessary, how far any existing over-elaboration of management could be simplified.

The human considerations at this managing level increasingly demand the qualities of the 'good mixer', the cooperative ability to find time to work with other managers and help them, in addition to other operative good qualities of the handling of staff and leadership. At this middle level all decisions increase in their importance and there will be an element of judgment in most of them. In most companies policy is clearly laid down so that decisions are in that sense guided, but initiative is very important and desirable in the manager. In the small company initiative may need to be curbed, but in the large, where inertia is a very real problem, initiative has to be encouraged.

The considerations of organisation at the policy or strategy level are obviously different from those at other levels. The work itself is more the application of clear thinking to confused

issues than of any observable process of operation. The different subjects or products with which the business is concerned may make quite obvious a division by groups of major activities or products or, on occasions, by the combination of some one or others of the eight management functions to be met in the governing of all enterprise. The division that suits one company will not necessarily suit another, even when both companies are in the same line of business. Human considerations at high levels are delicate, are often a matter for the chairman or the managing director himself and take a great deal of his time.

The last column of Figure 32 suggests that policy work involves judgment between variables, financial or administrative, and few guided decisions. The policy level is the final Court of Appeal for the particular business, and the need to perfect a functional or a Board judgment involves considerations of a different order to the speedier, perhaps 'rougher' judgments or decisions needed at lower levels.

This brief description serves only as an introduction to the question of reorganisation of existing activities. Great emphasis needs to be placed on the fact that at any one of the levels thought has to be given to the considerations that arise in all three fields — of work, of staff and of their decisions. In many cases a survey has found some saving that can be achieved in one of these fields, perhaps that of the work, and the surveyor has seized upon this and has cashed in on his recommendations, neglecting either the staff considerations or those of the effects of the change of organisation upon the decisions to be taken. This failure may account for some criticism heard after a reorganisation — that the new organisation looked good, but failed to work and had to be discarded. The approach to be recommended is pedestrian; to separate the different levels and to concentrate on one at a time, starting with operations; for the observer to discipline himself to reasoning in terms of three different sets of considerations; when he has tidied up the one level, and before he has made any changes, to look at the organisation of the next level and note what is missing, what is duplicated, what is unnecessary, in so far as these will affect the level he has already worked upon. Probably he can tackle the operations level with little more than a brief look at the impact of policy on operations. Operations and management will

interlock, as will management and policy, but the organisation of operations may well be re-examined without necessitating any interference with policy.

SUPERVISION

This section defines the work of supervision as anticipating and providing for the technical needs of the staff by planning their work, training them to do it, and explaining their instructions. Supervision also reports on staff and represents their interests to management. The supervisory level is the first line of management, i.e. the supervisor is in charge of the primary working group.

An understanding of what is involved in supervision is needed for several reasons. These may be as follows:

Many methods investigations deal with both the supervisor and the members of the group; O and M should therefore have a proper understanding of the relationships involved to avoid cutting across them in any way.

In a methods investigation the real problem may be found to be one of faulty supervision.

In creating any organisational structure to carry out a new or revised procedure provision may have to be made for direct supervision.

Resistance to change and to recommendations may arise at the supervisory level, especially since the supervisor normally has the task of explaining the change to the staff.

Although O and M may not report on the efficiency of the supervision there may be a need to take stock of it. The assignment and recommendations can then be developed in a way that will not risk unnecessary opposition. To do this the difficulties of the supervisor must be understood, although this may be difficult if the investigator has not worked in that capacity. The ability to supervise does not come naturally to most people. It is not necessarily the product of technical knowledge, nor of education, nor of length of service. There is a skill involved which may have to be learned, and some companies have brought the training of supervisors to something of an art.

Implementation of Policy

Supervision is the essential means through which the company's policy is implemented and management takes effect. This assumes that:

All corporate effort requires a policy to guide individual contributions towards the corporate whole.

To be realistic policy must be associated with a plan for implementation.

Implementation by any considerable number of staff requires organisation.

Organisation, as discussed elsewhere in this book, combines a structure of duties, the staff who carry them out, and arrangements for decisions to be taken affecting those duties. This organisation is based upon the supervised and the supervisor.

Management Aids to Supervision

The supervisor is the direct link between management and staff, having to be loyal to both. Supervision needs assistance from the management, as follows:

A logical organisation structure in which responsibilities are clearly defined at each level of authority.

A policy that is clearly stated and has been explained, so that the supervisor may understand and himself make clear to his staff what is required.

Careful selection and good training of the supervisor by the management.

According to conditions, the correct size of group.

In most cities staff come a long distance to work and consequently have no local friendships, loyalties and discipline such as are still known in country businesses. Seldom does the supervisor now work with a team he has known for years. He or she leads a group which forms and disappears as people change their jobs.

It is difficult to over-emphasise the importance of the handling of staff in the smaller groups working in intimate daily association with each other. The size of the group is important, between ten and thirty (interesting examples of the best attendance come from groups of about thirty workers where absentees

are clearly told by the others that they are letting the side down). Excessive absenteeism may be due to bad handling of staff.

Duties of a Supervisor

The work of the supervisor may be broadly analysed as follows:

Contribution towards the determination of work methods and choice of machines and procedure. (Technical)

The control of output to a predetermined quality. (Technical)

The planning of work, and the relation of output to a time factor in a programme. (Ordered operations)

The arrangement of the sequence of operations to permit an even and sustained flow of work, both within and from the units. (Ordered operations)

The issue of instructions. (Ordered operations)

The provision of accommodation, furniture, equipment, etc. (Ordered operations)

The coordination and balancing of all activities. (Ordered operations)

The control of output for quantity. (Ordered operations)

Good housekeeping. (Ordered operations)

The communication of policy and objectives to staff, enabling them to understand what they are doing and why it is necessary. (Sustained cooperation)

The assignment of work to staff. (Sustained cooperation)

The control of work relations and maintenance of high morale and human relationships. (Sustained cooperation)

Reporting to higher authority upon abilities, promotions, attendances and other matters. (Sustained cooperation)

Induction of new employees. (Sustained cooperation)

Readiness to listen to personal problems and grievances. (Sustained cooperation)

It will be seen that this work is divisible into three main categories — 'technical' — how the work is to be done; 'ordered operations' — planning production and control of output; and 'sustained cooperation' — group supervision which deals directly with the problems of getting people to work harmoniously together.

Assignment of Work to Staff

In assigning work to staff the following considerations are necessary:

When allocating work requiring varying degrees of skill or knowledge, any individual should if possible be given some tasks which may extend him slightly beyond his known level of skill or capability. This draws a man out and leads to satisfaction all round, but it is presumed that the abilities and skills of staff are studied and known. Such knowledge is perhaps essential to all leadership.

The quantity of work which is asked of him should be fairly adjusted to his capacity, remembering that too little work has a bad effect on a good man.

The scope of his duties should be defined. This avoids disclaimers of responsibility for a situation or a case without exact precedent. Care must, however, be taken to avoid inflexibility.

Issuing Orders

In the issue of essential orders the following points should be observed:

Any orders must be objectively necessary. They should arise from the situation and not from a personal desire to give orders.

Orders should be such as to retain the staff's respect for the supervisor.

Orders must recognise and allow for differences between individuals — differences of ability, of willingness, of temperament, of service and of age.

Orders should be designed whenever possible to encourage self-reliance and initiative.

Orders may take different forms and be delivered in different ways according to the situation and personnel involved. They may be direct and imperative where the nature of the situation calls for a rapid, positive decision, and the supervisor is the one responsible for that decision. Alternatively they may be conditional — when the experience of the individual to whom the order is

addressed enables the supervisor to give him an understanding of what is required, but the details of his actions are left to his own decision. Again, orders may be implied — usually addressed to a trusted worker or, for purposes of testing reaction and initiative, to a new member of the group. Finally they may be indirect — a method used in a situation calling for volunteers, testing the loyalty of members of a group, for instance, where there is a sudden call for overtime working.

An explanation of the reason for giving an order is conducive to its ready acceptance and cooperation in its execution.

Supervisory Qualities

A list of the desirable qualities required of the supervisor would include:

Judgment (based on knowledge of the job).
Ability to make a sound decision quickly.
Readiness to accept responsibility.
Readiness to change methods.
An active interest in and liking for people.
A sense of fair play and justice.
Recognition that he, the supervisor, may himself be wrong.
Equal readiness to give credit or helpful correction where either is deserved.
Intelligence and understanding in dealing with human problems.
Ability to interpret situations and problems to staff so that they may take some share in management.
Ability to 'jolly' his team along, without overdoing the role.
Loyalty to the staff in addition to the Chief.
Patience.

Much of the time of the supervisor is spent in the handling of staff. Although part of this chapter has been concerned with this subject, the general question of relationships with staff is discussed also in a later chapter on 'Human Considerations'.

Office Organisation

In the first part of this chapter a distinction was attempted between the different levels of organisation. The distinction is

thought to be necessary because on each of these levels different considerations arise governing the division of duty or the arrangement of work. This section is concerned only with those considerations which seem important at the level where ordinary office work is carried out.

When close study is made of office organisation two main alternatives appear. To organise by process, bringing together work of a similar character of operations as in accounting, statistical work or office services like wages sections, typing, etc. The alternative is to group quite different work together, the common thread being, for instance, similarity of purpose, subject or professional content. Luther Gulick described process departments as 'horizontal' and purpose departments as 'vertical' and some label like this may aid analysis.

Organisation by similar processes will be taken first. For all alternative forms of organisation there are advantages and disadvantages, and one of the best approaches to analysing organisation is to make out a trial balance sheet for each alternative method, weighing the arguments for and against. When a pool of work and workers is organised certain advantages are secured, such as:

Ease of supervision.

The sharing of standards of operation.

An operational strength greater than when workers are dispersed.

Potential advantages of competition between groups of staff and the emulation by one member of the pool of others who are speedier and more accurate.

Potential savings of marginal time, etc.

But there are also disadvantages:

Loss of personal contact with a job, or with the person for whom working.

Lack of interest through doing only elements of jobs or a succession of odd jobs, where the operator has no sense of continuity.

The inability of some members of either sex to get on with many members of the same sex.

The spread of ill effects from bad supervision.

A general slowing down if one or two persons are short of work.

This pool-form of organisation provides the opportunity for the office to learn from the factory, for when programming a machine the production manager has to think not only in terms of 'speed and feed' but also of the 'float', or reserve, needed to keep the machine running smoothly at a high speed. This applies to any pool of work. Bad supervision hands out too much work at one time and overwhelms an operator. Bad management sends work into the pool in rushes, so that staff are either lightly loaded or overloaded. The business of issuing work in 'digestible quantities' has a psychological effect on the staff in addition to giving each operator a small reserve needed to maintain his or her rate of output at a high level. To maintain this balance is one of the arts of the supervisor, who in offices may need to vary the load individual by individual to suit capacity and ability.

In short, there are possibilities of improving efficiency in the office from the use of process pools, but equal chances occur of losing good staff unless great attention is paid to the disadvantages of workers being treated as though they were machines — not many persons like being so treated or are happy working in pools unless these are well managed and supervised. Wherever pools are arranged in the office they afford an opportunity for the O and M staff to study the work of a number of operators and the furniture they are using so as to make work easier, more convenient, more productive in operation and cheaper.

The second main class of grouping of work brings together processes and work of a different character (by purpose), where quite different jobs are combined in a single unit. The five most obvious unit-groupings are as follows:

Those which combine all types of activities concerned with the same service, for instance, of personnel or O and M.

The unit for an office process, like wages or sales invoicing.

The unit concerned with a particular subject or project, often associated with development of markets or research and development.

Those which may be designed to carry out a particular duty, as with an internal audit.

Units involved in all the various activities that come under a particular function, like finance or distribution.

There does not seem to be any great value in analysing in

great detail the diverse ways of creating units of a heterogeneous character. Units may be grouped in many ways. But it is important to examine first the way in which the work processes may be arranged, and secondly the considerations governing the 'specialisation' of work or the alternative of 'generalisation' of work.

One of the most obvious ways of arranging work is to borrow from the factory once more and arrange the processes in the order of operation. This is seldom completely used in the office, for an important reason — 'the comprehension or assimilation factor'. In the engineering shop, and wherever mass production is employed, the operator, after performing his allotted process, reaches out for the next part and performs the same cycle of operations. The mental effort is one of recognition that the part is the same, to which he has to do whatever is required. In the office nearly all operations have some element of variety, and therefore of extra time during which the operator may need to read the papers to see what he has got to do in each particular case. He may not understand it; he may need to consult as to what it means; he may need to go and look up a rate or a precedent, or send for other papers to give him a guide. Whatever he may have to do, there is a time allowance needed for assimilating or comprehending what is involved in this particular job before he undertakes it; this is seldom present on the factory floor. If, however, the work is similar or so nearly similar that a clerk may tell at a glance what action he has to take, then it follows that this factory arrangement, in the order of operation, can be applied in the office.

On other occasions, when there is a great rush of work that has to be cleared quickly, it may be advantageous to employ a conveyor system, passing papers from one clerk to the next for acceptance of standardised treatment, where suitable, but rejecting anything unusual or unprecedented, for necessarily slower treatment in separate units and careful looking up of exactly what will be involved in the decision required. The conveyor idea can be used in other jobs, for instance in stores work, although the principle of arrangement in the order of operation cannot be followed to the same extent as in the factory. Nevertheless, a considerable economy can be achieved on occasions where staff are placed in a specially designed work-

place or desk, where, for instance, one man's 'out' tray is the 'in' tray for his neighbour, and a flow of work can gradually be developed.

Thus, although the full application of arrangement in the order of operation can seldom be used in the office immediately, the method of approach may always be used; that is to say, of trying to position clerks in a room in the order of their operation so that the work can move readily from one to the other; sometimes to arrange work in adjoining rooms to save unnecessary travel of papers and staff and, as already suggested on occasion of emergency, setting up the equivalent of a counter — so that papers may pass from seat to seat and be cleared in a matter of minutes.

A modification in this way of arranging work is used in very large offices. Where the work lends itself to being laid out in the order of operation each job is occasionally split, by using a multi-part form so that the various operations may be performed simultaneously on different copies of the same form and thus save time. This method involves two additional processes, the splitting up of the job and the reassembly of the various copies to make up a complete record. This latter process is, however, sometimes difficult to arrange.

The third nain method of arrangement is to group varied operations in a manner that will give an interest to the staff engaged upon them. The office worker undoubtedly likes to take an interest in his or her work. This interest is lost where work is arranged in the order of operation of processes, and the organisation becomes unpopular if each clerk has to do the same thing over and over again for any length of time.

Separating and Specialising Work

Perhaps the key to any problem of organisation is to know when to specialise staff on a particular kind of work and when, as an alternative, to 'generalise', by giving a clerk a number of different jobs to do. Specialisation by customer has well-known advantages so that one clerk looks after all the business of the same group and achieves a degree of variety in his work. When work is causing difficulty, and when in consequence the office is said to be inefficient, four possibilities of separation and specialisation may need to be considered:

To separate difficult or more important work from that which is more easy and to allocate the harder work to more experienced staff, conversely to separate the easy work from the remainder.

To separate the urgent work from the routine and to push the urgent jobs through, possibly in the order of operation, possibly by sending them through selected staff, possibly by having a whole group of quick workers dealing with 'rush orders'.

By separating work with a technical or professional content from more general work. Again, this specialisation involves using qualified staff, or arranging for regular visits of technical or professional staff to the office to clear special points outside the ambit of the ordinary worker.

To separate decisions which may involve other parts of the same organisation ('repercussion decisions') from those other decisions which are self-contained.

These four reasons for specialising work will reappear in the following analysis of some of the various considerations that arise in the arrangement of work of a mixed kind. Most work situations demand a carefully constituted organisation to suit their own particular problems, and any suggestion should be avoided that a ready-made answer is available, or that any other organisation should be copied. However, a survey might well be conducted along the lines outlined below:

The Nature of the Job

When studying the work processes that have to be organised, each of the following points should be considered separately:[1]

The difficulty of the Job. Is it really difficult? or important? Could it be simplified? Should a special qualified staff be posted to do it? Conversely, if the work is simple and repetitive does it not lend itself to mechanisation?

Accuracy. Records are frequently maintained to a higher degree of accuracy than is actually required. Figures may, on occasion, be kept in detail where only a total to the nearest hundred or thousand is required, for instance, in

[1] See also chapter on 'Simplification of Work'.

reordering stores. Many detailed records are also maintained where a periodic statistical sample or a statistical check will provide all the warning required to show if inaccuracy is present. Reorganisation of work demands therefore a challenge of method, of the purpose and the degree of accuracy to which the method is directed. Not until this challenge has been met should the work be regrouped. If great accuracy is required, very often specialisation of staff and work will pay, for such specialisation develops skill and therefore accuracy, even if at the cost to good staff of monotonous work.

The Changing Nature of the Work. Any considerable variation in the work is usually a pointer towards specialisation. There is a tendency in most large organisations to set up a new branch or a new group when some new job is to be done. This is often justified, and is known as 'elaboration'. A difficulty of organisation arises when at a later date the work has lost its novelty and has become routine. At that stage it needs to be 'concentrated' and perhaps merged with another branch doing similar work. Some very valuable reorganisation has been done in reducing the number of specialised branches, however sound the original justification for their being created. An 'audit', or survey of organisation, takes particular care of these 'new babies', takes them out of their separate rooms, makes them join their own kind.

The Size of the Job. Despite what has already been said, if the size of any job is such as to form a convenient unit on its own, easy to manage and interesting to a sufficient number of staff, then the work may best be kept separate and therefore specialised as a unit — irrespective of variety of process.

Time

Another element is that of time. The following are examples of points that should be considered:

Degree of Urgency. As already mentioned, one of the advantages of separation of the urgent from the less urgent is that the less urgent can be used as a 'back log', or float, for the urgent. In well-organised offices there are still

rushes and slack periods. When work has to be completed the day it is received there may be a slack period in the morning until work begins to come through from the mail room. Where urgent work can be separated from the less urgent, the remainder can be used as a reserve to keep staff busy and to balance the day's work.

Frequency. Quite elaborate organisation has on occasion been found surrounding important-looking work which does not happen often enough to justify this elaboration. In contrast, quite unimportant jobs, if they happen often enough, may need to be separated to make a self-contained unit.

Peak Loads. One aspect of this consideration has already been mentioned under the heading of 'urgency'. The best example of organisation to avoid peak loads is a merger of a summer business with a quite different winter business, to market goods with two different peak periods and to give a smooth loading for staff throughout the year. Although the processes involved may be quite different, such a merger may still have great advantage. A classic example is perhaps that of ice-cream and sausages.

Assimilation Time or Comprehension Time. Reference has already been made to this consideration. One of the difficulties that arises is that the same papers may have to be read by three or four people at different levels of the organisation before a decision can be taken. In complicated decisions, each reading of the papers may take twenty minutes or more and the perhaps obvious answer is one of special rerouting of this work on arrival in the office. Where papers require a great deal of comprehension time considerable dividends will accrue if they can be sent after a single scanning direct to the manager capable of deciding the question himself.

Layout of Office. The allocation of floors and rooms, and places in a room, is too often made in terms of prestige instead of productivity. Great savings of time are possible from studying the flow of work, and the times of consultation and decision, so as to bring closer together

the people whose work is associated. Large offices, suitably sound-proofed, permit such layout; where executives have to be separate from the work they control, a tube, conveyor, lift, improvement in messenger service may help the organisation.

The Organisation for Supervision

The following considerations are relevant:[1]

Control. Is there any need for a close control, e.g. security, young staff? On some occasions control should be tightened up, for such reasons as too much moving about the office, unpunctuality, talking, or too many errors. On occasion, advantages have flowed from bringing the supervisor into the same room, with or without a partition. There are some jobs where the supervisor should perambulate to answer queries and save staff from leaving their seats. Alternatively, light supervision may be needed. Where there is a good discipline and a good spirit, the supervisor may encourage initiative by withdrawing a little from direct control. On occasion a group has performed extremely well without supervision, by 'self-supervision'. This is usually possible only when the staff know their work so well as to need little technical guidance and where several of them have a high sense of duty and would themselves discipline any of the group who failed in that duty.

Adaptability to Change. Where work is of a routine character and changes very little, supervision may be almost unnecessary except at the time when changes actually take place, when new routines have to be laid down.

Cost of the Work

No survey of organisation is complete without thinking of the cost of the job.

Summary

This part of the chapter has given a considerable amount of detail to considerations that may help in the reorganisation of

[1] See also section on 'Supervision' pages 273-7.

the office work at the operational level. Very broadly, the recommendations lie between creating pools of work with similar processes, and grouping unlike operations together which serve the same purpose, function, or the public. If the former is adopted consideration should be made of the supervision and management of the pool; if the latter, then a list should be prepared of the considerations which may mean that one unit is better suited to the job than another. Two sets of problems arise, of the sort of unit to create, and the arrangement within that unit of the work to give efficient performance. In the arrangement of work the considerations are of the work itself, of time, of work supervision, of cost, and of any combination of any of these.

Reorganisation is interlocked with the simplification of office methods and should await the answers to a number of questions such as those on the following list:

Does the work lend itself to mechanisation?

Could difficult work be separated from simple work?

Before any attempt at reorganisation, can some be merged, or abolished?

What advantages will arise from specialising work to increase quality and the skill in doing it? (Remember however that specialisation creates problems of marginal time.)

As a converse, can similar work be pooled to reduce marginal time, even within a unit of dissimilar processes?

How good is the layout of operations and can any economy be created in movement of staff and papers?

Could work of a different character be pooled so as to create an interesting job for good staff, provide for interchangeability amongst them and create competition between them?

Has 'assimilation or comprehension time' been considered?

How often does this occur in the same work? And need it recur?

Are there inescapable fluctuations in work load?

Could units of work with quite different seasonal peaks be merged?

Would there be any advantage from separating the urgent from less urgent work?

If so, could the less urgent work be used as a 'back log' for urgent work?

Office Organisation Factors

Since no exact and universal principles of organisation exist, to be applied in each case, consideration of the relevant factors may guide reorganisation. The following notes are intended to suggest a practical approach.

Size of the Primary Group

The size of the working group has already been mentioned. This consideration is important and factors affecting it will bear summarising. They include:

The amount of work to be done.
The degree of specialisation of the work.
Fluctuations in work load.
The need to allow for sickness and holiday absence.
Economic use of most suitable equipment.
Effective supervision.
Human considerations general to people in groups.

The use of both large and small groups involves definite drawbacks, some of which are listed below:

Small Groups (six or Less)

Work loading is difficult. The smaller the section the greater is likely to be the 'fractional or marginal loss', in that the amount of work to be done is not exactly equal to the work which can be done by a round number of clerks. Fluctuations in the amount of work coming to the group cannot easily be spread. If provision is made for absences people are at other times under-occupied; if not, they are overloaded at times.

A full-time supervisor for so small a group is difficult to justify, and can result in undue interference in the clerks' work by the supervisor. In consequence, supervision tends to be of the 'working supervisor' variety, and the less pressing supervisory duties, particularly relating to the planning of work, improvement of methods, and staff training, may be neglected.

The scope and variety of the work may be reduced.

Large Groups (Fifteen or More)

Supervisors of a high standard are required, and these are not always easy to find or train.

Individuals tend to feel lost in the crowd so that team spirit, loyalty and sustained effort are difficult to maintain.

Organisation of Primary Groups

Mention has also been made of organisation by similar processes, or by grouping varied operations by purpose, and therefore different processes. The main factors involved in the selection of homogeneous grouping are as follows:

Mechanisation

Homogeneous organisation facilitates mechanisation, since the best machines can be used, and machine work is easier to control. If punched cards or computers are to be used a considerable amount of homogeneous grouping is essential.

Flow of Work

Homogeneous grouping reduces the effect of fluctuations in the work load. The work load at times of sickness and holidays can also be spread more easily.

Fractional Losses

Homogeneous grouping is likely to lead to less fractional or marginal loss because the groups are usually larger. In a heterogeneous group there may be someone with a particular skill, such as that of machine operations, which is not possessed by others.

Training and Promotion

An operator who is to perform only one job will take less time to learn it, and to achieve a satisfactory standard of performance, than one who has several. This favours homogeneous grouping, but a heterogeneous grouping allied to training of staff makes them more generally interchangeable and suitable for promotion, although their ability is easier to assess.

Work Measurement and Output Control

Control of output and flow leads to better performance. If operators are in homogeneous groups it is easier to control the output of the group and of individuals. In a heterogeneous group unmeasurable work is mixed with measurable, making standards difficult to use.

Interest

Heterogeneous grouping provides greater variety and therefore interest for clerks, and results in better work.

Team Spirit

A heterogeneous grouping can be used to encourage team spirit, in that the work is interlocking and individuals can see themselves as part of a team fulfilling an object which is easily recognisable as worthwhile.

Relations with the Outside World

Heterogeneous grouping, specialising by the customer, enables queries from outside the department to be answered more quickly and intelligently. It also enables responsibility for a particular transaction to be clearly seen.

Cycle Time

Heterogeneous grouping, as in specialising by the customer, enables any particular transaction to be processed more quickly than a homogeneous grouping, where the whole process takes place in the same group. There are less movements of papers and people, fewer transit delays and smaller pending files.

Assimilation or Comprehension Time

Each operator needs a certain time to grasp the facts of a transaction before action can begin. Obviously, if a document has to be passed through several hands before its purpose is fulfilled, total comprehension time will be greater than if the document is dealt with from start to finish by one operator. This usually favours heterogeneous grouping.

Experiments with New Methods

In a department where circumstances change rapidly this may be important. A heterogeneous grouping may facilitate experiments, in that a new scheme can be given a trial run in one of several heterogeneous groups. However, in certain circumstances, e.g. the evaluation of a new machine, experiments may be easier in a homogeneous group.

Supervision

Heterogeneous grouping usually involves a higher standard of supervision, owing to the number of different operations being carried out within one group. Also, a homogeneous group under one supervisor can be larger; therefore heterogeneous grouping may lead to a higher cost of supervision.

No list of organisation factors can be complete, but these will succeed if they suggest analysing the problem in terms of the conditions of each situation.

Human Considerations

Figure 32 in the introductory section to this chapter shows three columns of considerations that affect the division of work, the centre column being labelled 'human considerations'. The organisation factors mentioned in the other columns, of process, economy and judgment are all important, but running through them, and necessarily the centre of all organisation thinking, is the consideration that has to be given to people — those who do the work, those who supervise, manage or direct — and to the way in which they cooperate, or on occasion behave as individualists. The problems raised by these considerations at all levels take up a great deal of time; many of them are caused by poor supervision, poor management, or poor leadership. No longer may a new manager learn by experience of making mistakes. The cost of a strike is too great; the loss of good staff relations may be serious. He must become aware of difficulties without necessarily being involved in them, and this awareness may be obtained by thinking clearly about organisation.

Some of these considerations are separately discussed in the

section given to 'Supervision'. In many companies O and M stands back from the human considerations; they say that, as advisers on office organisation, management or methods, they have to take the human considerations into account, but must not interfere. Clearly they have to consider them when designing forms, when simplifying work, in job analysis, in approaching mechanisation of work, or in reorganisation at any level. As this book is concerned with all these subjects, some space, however brief, must be given to this human element.

Most businessmen have had experience of bad and good teamwork. Some of the things that affect teamwork have causes that are out of the sphere of O and M staff. For instance, the motives that arise from being passed over or reprimanded or discharged; the motives inspired by fear, by anxiety for more money, except for the possibility of tying greater effectiveness to greater reward; the desire for mastery or power, whatever form that may take; to some people the pleasantness of submission and to others of association with people of either sex and, perhaps, the reputedly masculine wish to realise self-importance.

All of these are familiar, but they are also the subject of constant institutional discussion. This book is concerned only with the practical considerations of O and M work. The two easiest things that management can do in improving relations are firstly to reduce monotony and increase interest, where staff want it, and secondly to simplify any work that is too difficult. But underlying both are four considerations that will affect the quality and quantity of work:

The will to work.
A well-planned job.
Continued concentration.
Skill.

Much that is involved in the first three considerations belongs to the sphere of the 'untouchable' — that is to say, that few managers, and no O and M staff, will interfere in the highly personal matters that condition all three of them. The main practical contribution to be made is obviously in planning the job well; yet there may also be some contribution to be made, directly or indirectly, to each of the other three — will, skill and concentration.

The Will to Work

O and M recommendations usually involve change. Some of them may affect the staff themselves, or the relations of staff with supervisors and managers, unless the changes to be recommended are intelligently developed so that they can be evolutionary and gradual instead of revolutionary. The section on 'Conduct of the Assignment' laid down that O and M recommendations must be very carefully explained, and accepted on their merits by those who are going to live with them. The advantages to be derived from them should be apparent and ample time should be given to make them so.

It is perhaps trite to mention that there are two forms of relation in any business — the formal relations of duty, and the informal relations of friendship or cooperation. When duties are reorganised, new relationships have to be created of a formal and informal nature. Some staff will have to cooperate closely with people they do not know or do not like, whereas previously they may have worked with someone with whom they were on the best of terms. When any reorganisation of structure is attempted attention has to be given to good leadership as the touchstone of good informal relations, particularly during the phase when the new organisation is 'shaking down'.

Should leadership be used, or drive? Perhaps drive is implicit in leadership, but there may be occasional periods when a little driving is salutary, in addition to good leadership. The days of enforced discipline have largely gone, but the self-discipline that should take its place does not come easily. Staff have been known to like a mixture of leadership with a little driving, although the man who is only a driver may fail unless he develops powers of leadership.

What is leadership? Presumably every leader presents a different combination of qualities and abilities in association with his particular individuality. Some leaders are tough, some are gentle, some are noisy and some achieve their ends without any apparent interference in the habits of others. The attributes that in different proportions or mixtures seem to make up a leader will include fairness, initiative, enthusiasm, thoroughness, consistency, sense of timing, emotional control, tact, decisiveness, never giving unnecessary orders, and never issuing an

order unless prepared to see it through. These are not listed in any particular order, nor will any one leader necessarily possess all of them; but they seem to be noticeable in managers or supervisors who excel at handling staff.

The size of the working group, a subject touched upon in the preceding section, is sometimes important. A small group of up to five persons may not be large enough to withstand absences on holiday or sick leave. A group of ten may be large enough for its individuals to extend themselves, if one or two are away, and will cope with the extra load without the introduction of additional staff. People who form dislikes find a small group too small to work in. A group of ten may be large enough for them to find someone in the group with whom they can make friends, and as a result dislikes may not then arise. Universities have found that meetings of more than ten heads of colleges can be difficult. Businesses have found that very large groups generate friction which is not noticeable with groups of ten people. O and M, therefore, may make management difficult by so dividing work as to spoil good relations, although in other ways the organisation may look efficient.

Giving important work to particular members of the staff can have a valuable effect in acknowledging someone who needs recognition, but there is a danger in encouraging the individual or giving him opportunities to satisfy some personal motive. The balance lies between offering a sufficient interest to individual motives and securing cooperation within a common purpose; this perhaps underlines the importance of discussing with staff the purpose to which they are working, in the hope that they may come to understand not merely their own parts but the share each contributes to the whole.

Earlier in this chapter the statement was made that O and M can improve human relations by reducing monotony and increasing interest, or by easing work that is difficult. Emphasis is needed upon the idea of improvement, for the best can seldom, if ever, be attained. There is a danger in simplifying work without giving consideration to what the operatives want from it. Throughout the whole process of streamlining office procedures, the regrouping of tasks or organisation must be considered as a means of restoring an interest which may have been killed by over-simplification.

Because there is no single answer to creation and maintenance of the will to work the possible answers to the following three pertinent questions may suggest to each reader a different line of treatment.

Why Work?

'To get money.' 'To get away from home.' 'To widen the matrimonial horizon.' 'To get on.'

Why Work Slowly?

'Don't like the supervisor.' 'Something isn't fair.' 'Other people are going slow.' 'Dull stuff.' 'Too difficult.' 'Not feeling too good.' 'No-one seems to care, so why worry?' 'Going out tonight, or went out last night.' 'Didn't know I was going slow.' 'Don't like the people I work with.'

Why Work Hard?

'Like the person worked for.' 'Other people are working fast.' 'The work is interesting.' 'You get home sooner.' 'Self-discipline — taught to work fast.' '*They* notice hard work.'

A Well-Planned Job

The ideal structure, from the point of view of presenting no problems of organisation, management or handling of staff, is the small unit headed by one man who knows intimately not only the work but also his staff, and is a good leader. The opportunities for misunderstanding, paper-administration, for 'line-shooting' to a chief who does not know what is happening, or for bad supervision are all diminished. The manager, knowing his work well, does not need to spend very much time on paper work, but can himself move about among his supervisors and operatives and prevent work from going wrong or relationships from going sour, before either becomes bad enough to create a serious problem. From the human relations aspect, therefore, it is important to ascertain the optimum size of the department because it is the easiest to manage; the size will vary according to the work being done, and the measure of it is that one manager can, with first-hand knowledge, manage

all operations and personalities. O and M can help in determining this optimum and in recommending reduction or increase, to that size.

In a large organisation there is a corresponding need in a well-planned job for flexibility and understanding of both sets of problems, of work and of staff. The requirement is for close coordination of work and the establishment and maintenance of good relations up, down and across the business, resulting in close cooperation and a community of interest.

As has been suggested in a previous chapter, human relations do not present a separate subject. They are closely connected with the management and the direction of the work. If these are bad, apart from good or bad leadership, good relations are difficult. When O and M is directed to review organisation, which includes studying the harmonious interrelation of functions and staff, then it may make a contribution towards good human relations throughout the business. O and M has to look out for symptoms of bad organisation such as 'Nobody told me; I didn't know what they were doing'. This may recur until new informal relations have developed or special coordinating measures have been taken to bring people together.

There is a danger that those concerned with reorganisation may place too much weight on organisation charts to show new posts. Charts are necessary, but the posts shown in them have to be held together with a flexible human coupling of staff and their relationships. These couplings do not appear on the chart, and have to be developed to make a new organisation work well.

Some difficulties are removed if the chief will make a point of explaining 'the big picture' to as many of his staff as possible. As already mentioned, staff cannot be expected to cooperate intelligently with something they do not understand. If the policy and objectives have been changed, the new arrangements need not merely statement, but explanation, as to how they will affect day-to-day operations and their management. These may not be known all at once, and may need to be disclosed over a period of time. The planning of work demands not only an efficient layout of the job but consideration and allowance for the abilities of staff and their relations with one another. History shows that early attempts to achieve efficiency failed because of neglect of the effects of efficiency on the staff.

Skill

Consideration must be given to as many as possible of the effects of change in methods upon the different classes and ages of staff who will have to carry them out. Some older staff, good at their jobs, use a routine and experience they have accumulated, but not necessarily understood; they may be jolted out of their positions by being given new work to do. Some new office work demands a level of thinking that is outside the scope of existing staff. The new systems or machines recommended may be better suited to young staff than to old. In any case, young or old, they must be able to adopt new work habits to replace the ones that have been changed. They will make more mistakes during a learning stage, and they will need help to be able to build up speed and accuracy in the new methods. Apart from this, the supervisor and manager will have considerable variety of headaches from 'teething troubles' and may have to work longer hours, without overtime, dealing with these problems.

Specialisation of work takes two forms; specialisation on difficult work, which is a means of giving good staff an interest in what they are doing, and specialisation on easy work, whereby some operation is performed over and over again. With good staff O and M on occasion may be able to suggest specialisation on particular difficult work, but this is dangerous, if left permanently, because only one member of the staff will be able to deal with the more technical side of the work, and if he becomes temperamental or sick the organisation breaks down. With untried staff, or when there is no time for training, specialisation on a small portion of easy work will give valuable results. Very seldom should this organisation remain for very long.

Continued Concentration

In this section it has already been suggested that the major contribution of the methods officer to human relations lies in making the work more interesting and less difficult. However, some staff like routine work which does not demand much thinking, so that once a habit or routine has developed they can take a mental rest, and yet satisfy the supervisor with their output. This is less noticeable perhaps in the office than in the works, but there are jobs in offices which are extremely simple,

for which this class of staff may be well suited. Some simple office machines appeal to these same people, and mechanisation may be essential if good staff cannot be obtained.

Other personnel will dislike monotony or boredom, and prefer work that is interesting. They like an organisation that allows them to see the beginning and end of a job, for instance, a letter and its answer. Cases are plentiful of the regrouping of work so that staff can have an interest and a personal association with, for example, everything that concerns a whole group of customers. This organisation has been suggested in a previous section.

Concentration demands the ability to shut out interference, combined with an interest in the task in hand. A later section will be devoted to the improvement of working environment to reduce distractions; thus perhaps all that need be said on maintenance of close concentration is to stress the need for association by the worker with his interest in the work and, therefore, in its success. In large offices where groups of staff do similar work, competition between the groups may be encouraged to provide a different form of interest.

To summarise this section, most staff, whatever their rank, contain a bundle of emotions and motives more or less under control which are influenced by other people, the organisation, their duties and the work undertaken. O and M can, on occasion, do something to put the 'externals' right when they seem to be wrong but can do very little, if anything at all, about the 'internals'. Some of the externals that may be varied to advantage are:

Monotony and interest.
Difficult or simple work.
The size of the working unit.
The size of the group.
The allocation of duties.
Misuse of staff, particularly in faulty allocation of work.

Some of the internals, which may or may not be studied and improved upon by management, are:

Relations between the Board and the management.
Relations between management and supervisors.
Relations between supervisors and operatives.
Relations between each of the different levels.

'Square pegs in round holes.'[1]

Opportunities for advancement versus frustrations.

Over-specialisation, whether on too small a job or for too long a time.

Any work of reorganisation demands a sympathetic understanding of attitudes that are not easily changed. Efficiency by itself is a measure of things mechanical, and organisation in contrast is very human. Investigations of methods, office organisation or main organisation will become entangled with human considerations, and the man who wants an exact answer as to what can be done about them, or a measure of human efficiency, is likely to be unsatisfied. He must learn to anticipate difficulties by considering the interplay of work and worker, management and manager. In doing O and M work the risk of upsetting staff is considerable. The business of being an adviser is of itself not easy, and is particularly delicate when nobody shares his view of the value of his advice.

The strength of an organisation lies in its human couplings, and these are the relations that link different levels and groups together. Perhaps the experienced manager knows all this intuitively, but the methods man may not yet have had experience as a manager. He has to rely upon advice from his elders, or may possibly seek out for himself some of the contradictions and cooperation discussed in this section, which is itself designed as a medium for discussion of a subject to which there is in general no answer.

Organisation for Management and Direction

The introductory section on organisation has outlined the three levels of work and decision which are distinguishable, even in a small business. The section on Office Organisation Factors was largely concerned with activities that are in some way measurable, in that for the most part they employ distinct processes, whether mechanical or clerical. Above this, at management and higher levels, operations are concerned more with the workings of the mind. They involve planning progressing, controlling and dealing with human difficulties;

[1] See section of Chapter VI on 'Job Analysis'.

they are also heavily preoccupied with the exercise of authority, that is to say, the taking of decisions or the forming of judgment. These processes are measurable in their effects, but not in their operation — hence the difficulty in estimating the 'productivity' of management.

Content of 'O' in O and M

It is difficult to draw the line between the restricted view of O and M, which emphasises methods to the exclusion of organisation, and the rather Utopian view, which sees it as a study of higher organisation. The emphasis will depend upon the circumstances of each business and the stage of its development. The line must be drawn at an appropriate level and moved from time to time from the limited approach to the wider approach. The purpose of organisation studies must not be regarded as a means to producing ideal solutions; all that can be done is to improve the state of affairs that already exists. Organisational studies are therefore a quest for improvement.

A minimum content for the 'O' in O and M is almost impossible to agree upon. Thinking on this subject has advanced further in America than in this country. There, top management is willing to discuss its problems with great frankness, with people down the line and with people outside the business, a much more open attitude than usually pertains in this country.

Reorganisation of Management

Experience of managing is an essential prerequisite to success in reorganisation at the management level, where the work is of the mind and not of the hand; the experience brought to bear by the manager may represent an unknown field to an O and M man who has never managed. Some companies find that when working at the management level O and M needs to co-opt a manager in order to interview other managers, to point out shortcomings and to recommend improvements. The newcomer to business must be warned against thinking that the organisation of management or the working of management are things to be treated as a matter of principle or a matter of theory. They are not; and herein lies the difficulty of a management or organisation survey. There are often considerable savings to be made from reorganisation, but the approach to the work is

difficult and unlikely to be successful unless associated closely with one or more of the managers themselves.

Static versus Dynamic Organisation

What is meant by organisation? The fact that organisation is apparently concerned largely with dividing up and apportioning — authority, function and management — and that the resultant divisions take the form of duties, which can be written down, has been known to lead to the assumption that organisation consists mainly of making lists of duties and perhaps preparing a chart for them.

Following this line of thought, some people hold that organisation is solely concerned with the structure of the business, i.e. with the allocation of duties and their resultant responsibilities. This view is a little static; the more dynamic view includes relationships, the exercise of responsibility, the carrying out of duties and the productivity and efficiency of management. The distinction between effectiveness and efficiency already made in this chapter should be carefully observed. Effectiveness is reaching the stated goal; efficiency measures whether that goal has been achieved with an eye to cost. Organisation in the dynamic sense must be very closely concerned with aiding the efficiency of administration and of management. In short, a study of Organisation concerns itself with how the management structure works in practice.

The Exercise of Authority

The two words, 'decision' and 'judgment', have been used in the introductory paragraphs to this section as though they represent different activities. There is, of course, some judgment in any decision, and there must, for effectiveness, be some decision in any judgment. Perhaps the important distinction to be made is that, at the lower levels in organisation, supervisors and managers are concerned with deciding matters that come within a laid down policy or a documented precedent; above that level, those engaged with policy, whether they are called executives or directors, are largely called upon to deal with unknown or unpredictable situations, for which no policy has been laid down and for which there is probably no exact precedent.

Consideration of what are called the lines of communication in business will show that some matters, involving policy or a new situation, must be referred up to the Board, if necessary, for judgment, whereas questions arising out of day-to-day business will be sent down to the manager or supervisor, who combines a knowledge of what is involved with an understanding of policy and precedent. The distinction between the downward movement of decisions and the passing up of matters affecting judgment may appear arbitrary, but is useful in determining correct levels for authority and in studying organisation in the broad sense, of structure, staff and authority, and particularly of authority, decentralisation and delegation.

Decentralisation

Decentralisation itself may be less a matter of broad policy and more the natural outcome of the geographical spread of the business which, in an international company, prevents rule by one man at the centre. Whether or not delegation is liked, a certain amount of discretion in day-to-day matters must in such an organisation be left to the local manager. Failure on his part to take action represents a negative aspect of decentralisation, as occurs when he is prevented from, or incapable of, taking action.

Diversification of products may in itself also demand decentralisation. The wider the range of products the less the likelihood that the men at the centre will be able to decide in detail what happens in individual subsidiaries. Geographical spread and diversification of products therefore bring with them as a matter of course a degree of decentralisation of management.

But decentralisation of authority means much more than this. It means a conscious policy to ensure that decisions are taken at the lowest possible level, at which first-hand knowledge and information are available and action can be taken. Every decision taken above that level is a reduction in the efficiency of the business. A survey of organisation often indicates to the objective observer that many decisions are taken at third and fourth information levels. Information reaching top management has by that time been vetted and edited so often that the ultimate decision may well be based on faulty information.

When decentralising decisions no conflict is necessary if

careful consideration be given to the nature of advisory services, the guidance or controls to be centralised. There must always be some means of coordinating decisions, even though the initiative to take them has been passed down the line. Decisions must be seen to be taken in the correct context of the broad policies of the business. Great care should be given to the choice of the kind of control to be imposed on delegated authority; by control is meant comparing and measuring performance against some standard, rather than the 'watch-dog' attitude.

Where there is a case for centralisation of operations (because of mechanisation, marginal time, cheapness, etc.) there should be no hesitation about reversing policy. Cases for centralisation may be:

The nurseling, a new company which is not yet strong enough to be left on its own to fare as best it may, but has to be helped by headquarters until it has outgrown this stage.

The subsidiary company which has run into difficulties, and therefore is given more management support from headquarters than could otherwise be justified.

The decentralisation of management involves delegation of the power to decide, itself largely an act of trust, since the centre shows its willingness to entrust part of its own authority to somebody else at a lower level. Failure to delegate to subordinates may well be taken as a conscious sign of a lack of trust in them. But the continuing difficulty of delegation is not always realised. A conscious effort is needed to maintain it, and a large number of acts of abstinence are also required, such as leaving letters to be answered by somebody else, and allowing other people to provide guidance and information; it means permitting someone else to do all the things that the person delegating knows he could do better; instead of backing his own judgment to take a decision he has his faith in allowing another person to take that decision for him. He must not delegate and then watch over the results, yet remember that when he delegates he gives away none of his own responsibility, but only the power to act in his name, and that he is therefore still to blame if anything goes wrong.

Another problem in decentralisation of a large company is the location of head office services. Do they need to be accessible

to everybody else? Will the fact that they have to be located centrally virtually mean that there is no decentralisation at all?

In making decisions, the main considerations are:

The choice between speed and quality.

The need for decision by agreement.

Some managements feel it is important to obtain agreement on decisions. Often, in the last analysis, when the choice lies between speed and quality, speed wins. This should not be taken to the point where the quality of decision is lowered, but is more a matter of timing, for seizing the key moment may be the essence of success. A sense of purpose is achieved by speed of decision.

Central Services

In the taking of decisions or judgments some improvement in organisation may derive from the study of three questions about the provision of advice on:

Policy, whether for interpretation of existing policy or for guidance in some new development.

Professional or technical questions. Is the manager quite clear who can give him advice or guidance, and are these service agencies (including O and M) efficient and willing to help? Are they all necessary?

Staff matters, when necessary. Can the manager be sure of help in any reasonable demand, and of cooperation from other managers in the horizontal transfer of someone who is causing trouble?

All these questions should be tied up closely in the cooperation between managers, but on occasion some of them are overlooked.

Centralised versus Decentralised Services

Services can be divided broadly into two kinds. There are the specialist services which deal with matters of a professional and technical nature such as accounting, purchasing, work study, research, legal and personnel management. The second kind is the general office service, such as mail and messengers, telephones, typing, duplicating, filing and statistics. In both cases centralisation is justified only if greater efficiency can be clearly demonstrated.

Professional Services

People with specialist training of a professional nature are relatively scarce and expensive, and need to be used economically. Smaller firms which cannot afford to employ their own experts may look to consultants or agencies; but employment of these brings its own problems. Where specialists are employed by a firm, they are usually centralised, so that they can best be used to the general benefit. Before considering the difficulties which employment of such people can involve, it is as well to be aware of the advantages:

Specialists assist the line (operational) manager to operate more effectively, and help with problems for which he has neither the time nor the special knowledge or experience needed; they improve the quality of decision.

They stimulate improvements, research and development in their own particular fields.

They collect information from inside and outside the organisation, and transmit it to the line managers.

They help to uncover needs for policy decisions, and to keep existing policy up to date.

They help to ensure some uniformity of practice. The chief virtue of this is that information can be presented to top management in a common form.

Difficulties which may arise are:

Personality clashes may occur between specialists and operational managers.

Unless great care is taken specialists can weaken the authority of line managers through their special knowledge, their nearness to top management and their contact with day-to-day operations.

Specialists may become out of touch with the needs of operational managers or indeed with the nature of the operations themselves.

To minimise the disadvantages and to gain the maximum benefit from specialist assistance, both operational and specialist staff need to be clear about the difference between operational and specialist (functional) responsibility; i.e. operational responsibility means day-to-day responsibility for the day-to-day running of persons and things, whereas functional responsibility means responsibility for a certain function throughout the whole

or part of an enterprise. Confusion can only weaken both the speed and the quality of decisions.

Functional responsibility may or may not be mandatory in the sense of exercising authority. The extent of authority needs careful definition, and operational and functional staff need to establish some mutually acceptable practice concerning orders between the operational and functional staff, and to make this generally known.

Decentralisation of Specialists

When a central pool of specialists serves a number of associated offices, e.g. a number of scattered factory offices, they may operate from a central point, or individual specialists may be outposted or located in some or all of the local offices. A problem of responsibility then arises between the head of the specialist department at the centre and the manager of the local office.

The principal factor for consideration is the importance of the proper leadership of the working unit. Anything which is likely to damage this leadership must be avoided. Coupled with this is what can be considered a fundamental fact, namely that a man works better for a chief who is near him. Consequently there should be a bias towards placing decentralised specialists, for operational purposes, under the local manager. The need then arises to keep the isolated specialist up-to-date and in touch with new developments in his particular field and to prevent him from 'going native'. He owes some allegiance, that is a functional responsibility, to the head of the specialist pool at the centre.

Defining Responsibilities

It follows that, in defining the responsibilities of specialist service staffs, the aim is to have them understand that their only task is to contribute the maximum benefit to the operational staff. Responsibilities are defined by the following alternative criteria:

The extent to which the specialist authority is mandatory.

The way in which orders may be exchanged between the operational and functional staff.

The responsibilities of a specialist located away from the

centre, both to the local manager and to the central specialist manager.

In any such definition a person should be made operationally responsible to only one chief, although he may have a functional responsibility to various other people.

The publication of responsibilities is a matter for controversy. The main argument for doing so is the definition and allocation of duties. Arguments against include the risk of rigidity and over-dependence on written instructions, and that duties should not therefore be fixed, but should change with varying circumstances and the development or otherwise of the person who bears them.

Centralisation of General Office Services

Some office services must of necessity come under central control, for instance, the communication services, principally telephone and teleprinter, mail and messenger services. Between these and the specialised work of the various office sections falls an area of work which may or may not be centralised. This includes typing, filing, calculating and statistics. The advantages of centralisation include:

Economy in machinery and stationery.

More highly skilled operation, training and supervision.

Supervisors and staff of other office sections can concentrate on their main work, without problems of administering fringe services.

The disadvantages include:

Possible queues and delays.

Difficulty in assessing priorities equitably.

Difficulty with regard to maintaining good relations between service staff and users.

Difficulty in keeping service staff adequately informed about content and significance of work.

Possible duplication of service by users, after experiencing one or two delays or errors.

It is sometimes possible to minimise these disadvantages by centralising control of service staff, but at the same time breaking up one large central pool into smaller units located near the users. This increases the problems of supervisors, but reduces the delay factor, and thus helps in establishing good

relationships between service staff and users. In such cases it is important that the small units should be large enough to be 'viable'; an example of a service where this does not apply is the preparation of statistics by means of punched card equipment. On occasion the central service is relied on to produce slow and accurate data, while this kind of work is duplicated by the users of the service for selected items, when approximate figures are required at short notice.

Decisions

The question of the level at which decisions are made is important. There is often an implied assumption that the higher the level the better the decision will be. In general terms, decisions should only be made at the place and level where full and first-hand information is available. The relevant factors which affect the selection of the proper level of decision include:

The standard of knowledge required for making the decision. Decisions are often reserved for a higher level than is warranted on the grounds of information, because staff at lower levels are not adequately trained and informed. The quality of decision by clerks improves with their contact with people and things; with the people whom their work affects and by whom it is affected, and with the products, materials and other things which are similarly connected with their work.

The calibre of staff at lower levels. In thinking of clerical work there are two types of intelligence involved. The first is that which enables a clerk to absorb a great deal of detailed knowledge, e.g. detailed official regulations. The other is that which enables him to weigh imponderables, and to use his judgment in making a decision. The two do not necessarily go together. There is often a tendency to overrate the calibre of person required to do a particular job, and to underrate the effect which greater responsibility, and thereby greater interest, can bring. There is no easy method of finding out whether staff are capable of making decisions of a particular type. The best that can be done is to try them out, ensuring that they are properly trained and guided in the early stages.

Personal responsibility. There are certain cases in which the level at which decisions are made is governed by rule. Most of these rules have a financial basis, e.g. people permitted to authorise expenditure. If these rules are causing minor decisions to be pushed to too high a level, they should be reviewed. Other than this, certain people may have acquired, by custom or ability, the habit of making decisions which would be made better elsewhere. Changing circumstances play a part in this, and the exact application of personal responsibility may require occasional review.

Controlling Decisions

If information is passed down the line or out from the centre, so that decisions can be made without check or delay, work is speeded up and individual responsibility is increased. For this to be achieved, several things need study:

The type of decisions made, and their frequency.
The information and advice required for these to be made well.
The information required by central or higher management to enable them to shape the strategy of the business.
The kind of decisions that need to be recorded or notified.
Treatment of mistakes, including sanctions and reprisals.
Responsibilities concerning mail and documents.
Circulation of copies.

Coordinating Decisions

It should be regarded as a rule within a department that as far as possible the organisation structure should be designed to promote necessary coordination, and that people should be trained so that they work together towards a common end, and realise when others should be consulted. As a corollary of this, managers should see that everyone down the line is sufficiently aware of departmental policy to ensure that they work in concert.

Organisation and the Individual

In considering any organisation structure the personal qualities of the individuals in it should at first be ignored, so

that an organisation suited to the purpose and the work process may be designed. The next problem is how the design may have to be adjusted to suit the staff; this element of human ability may also affect the levels of decision. If the staff cannot do the work designed for them or are unable to accept the necessary responsibility involved, the questions arise as to whether they can be helped to do so by further training, and whether management in the past has done all it can to develop people to accept greater responsibility.

If it is necessary to adjust the organisation design in such a way, care should be taken to see that good organisation is not lost, and that the manager retains an ideal organisation chart, which he is gradually adapting and keeping up to date.

On every movement of staff, the existing structure should be reviewed and a step made towards the organisation desired. If this is not done, people can be sought for jobs which were fashioned to suit other and quite different individuals.

Organisation for Management

The management level of authority lies necessarily between broad policy and detailed operation. Management itself is in the stage of emerging from direction. Within recent years the directors alone managed the business with clerks to help them, as they still do in small companies. As a result, the organisation of the management level often either reflects the top organisation of the Board, or has been set up as a bigger and better level of supervision. This means that either the management consists of a number of managers, each acting as an assistant to one or other of the directors or that, alternatively, each main group of operational activities has a supervisor, and for every three or four supervisors there is a manager.

There is a constant rise in the cost of administration, i.e. of total operating costs in business incurred other than in the productive and selling process. In America as well as in Britain the employment figures of people who do not appear to be engaged directly on productive processes are rising in a staggering way. Are we content to allow the cost of paper work to increase in the way it does? In this problem a distinction must be made between (direct) commercial paper, that is, the evidence of buying or selling goods, storing them or holding

them, invoices, stock sheets, etc., and the (indirect) information called for by management. Often one is based upon the other.

There is room within the broad limits of organisation to examine management information; to find out what are the facts upon which management base their decisions; what sort of facts they collect; what kind of information is required at different levels of management. Often there is some confusion as to what is required. Some people in a head office will say that nothing is required except that which is directly necessary to the running of the company. Anything else, they say, is worthless information. On the other hand, head office may want certain facts which may themselves have to be consolidated and deduced from information supplied by local companies.

Who shall be responsible for seeing that management gets the minimum information required for managing? Perhaps the accountant, because so much information develops from financial records in the accounts office. On the other hand, many consider that the field is too broad to come under the heading of accounting information, because of the physical information that is frequently required, e.g. the amount of steam required, the amount of labour hours required to work a certain machine. A vast quantity of information arising from work study is needed by management, and much of this is not in money form but in physical measurements.

Managers themselves often ask for information which they will never use. This can happen in the case where a manager has been promoted within the same part of the organisation and may wish to retain all the information gathered since he began the job. The better manager will allow some external body — whether external to the department or the company is immaterial — to examine the flow of information. Valuable results can be obtained by this method, and the information required by management at each level can thus sometimes be defined and later reduced.

Near the top of an organisation the necessity for material of a detailed character diminishes, but what is left should be more precise, objective, directional information. It may be based on the same basic data, but should be presented in a different form for top management purposes. The manager may himself know what is happening in the region, and the man in the region

know what is happening in the depot, but the man at the top should seldom know in detail what is happening at the depot. If he has information of what takes place at all levels he may often draw different conclusions from those his regional manager is drawing. Management information should be made appropriate to the decisions which have to be taken at each level.

In order to manage, information is required from planning, progress and control. The way in which this information is presented is a matter in which O and M can assist. A separate chapter will follow on management information, but the broad principle is to simplify the presentation of information so that the manager may be in command of the situation without spending too much time in piecing together the various parts of his duty.

Management Capacity

Under these conditions, two considerations affect the organisation of the manager. Firstly, how many different kinds of work may one man manage? (Not how much work, but how many different kinds of work, because there is a state of worry arising from constant switching from subject to subject.) Secondly, with how many people above and below him can a manager deal? Given good supervisors and a homogeneous kind of work he can have a large number of subordinates, depending upon how many of them require direct access to him. An increase in the number who give him instructions, whether operational or functional, from above may, however, become serious, for thereby his work becomes too complicated.

These two considerations may be combined under one label — 'the range of attention'. The range will vary with each manager. Some will like a large variety of subjects to manage; some cannot work comfortably with more than three or five different subjects. The consideration is personal to the manager, although obviously it affects the way in which work can conveniently be organised.

Another consideration that is sometimes important is that of the interlocking of decisions. Where a decision is self-contained, the number of decisions a manager can take may be limited only by his capacity. Where, on the other hand, the decisions he takes will affect another division or divisions of the business, he

will need to take a considerable number of other considerations into account before he makes any decision, and will need much more time. This consideration also has a label — 'span of control'. There is no exact measure of this span, often said to be between five and eight, for some individuals can coordinate decisions better than others. An important distinction is that the span of control only applies where decisions have to be taken which affect more than one subject, division or department of the business. The label has been used on occasion as an excuse for 'empire building' where the decisions have been self-contained. There are many examples of the application of the 'span of control' theory, but two of the classics are involved in building a warship or making an aircraft — decisions affecting each main part have to be coordinated with other decisions about other parts or the ship would not float, nor the aircraft fly. There is, then, in these cases a limit to the number of subordinates whose decisions a manager may manage. Quite often business is organised so that decisions are self-contained, and no question of 'span of control' arises, only the considerations of range of attention.

In the sections on Office Organisation Factors and Human Considerations, reference has been made to the comfortable size for a unit, comfortable being used in the sense that the manager is able to know all about the work he is managing and all the staff working for him. Under these conditions he is able to work with the most simple of organisations and a minimum of paper. He is able to leave his chair to see what is happening and how people are progressing. He can be available at particular times, or any time, for interviews with staff who may want guidance or advice, or have problems to raise. The optimum size will vary according to the difficulty of the work and the ability of the particular manager to remember names and faces, abilities and limitations. Where O and M is able to suggest the division of units into sizes that are easy to manage, the whole organisation benefits from smooth working.

No manager can be considered a good manager unless, in addition to his technical and specialist knowledge, he has an understanding of personnel and organisation. Because a man is good in his technical field he is not automatically a good manager. Sufficient importance is seldom attached to training a

man to be a good manager, although importance is given to training him technically. Many problems of organisation stem from this fact.

Division of Managerial Work

When the company becomes very large or the work becomes specialised and technical, a new division of work appears at the management level. The manager is given planners, progress chasers and controllers. This organisation represents an attempt to divide the work of management into these various parts of managing, in contrast with the usual method, which is to divide the field of management by different products or convenient tasks for sub-managers. The investigator may, on occasion, find that he is able to help an overburdened manager by dividing his work in one or the other of the ways suggested, but there is no golden rule to be applied. Some managers will delegate gladly, some will go through the motions of delegating, but insist upon keeping the decisions to themselves. In this case the provision of sub-managers merely increases the number of people with access to the manager.

O and M should be encouraged to assist management to identify their problems, even though they are not allowed to solve them. Frequently the department does its best work when it can assist managers to understand the precise nature of their own problems, even though no attempt is made to tell them how to solve them. Often when management does identify its own problems managers produce their own solutions.

Cooperation

Cooperation is necessary at all levels of business, but at the management level cooperation is of vital importance. The division of authority between managers is an artificial one of a single responsibility, and can be an embarrassment to those above unless the heads of divisions are ready to help one another at all times.

The work of coordination is different, for coordination is the rejoining of subjects divided during organisation. Coordination may be effected by appointing one man as the chief of several divisions whose work has to be inter-connected; on other occasions coordination is achieved by a committee or a Board.

Apart from the inter-connection of subject, cooperation of those in charge of each subject is essential, for without their help coordination is difficult. Perhaps O and M can do little about lack of cooperation, for the answer does not involve reorganisation but better leadership, or better selection of managers.

The investigator should ascertain what machinery, if any, is at present employed to bring different managers together for various purposes, in order to develop cooperation. He may suggest a need for short meetings, with the chief in the chair. He may be able to suggest aids to coordination also, some of them of a physical character, such as the positioning of staff.[1]

Main Organisation

Some help may be obtained in analysing good organisation from writing down some of the recognisable symptoms of bad organisation. These may include over- and under-loadings, duplication between different levels of operations, management and policy, unnecessary duplications of processes, rewriting and copying, rechecking, a hundred per cent checking, omissions, delays, undue haste, too many committees, failure to coordinate, lack of cooperation, conflicts, too-ready compromises, breaks in the line of authority (irresponsibility), round about treatment of matters needing immediate decision, unnecessary inflexibility in functional direction or advice ('red tape'), overstrain upon top management, excessive paper work, conflicts between specialists, queueing for decisions, frustration.

These symptoms apply at different levels of organisation, some low down, some high up. An important question for a book such as this is to decide how much organisation an O and M man should understand before being allowed to move into the deeper waters of any problems of organisation that may arise. It must be emphasised that this is not a question of knowledge or memorising or expertise, but merely one of understanding the difficulties, and the possible contributions of alternative methods of organisation.

Whatever views are held about the organisation content of O and M there should be someone whose function it is to assist management in ascertaining whether the best use is being made

[1] Discussed in the section on 'Design of Buildings', page 355 *ff*.

of man-power, materials and equipment. When a survey is to be attempted the investigator must first push the background of the company's organisation into the forefront of his mind. He will usually find that the existing organisation reflects the interaction of four main factors:

The purpose of the company.
Its past history.
Personalities.
The philosophy of its management.

Purpose in Organisation

The purpose of a company changes. The small company may have a limited purpose, to make one single product; as it grows it may buy up competitors, other small companies, and enlarge the overall purpose in different ways. This purpose is not solely to make a profit, although obviously no company can remain in business without making a profit. Today the emphasis on different products or different lines of product may be changed, giving a new slant from industrial to consumer sales, or from home to export business, to the purpose which governs the whole organisation. In some companies the purpose of the whole and the subsidiaries is the subject of study as much as the management and the organisation.

Past History

Tradition has value and has faults. The old-established company has a sense of continuity and, if it has been well managed, an excellent loyalty. But looking backwards is of itself very little use in changing markets and the danger of too strong a tradition is the sterilisation of policies. The view that because something has always been done in a certain way it will therefore continue to be done that way reveals the absence of progressive ideas. The investigator must, however, be warned against lightly disregarding tradition, for in an old company the tradition is probably indicative of something good, even if that is now out of date. He has to study the history in the light of the purpose of the time, so that recommendations can be based logically on changes of purpose and may not appear as criticisms of tradition. Loyalty remains a force which the professional manager disregards at his peril.

Personalities

Some businessmen say that all organisation is a matter of personalities. In part this is true, because organisation, particularly at high levels, is the division and grouping of people to take important judgments and decisions. Personalities change as individuals mellow and retire. Some major reorganisations have to wait until the retirement of a key executive. In the large corporation personalities, although still important, are no longer as important as they were in the earlier family stage of organisation. These questions do not apply only at the top. At various points in the main organisation personalities may obscure the purpose and the organisation. In some companies the grooming of executives is a constant preoccupation, to eradicate over-specialisation of function or technical administration, or the association with one particular part of the business to the exclusion of others.

Philosophy of Organisation

Whether the attempt is deliberately made to develop a philosophy or not, some company policy of organisation will evolve on its own. Some companies prefer to do their own development, to state their philosophy, their attitude to the problems of business and to the problems of organisation. As part of this attitude they show a willingness to discuss these problems with the people beneath them, whether at an annual conference or at occasional meetings.

Organisation Studies

Organisation studies made in any business must be determined by the climate in that business, and the type of study permitted. If it is to be of any benefit, each study must be tailored to fit the particular circumstances. Who is the best person to undertake these studies? The investigator must have great discretion, and know how to approach his subject by other than purely rational means; he must be the type of person who can keep an enormous amount of information to himself. He is dealing with people, and something more than tact is necessary to succeed. There is an ethic in this work, and although on occasion it may be necessary to report upwards,

great care must be taken over so doing if the investigator is to continue the job. He needs an enquiring mind and to be creative.

A good deal can be done towards training a man for this work inside the business, depending upon where he is allowed to operate and the experience he is allowed to accumulate. Obviously there is a question of level, and junior people cannot be allowed to investigate at senior levels; the best solution is perhaps to have available a wide range of teams at all levels. It is very unwise to put an inexperienced person on an investigation, not only for his own sake but because the reputation of the department also is at stake. Not infrequently managers will adopt new methods, but their own experience and knowledge must be taken into account and the objective view of someone from outside is not always advisable. A careful inside approach is better.

Another question often asked is whether to start an organisation survey from the top or from the bottom. This again must be answered in the light of the climate of the situation concerned. If it is necessary to start a study at the top, this must be done, but it is better to leave the study if difficulties are encountered thereby than to waste time. The effect of walking out to take on another urgent job may suggest the need for a later recall. The investigator must not be worried about being rebuffed or rejected.

Alternatively, the survey started at the level of operations gives valuable experience to new staff. If, in fact, the investigator has the management behind him it does not matter where he starts. He can even start in the middle and work outwards. If the climate of opinion is good and the management is making it known down the line, then the way is clear and O and M should go ahead in the best mechanical way it can with the resources it has to hand.

Summary

No form of organisation is perfect, even at the time of design. To form a balance sheet of the good and the bad points of every division is helpful. When the organisation of department 'A' is approached it is recognised as a division, say, by process. The advantages and disadvantages of this are automatically noted. The four or five alternatives that could be used for the same

work must be marshalled in the mind. For each alternative another balance sheet is made and gradually, by a process of elimination, the number of alternatives are reduced. Because of the interlock between organisation and methods, and before finally accepting that the stated purpose of the organisation is sound, the method must be examined to see that it is designed to suit the purpose of today. This needs to be done before finalising the alternative forms of organisation.

At this stage, a discussion with the manager is essential. The alternatives in mind should be placed before him, to find out if he has any particular leaning towards any one of these alternatives. Provided that the manager would be equally happy about the introduction of any of them but would perhaps particularly like the second alternative, the others may be dropped in favour of the one he likes. With care this reorganisation will then be his reorganisation. He has been given the opportunity of selection, has said that this is the way he would like the job done and should implement the changes thoroughly. If he does not want to have anything to do with the reorganisation, the chances of success are remote.

The advice offered suggests how to analyse a reorganisation, but does not tell how to reorganise. Reorganisation should not be attempted from a distance, and it is seldom possible to succeed in reorganising against the wishes of the man in charge. Success depends on a careful examination of the work and of the considerations involved; of working through the alternatives until several are found that might suffice; of approaching the chief for his decision as to which of the alternatives is most suitable to the conditions of work and his staff. Much of this work lies in preparation, careful thinking out and presentation. No suggestion has been made that reorganisation ought to be 'sold'. For success the man in charge must not feel that he has 'bought' it, but that he himself has chosen the new organisation, without any loss of stature, authority, importance or influence.

An objection is that the process is slow. But the alternative, 'reorganisation in a hurry', has been tried by some companies, and reveals that after a few months the reorganisation has usually 'slipped back'. The visitor who advised the change has left. No one admits responsibility for the change; nobody liked

it very much. A great deal of money was spent on the advice and on making the change, and the result is a total loss.

Resistance to change may not arise if:

The reason for the change is obvious or at least visible to those affected, and therefore acceptable.

The initiative for change arises at the same level as that at which the need has appeared.

The change is gradual, except where a 'shake-up' is absolutely necessary.

Wherever possible the change is tried out on a small scale, under observation, and only applied to the whole unit after any necessary modifications have been made.

Finally, there is the extremely difficult stage of implementation. Any major reorganisation will involve new habits, new routines, new duties and new responsibilities. Some people will have larger and some will have smaller jobs. To hand over the new organisation without some provision for 'after care' is inviting a failure within a matter of months. Any major reorganisation needs not a temporary interest on the part of those in charge, but a semi-permanent provision for dealing with the 'teething troubles' that will arise for a matter of months. The man who works out the changes should be available; he should at first be on call at all times and then gradually fade out, leaving all the decisions, authority, and any credit to those who remain in charge of the new organisation.

Why is it that the organisation of one manufacturing company does not suit another? Quite apart from differences of law, custom and objective between companies doing the same thing in different countries, there are changing considerations in the same company. These, as already suggested, will include the age and history of a company; the dynamic character of some companies, due to an expanding market or a particularly lively personality at the helm; the 'defence organisation', where a company's market may be slipping away, or where the Board will not change products and methods (when the organisation is for 'attack', great delegation is possible, but when 'defence' is the order of the day over-centralisation takes place on someone who may not dare to make decisions); occasionally the state of executive stagnation preceding bankruptcy.

Apart from these perhaps historical stages of organisation,

there are others, when there are too many clever men at the top, or not enough, or when there are too many smaller men at the management level. Normally an organisation adjusts itself very gradually to suit the quality of directors and managers, or the changing circumstances of the business. These subjects need careful consideration in shaping an organisation to suit the present conditions, work and staff.

The division of organisation into three separate sections may aid consideration, for no solution to any problem of organisation should be put forward that does not take all three considerations into account, namely, duties and their structure, personalities and their relations, and authority, responsibility and decision. In theory, all organisation which is only concerned with part of this large field must obviously be incomplete. There is no blueprint to show that under specific circumstances this or that theory should be applied. The suggestion here has been that the organisation should be tailored to fit the various considerations, whether of duty, person or authority, and that in consequence no two structures of organisations are likely to be exactly the same.

Organisation Charts

An organisation chart may be likened to an engineer's drawing. It can be a plan, showing the area of ground covered by a group of related departments or firms; or an elevation showing the height or 'distance' from the operator to the chairman; or a section at any point showing organisation in greater detail.

An organisation chart properly used is a valuable tool of management; improperly conceived or badly introduced, it can be the cause of much misunderstanding and ill-feeling. The uses to which it can be put are many. To revert to the analogy: just as from the engineer's drawing, for example, can be read off the quantities and qualities of material required to build the machine, so from the organisation chart can be ascertained the quantities and qualities of the men required to build the organisation. Just as with drawings, which may cover the same subject in different ways, the information to be derived from the study of organisation charts will depend to a great extent on the purpose for which they were designed. They can serve as a

basis from which the Personnel Officer will make an assessment at all levels of management of his requirements in terms of personnel in order to secure continuity, or to illustrate the plan for a projected organisation. They may be used to show the allocation of functions or division of authority and responsibility among people; they can describe the formal lines of communication with a firm, or a connection between people and posts. The simplest of all have an immediate and appreciated application as guides to the background, nature, size and business of a company when they are put into the hands of newcomers to the firm.

The word organisation itself has several definitions. It is sometimes used to describe, for instance, the formal structure of a firm. In this 'structural' sense, the main operations necessary to the achievement of the object of the firm are broken up and arranged into groups appropriate to individuals. This treatment gives a framework for a company. Again, the word organisation may be used to refer to the people in the framework — the organisms in the organisation. Provided that it is known in what sense the word is used, the organisation chart will give an accurate diagrammatic representation of at least the formal relations.

Organisation Charts and O and M

In tackling an assignment, the investigator needs two practical tools:

A plan of the Department into which he is going, i.e. an organisation chart.

A description of exactly what goes on inside that plan, i.e. a list of duties.

If the tools do not already exist, the investigator will have to make them. Since the organisation chart is probably one of the best known and most widely used (and misused) forms of O and M record, it will be advantageous at this point to indicate the main principles of its construction, and to describe a few of the commoner forms which it may be expected to take.

Construction

An organisation chart should be kept simple. Simplicity is the essence of good charting, and any attempt to convey too

much information by means of one chart will only confuse the reader.

The first requirement is a heading which makes clear the nature of the chart; the second is, somewhere on the chart, a date which will relate the information on it to a point in time, e.g.

ACME CO. LTD.
RESEARCH DEPARTMENT—PRESENT ORGANISATION
(March 1959)

or

ACME CO. LTD.
RESEARCH DEPARTMENT—PROPOSED ORGANISATION
(March 1959)

A note at the foot of the chart could indicate the department responsible for its preparation.

The principle of clarity should be consistent throughout the chart, and all descriptions of posts or functions should be adequate and unambiguous. Only vertical and horizontal lines are normally used and posts may be arranged either vertically or horizontally. The boxing may be omitted. Example 1 demonstrates the vertical arrangement:

Example 1

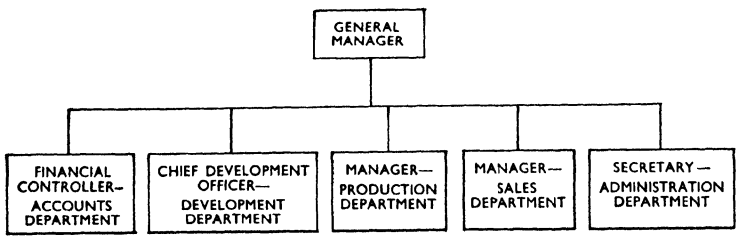


FIG. 33

The formal authority always flows from the top downwards. Thus, Example 1 shows clearly that each of the five officers is responsible directly to the General Manager and that each derives his authority from him. The chart also shows the responsibilities of each officer.

Example 2 shows the same posts arranged horizontally:

Example 2

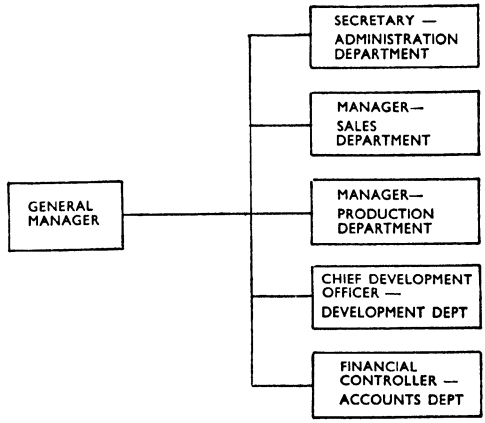


FIG. 34

Example 3 is a combination of the vertical and horizontal methods, and is used where there is a large number of posts to be shown and space is limited. Both Examples 2 and 3 are forms of charting which tempt people to read 'status' into them and to assume, for example, that the Sales Manager is of greater importance than the Production Manager merely because he occupies a position higher up in the chart. This may be the case, but equally it may not be; it is therefore of vital importance that a definite heading is given to the chart.

Example 3

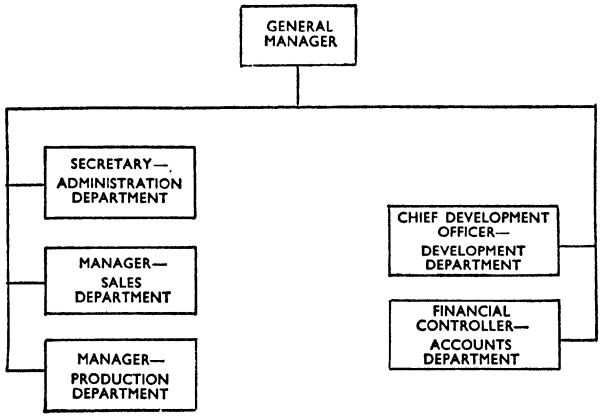


FIG. 35

Example 4 shows one way in which the attention of the reader is drawn to the fact that only part of the organisation is charted. Sometimes dotted or broken lines are used for the purpose, but this is to be avoided, if possible, since they can indicate lines of function (whether advisory or executive, in contrast to direct authority), informal communication or liaison.

Example 4

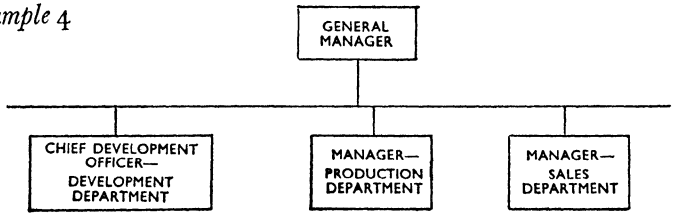


FIG. 36

There are several methods of recording the Deputy to a senior position. Great care must be exercised in choosing one which will properly describe the situation as it is found or as it is planned it should be. In Example 5 the Deputy is in the direct line of authority. This means that all communication between the General Manager and any of his first line officers (Financial Controller, Chief Development Officer, Production Manager, Sales Manager, Secretary, in this example) must pass through the Deputy. The Deputy is thus the effective General Manager, while the person filling the more senior post is only a figurehead. Such a situation arises in practice, for example, where the General Manager is on the point of retiring and has handed, or is handing over the reins to his successor.

Example 5

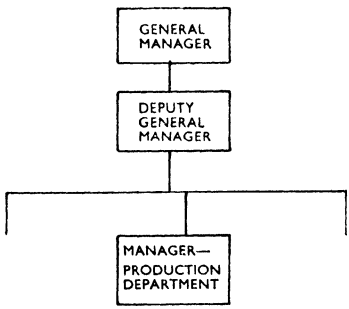


FIG. 37

The method of positioning the Deputy in Example 6 leaves no doubt as to who possesses the ultimate authority. It also clears the way for showing the direct responsibility of the Deputy for a particular function or functions.

Example 6

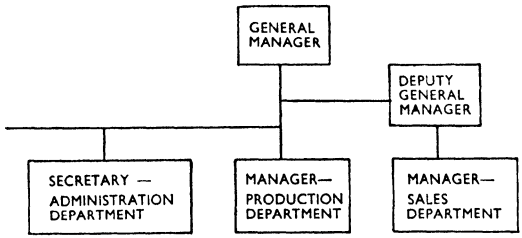
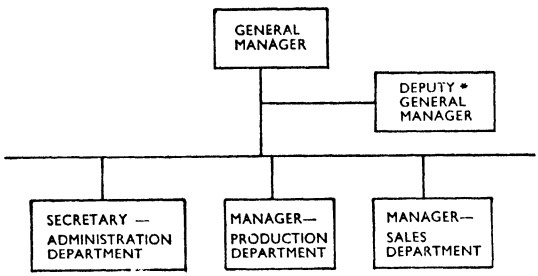


FIG. 38

This method of showing the particular responsibilities of the Deputy is open to criticism on the ground that they may be, and often are, temporary in nature according to the needs of the moment. They are liable to change, as the General Manager delegates different functions to the Deputy from time to time.

If the Deputy has specific functions these could be stated in a footnote to the chart. The functions are then shown on the chart in their proper place. If, for example, the Deputy is in charge of the Sales Department, the correct form of the chart would be, on this reasoning, as in Example 7. If the names of the officers are shown on the chart, the same name would appear under the Deputy General Manager and the Manager — Sales Department.

Example 7



* Deputy General Manager is also Manager of Sales Department

FIG. 39

As mentioned, dotted or broken lines may be used to indicate functional authority or staff relationship. Example 8 shows functional authority between the Controller and Departmental Chief Clerks. Alternatively, functional authority or contacts of an advisory nature can be shown in a different colour from line authority. An interpretation of Example 8 would be that the Chief Clerks (Production, Sales, etc.) are responsible for the day-to-day running of their sections to their respective Departmental Heads. The Controller — Accounts Department, cannot interfere in this, except in the case of his own Chief Clerk where he has line authority in any case. But he can give general guidance and advice on how work should be carried out, what returns are required and in what form, what procedures are to be followed, and so on. This kind of liaison can lay the basis for standardisation of procedures, forms, documents and reports where, for example, information is required from many different departments or sections.

Example 8

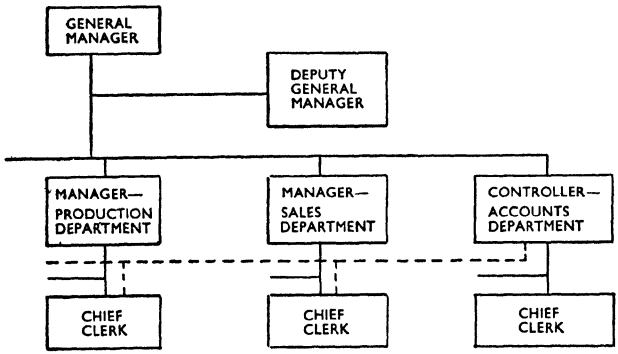


FIG. 40

The chart can be completed by applying the principles already stated for as many levels of the organisation as are desired. Example 9 completes the picture to the shop floor in the Production Department. The thick line indicates the line of authority between the operators A and G and the General Manager. It is the same for any of the others.

Example 9

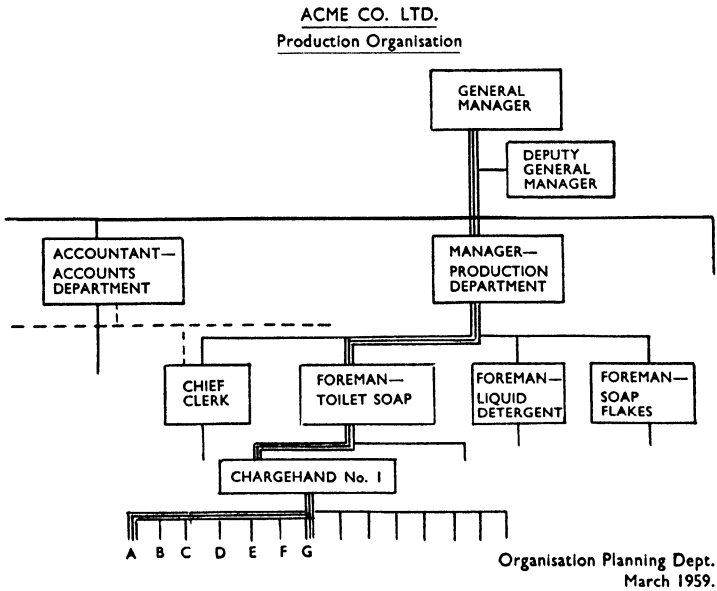


FIG. 41

The names of individuals occupying posts can be inserted if it is desired, for instance, to reflect changes in an organisation in relation to staffing or recruiting problems. However, if the chart is intended to provide a reference for some time to come they are better left out. It is worth while repeating that every organisation chart should carry a date which will relate it to a point in time. It might also usefully indicate the department which was responsible for its preparation. Example 9 incorporates both these points.

For particular purposes it may be desired to lay the main stress on the functional and advisory contacts in an organisation and in other cases they may be included only as 'incidentals' in order to lend background colour to the formal organisation which is being portrayed. Example 10 provides an illustration of the latter case, where the main purpose is to show the Works organisation.

Example 10

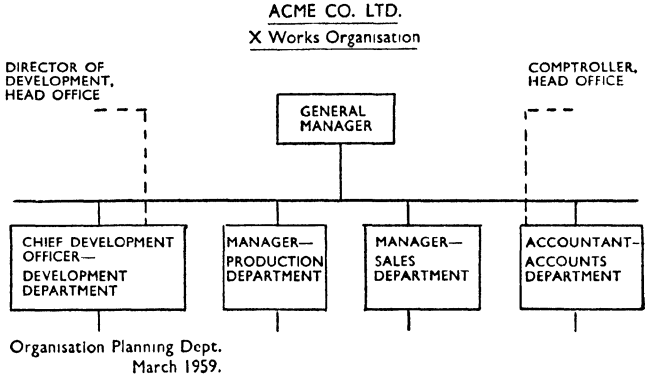


FIG. 42

Where, on the other hand, more emphasis is on liaison or the functional relationships, or aspect of an organisation, a chart similar to Example 11 might be employed. Certain of the line relationships have to be shown, of course, in order to make the picture intelligible.

Example 11

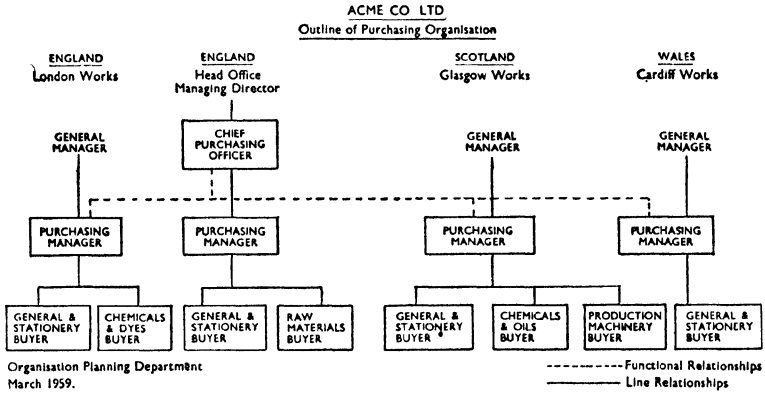


FIG. 43

Types of Organisation Chart

Two of the main types of chart have already been mentioned — the horizontal and the vertical. To these can be added a

third, the circular or concentric chart. A fourth type, the radial, is really a combination of the horizontal and vertical methods, and was developed for a specific purpose; nevertheless, a general application might be found in any company.

Chart A is an example of the vertical form, which is probably the most common.

Chart A

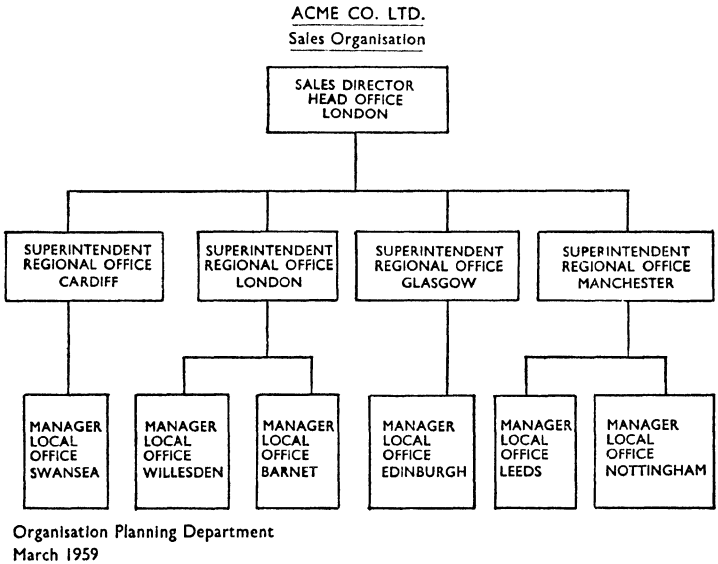


FIG. 44

A possible use might be to show the territorial spread of the company's markets. The relative importance, for example, of the London Market over the Welsh Area might be presumed from the fact that the former has twice as many local offices.

Chart B, which contains the same information as Chart A, is an example of the horizontal organisation chart.

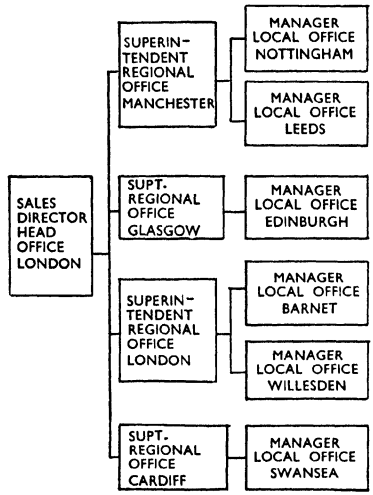
A chart of the type illustrated could, in conjunction with the table, be used to help in assessing intakes of personnel to fill posts becoming vacant through normal wastage, promotions and retirements.

Chart C is a simple example of the radial type of chart. It is very often used to show in which country or countries a firm

Chart B

ACME CO. LTD.

Sales Organisation



Regional and Local Sales Staff

Sen. Reps.		Jun. Reps.		Clerks		Typists		Total	
Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.	Act.	Est.
10	10	14	12	6	7	7	7	37	36
7	8	6	5	3	4	3	3	19	20
20	25	15	15	7	8	8	10	50	58
7	7	5	6	2	2	3	3	17	18
44	50	40	38	18	21	21	23	123	132

Organisation Planning Department
March 1959

FIG. 45

operates, or those to which its products go. For this and similar purposes it is eminently suitable. Its impact level is high; it attempts to get one main message or theme across, and succeeds because of its essentially simple nature. It would, however, become confusing in the example if it was necessary to show a relationship between, for instance, Cardiff and Glasgow.

INDUSTRIAL ENGINEERING (HOLDINGS) LTD.
Organisation Chart showing Geographical Locations and Products of Main Subsidiary Companies

Chart C

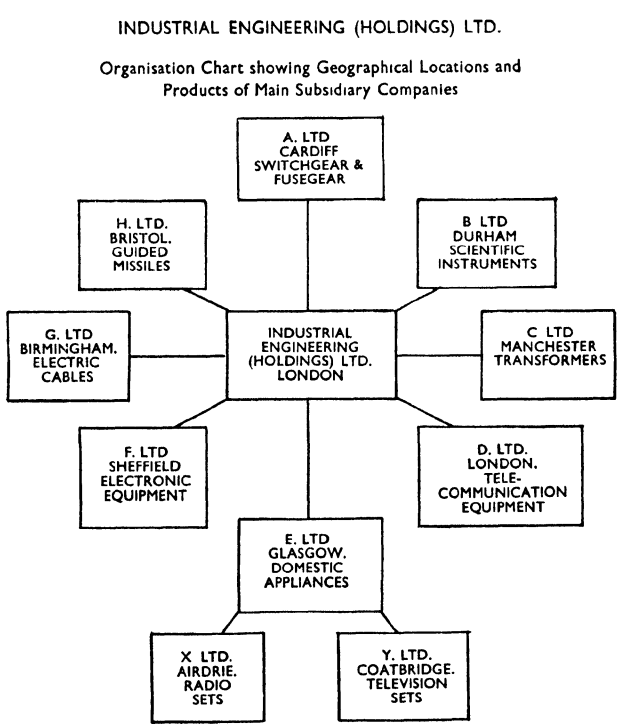


FIG. 46

Charts D and E are to be considered together. Chart D shows certain information in the 'conventional' way. Chart E is useful for someone who requires only names and jobs, e.g. the

Personnel Department, as a handy reference. However, it is not difficult to trace the relationships between individuals and groups of individuals. Indeed, the chart need only be laid on its side with the names to the top of the page to give a fair representation of a vertical type of organisation chart. This form of chart has been used with some success to introduce personnel to the idea of organisation charts in particular, and the subject of organisation in general.

Chart D

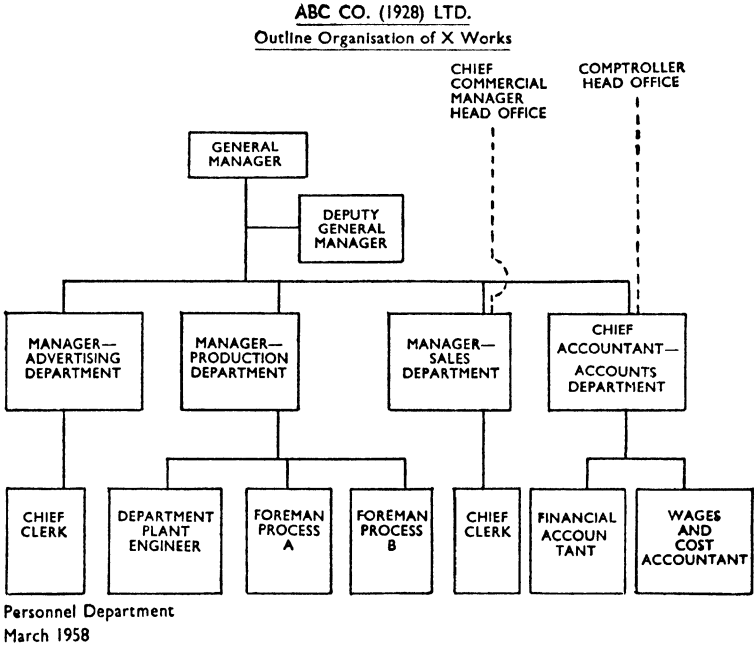


FIG. 47

General Considerations

Three cardinal points must be remembered when a chart is drawn — to give it a title, to give it a date and, above all, to keep it simple.

The tendency of people to read into charts something other than what was intended has constantly to be guarded against. The most common fault in this respect is that of viewing

organisation charts as status charts, when they are, in fact, meant to show responsibilities or to define functions. In Chart D, for example, although the Managers of the Advertising and

Chart E

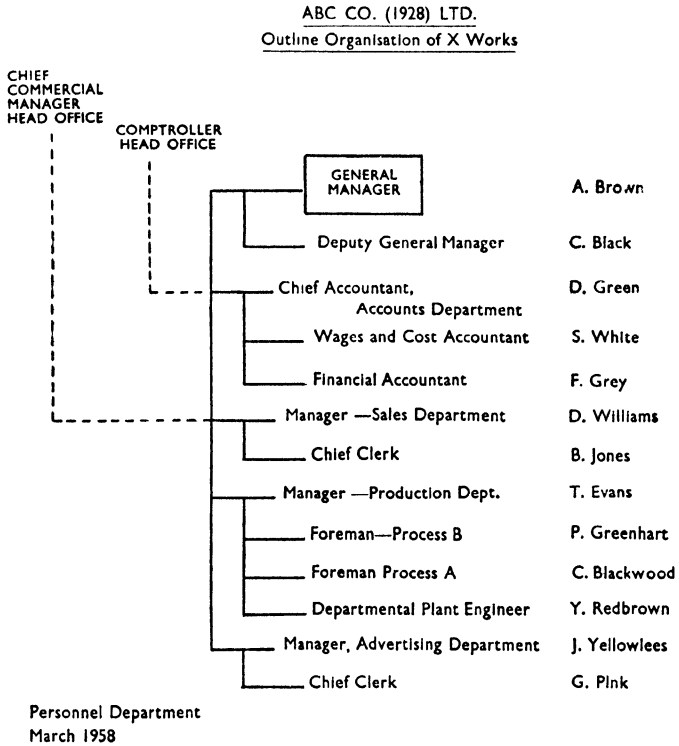


FIG. 48

Production Departments are shown in the same level it does not follow automatically that they enjoy the same status. The fact that such misapprehensions arise so easily underlines the necessity, on the one hand, for the person who is constructing a chart to know exactly what it is he is attempting to illustrate, and, on the other hand, for the person reading it to study the title and understand clearly the nature of what he has before him.

In practice there is no limit to the nuances and fine shades of meaning which can be read into or incorporated in charts. It does not pay to be too dogmatic without a full appreciation of

the particular circumstances. A chart must portray an organisation; the organisation may be a good, bad or indifferent one, but whichever it is the facts must never be bent to fit any preconceived notions of what a good chart looks like. The above principles of charting outline are not in any way changed by the nature of the work to which they are applied.

Uses

More particularly, from the O and M point of view, organisation charts can be used:

As a means of recording existing organisations, whether formal or informal.

As a means of recording proposed organisations.

To provide a starting point for discussion and analysis of either of these.

To help O and M to appreciate the size of the problem facing them when undertaking an investigation; and to indicate the best point at which to begin.

As a guide, enabling staff to understand the structure of the whole organisation, and thus their own position in it and, by making clear limitations to authority and responsibility, the contribution which each member can be expected to make.

In order to keep charts as free from detail as possible, separate lists of duties are sometimes compiled for each position shown. These lists can be referred to in conjunction with the charts as the need arises. Congestion on the organisation chart itself is thus avoided. In this way the essentials can be grasped immediately, omitting the lower levels for later consideration.

There are many other more general uses to which organisation charts can be put, e.g. they enable a positive personnel recruiting and training policy to be developed and carried out; they may also indicate past failure to provide for adequate executive and administrative leadership; job descriptions can be prepared; assessments of capital required to meet expansion can be gained; forecasts of buildings and equipment to achieve new objectives can be made, and so on. These illustrations are not by any means exhaustive, but may serve to indicate the kind of problem which the study of organisation charts may help to solve.

Conclusion

Organisation charts are two-dimensional at the most and use only straight lines. Real life relationships are multi-dimensional and often follow the most tortuous paths. The difficulties inherent in any attempt to illustrate existing organisation complexes by means of such an inadequate medium are therefore obvious. No matter how clever or curious the skill used or how numerous the colours and symbols employed, the chart so drawn does not disguise what is disordered and untidy. If without organisational change the chart is made to look symmetrical it will be so far removed from reality as to be valueless as an appreciation of a situation.

To return to the analogy between the engineering drawing and organisation chart, it will become clearer just what it is hoped may be achieved by the use of charts. A designer, by looking at a drawing, will be able to tell if it is a good one, and also if the design is in accordance with recognised principles and current practice. Similarly, the O and M man can constantly compare in his mind the charts he draws with the generally accepted patterns of good organisation, with which he is familiar by virtue of study and experience. Any divergence between the two will serve as an indication of the whereabouts of faults, and reasons can be sought and action taken accordingly. A chart will also help in rationalisation or avoidance of duplication of departments, functions or processes.

The chart will never, of itself, give a complete answer; at most, it will give a pointer. It is vital that this be realised and understood.

CHAPTER IX

BACKGROUND SUBJECTS

Statistical Sampling

In the course of O and M work; it is often necessary to obtain quantitative information; for instance, in a study of a sales office, the average time taken to process an order, or the proportion of orders containing more than three items. This information could be acquired from an exhaustive study of all orders received over a long period, but it is more easily obtained by examining a sample of orders and assuming that what is true of the sample is true of the whole. All sampling is directed at drawing general conclusions from limited evidence.

Sampling is frequently carried out without any statistical basis. For instance, in the above example, it might be felt that examining a week's orders would suffice; or an auditor might decide to check the accuracy of a year's accounts by detailed examination of one month's transactions and entries. Such applications of informal sampling take place constantly, and in many instances give adequate answers. There can however be pitfalls, in that common sense, intuition, or personal judgment may suggest that reliance may safely be placed on the evidence of certain samples when in fact it may not. Further, too much effort may be expended on occasions by taking a bigger sample than is required.

The advantage of applying statistical techniques in sampling lies in the fact that a certain specified degree of reliance can be placed on the results. From a sample of one size the average time to process an order might be estimated at 10 minutes plus or minus 20 per cent, and from a larger sample it might be found to be 10·3 minutes plus or minus 10 per cent. Statistical sampling answers these questions:

How accurate is an estimate?

How large a sample should be taken in order to attain a required degree of accuracy?

It thus overcomes the disadvantage that an informal sample

may be too small to give sufficiently reliable results, or too large and involve more work than is required for the purpose in mind.

It is not possible to devote sufficient space here to provide such knowledge of statistical sampling techniques as will enable anyone to apply them without further study. This section will therefore merely try to give an introduction to some of the methods used, and to indicate by examples where such methods may be applied. This should enable the reader to recognise possible applications in his work, and also to have an elementary knowledge of the field, which will ease the task of discussing a problem with a statistician or of expanding that knowledge from statistical textbooks.

The Variability of Data

Suppose that successive times for a particular clerical operation were (in seconds) as follows:

7·0	7·1
7·0	6·9
6·9	7·0
7·0	6·9
7·1	7·0, etc.

A fairly small sample would indicate an average time of 7 seconds in which considerable confidence could be placed. If, however, the successive times were:

4	10
9	10
10	5
5	9
1	7, etc.

while the average indicated might still be 7, this estimate could not be regarded with as much confidence as the first when taken from a very small sample. This is, of course, common sense; it represents an essential of statistical sampling techniques — that to make an estimate with a specified degree of reliability, the size of sample required depends on the variability of the data. Statisticians therefore require some measure of variability; the one most commonly employed is known as 'standard deviation'.

Standard Deviation

Most people are familiar with the term 'arithmetic mean', or average. The arithmetic mean of several values is obtained by summing the values and dividing the total by the number of values. To measure variability of data, some sort of average of deviations from this mean value is required. If the deviations are added in the normal way, positive and negative ones will balance each other out and their effect disappear. Accordingly, the mathematical trick of squaring these deviations before averaging them is used. In this way, they are all positive and do not cancel each other. The square root of the answer so obtained is known as the 'standard deviation' or 'root mean square deviation'. It can be calculated as follows:

Time of Clerical Operation	*Deviation from mean value 7*	*Deviation Squared*
4	−3	9
9	+2	4
10	+3	9
5	−2	4
1	−6	36
10	+3	9
10	+3	9
5	−2	4
9	+2	4
7	0	0
70	0	88

Mean $= \frac{70}{10} = 7$

Mean Square Deviation $= \frac{88}{10} = 8{\cdot}8$

$\therefore$ Standard Deviation $= \sqrt{8{\cdot}8} = 2{\cdot}97$

In practice, with real numbers rather than the convenient ones of the imaginary example illustrated, this method of calculation would prove rather tedious. Various arithmetical short-cuts have been devised which would yield the same answer; these can be found in any statistical text book. The straightforward but lengthy method has been used here in order that the student can better appreciate the nature of standard deviation.

In this example, what has been calculated is the standard

deviation of the figures themselves. If an estimate is required of the standard deviation of the larger range of figures from which these are a sample, a better answer results from dividing by $(n-1)$ rather than n, where n is the number of items in the sample. The word 'population' is used to mean this aggregate of similar items under investigation, because early statistical investigations were concerned with citizens.

In the above example, estimated standard deviation of population $=\sqrt{\frac{88}{9}}=3{\cdot}13$.

Frequency Distributions

The data shown in Figure 49 are times (in seconds) for the preparation of one hundred invoices selected at random.

FREQUENCY DISTRIBUTION

TIME IN SECONDS FOR INVOICE PREPARATION

66 5	65.9	69.3	70.2	64.3	64 6	68.0	73.2	67.9	67 4
67 7	68 8	67.5	63.8	67.6	68.1	72 5	71 3	67.0	58.3
65 5	65 2	74 7	66 8	63.5	68.1	70 5	67.0	65.9	71.6
70 5	66.5	66 0	71.4	63.4	66.2	69.8	69.3	70 9	69 8
64.9	66.8	67 3	66.7	69.6	68.5	65 1	64 5	62.6	67.7
69.4	69.9	68.2	72.6	65.3	68 4	67.6	66.3	70 3	69 8
71 2	67.0	68.8	69.7	66 3	67.8	69 0	64 8	66.9	70.9
66.0	64.9	73.9	65.8	66.0	68.7	68 1	70 3	68 0	61.2
65.4	67.5	68 3	63.5	68.0	67.5	64.6	62.4	67 0	64 0
65.4	65.3	71 8	69.7	69.8	67.4	65.6	68.3	66.6	66.8

FIG. 49(*a*)

Figure 49(*a*)

The times are shown as they were collected. It is difficult to draw any conclusions from these figures as they stand.

STROKE RECORD

61 -	I				1
62 -	II				2
63 -	IIII				4
64 -	𝍸	III			8
65 -	𝍸	𝍸	I		11
66 -	𝍸	𝍸	IIII		14
67 -	𝍸	𝍸	𝍸	I	16
68 -	𝍸	𝍸	𝍸		15
69 -	𝍸	𝍸	II		12
70 -	𝍸	II			7
71 -	𝍸				5
72 -	II				2
73 -	II				2
74 - 75	I				1
TOTAL					100

FIG. 49(*b*)

Figure 49(*b*)

Times are shown as a 'stroke record'. The strokes indicate each step of one second, i.e. the number between 61 and 61·9, 62 and 62·9, etc. The fifth stroke is drawn through the first four.

Figure 49(*c*)

Here the times are shown as a histogram. The height of each block in this diagram represents the number of times that lie within the range shown along the horizontal axis. It is easy to see from this that the most commonly occurring time is in the range 67–68 seconds, and that the frequency of occurrence tapers off on either side of this.

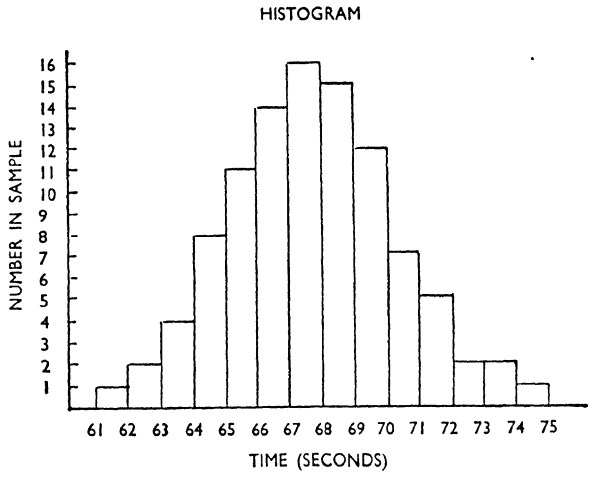


FIG. 49(*c*)

The histogram shown (Figure 49(*c*)) represents what is known as a 'frequency distribution', i.e. it indicates the frequency with which the various possible times occurred. If the sample were much larger, and smaller steps were specified — e.g. the data might be assembled in steps of one-tenth of a second instead of one second — then the histogram would have a much smoother outline. For a very large sample assembled in very small steps, it would in effect become a curve. Frequency distributions are therefore usually shown as curves, thus:

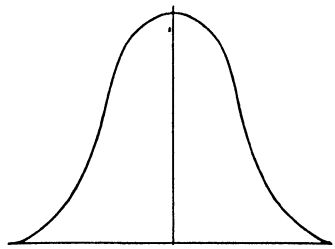


FIG. 50

The Normal Distribution

There are several distinct shapes that frequency distributions commonly take. One of the more common is called the 'Normal' distribution. The word 'Normal' was used originally because it was thought that if any natural characteristic were measured and the distribution plotted, it would make up a curve of this general form. In fact, it is not universally applicable, but it is true that many frequency distributions do conform to its shape, e.g. heights of people, school examination marks, etc.

A 'Normal' curve is always symmetrical and shaped like a bell. Both curves in the following diagram (Figure 51) are 'Normal' in form, and they have the same arithmetic mean, but the spread around that mean is different:

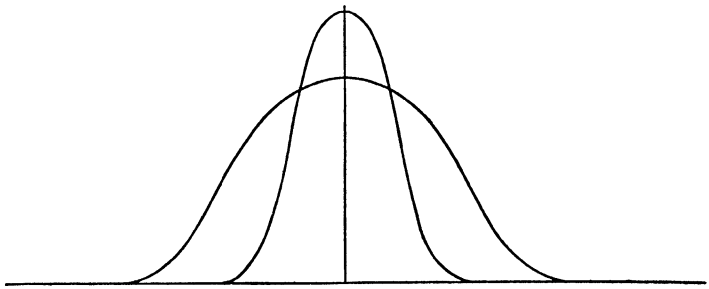


FIG. 51

The spread (or width) of the curve depends on the variability in the data, i.e. on the standard deviation. It will be remembered that this is what determines the size of sample required to make an estimate with a given degree of reliability.

The formulae given below for use in sampling apply only

when the Normal distribution is involved, and depend on this characteristic of the Normal distribution:

> that 95 per cent of all values lie within two standard deviations of the mean value.

Thus, if a Normal distribution has a mean value of 50 and a standard deviation of 5, then 95 per cent of values will lie between 40 and 60. If an item were picked from the distribution at random there would be only one chance in twenty (i.e. 5 per cent) of its lying outside that range.

Sampling for an Average

The sample of one hundred invoicing times on page 339 has an arithmetic mean of 67·6 seconds. The problem to be considered is whether this is a good indication of the average time for all invoice preparation in this context, or whether a different estimate would be obtained if a much larger sample were taken. To answer this question some further incursion must be made into the realms of theory.

Suppose that instead of just one sample of one hundred, a series of samples, each of one hundred items, had been taken. There would then be a number of sample means. These means would themselves conform to a Normal distribution, just as the items within one sample did, but would present a much tighter curve with a very much smaller standard deviation. The standard deviation of this hypothetical curve (for in practice there will only be one sample) would in fact be:

$$\frac{s}{\sqrt{n}}$$

where s is the standard deviation of the population (estimated from one sample), and n is the number of items in that sample.

A very interesting conclusion may be drawn from this, because of the particular characteristic of the Normal distribution mentioned above. Any one sample mean has a 95 per cent chance of being within two of these standard deviations of the true mean. Hence:

$$\text{True Mean} = \text{Sample Mean} \pm \frac{2s}{\sqrt{n}} \quad \text{.....Formula 1}$$

This formula gives the true mean of the population; i.e. in this case, all the invoices prepared in the invoicing section from which the sample was taken at random.

Q. How accurate was the estimate of 67·6 seconds?

A. Standard deviation of sample = 2·6 seconds

$$\text{Hence true mean} = 67{\cdot}6 \pm \frac{2 \times 2{\cdot}6}{\sqrt{100}}$$

$$= 67{\cdot}6 \pm 0{\cdot}52 \text{ (with 95 per cent confidence).}$$

The formula can be turned round the other way, so that the size of the sample necessary to give specified tolerance limits can be determined, for:

$$\text{Tolerance Limits} = \frac{2s}{\sqrt{n}}. \text{ Thus}$$

$$\text{Sample Size} = \left(\frac{2s}{\text{Tolerance Limit}}\right)^2 \quad \ldots\ldots\ldots\text{Formula 2}$$

This means that, for example:

Doubling the confidence limits allows the sample size to be *quartered.*

Halving the confidence limits means that the sample size is to be *quadrupled.*

Q. What size of sample would reduce the tolerance to 0·26?

A. $n = \left(\frac{2 \times 2{\cdot}6}{0{\cdot}26}\right)^2 = 400$

Sampling for a Proportion

Besides sampling to determine an average, the other case often met in O and M is that of estimating a proportion. For instance, what percentage of orders contain more than three items? What percentage of new employees leave within a year? What percentage of stores issues have a value of less than £1?

A sample of size n items is taken and the proportion p (as a percentage) of those which have the specified characteristic is calculated. Then if, as before, a whole series of similar samples is

imagined as being taken and the proportion for each found, these proportions would form a Normal distribution with a standard deviation, which here would be:

$$\sqrt{\frac{p(100-p)}{n}}$$

As before, therefore, with 95 per cent confidence:

$$\text{True Proportion} = p \pm 2\sqrt{\frac{p(100-p)}{n}} \quad \text{.....Formula 3}$$

$$\text{Sample Size} = \frac{4p\,(100-p)}{(\text{Tolerance Limit})^2} \quad \text{.....Formula 4}$$

Q. A random sample of four hundred orders is taken, and 20 per cent are found to have more than three items. How accurate is this estimate of 20 per cent?

$$\text{True Proportion} = 20 \pm 2\sqrt{\frac{20 \times 80}{400}}$$

$$= 20\% \pm 4\%$$

Q. What size of sample would reduce the tolerance to 2 per cent?

A. $\text{Sample Size} = \frac{4 \times 20 \times 80}{2^2} = 1600$

Some General Points About Sampling

Absolute Numbers

It is seen from Formulae 2 and 4 that the size of the sample required does not depend on the size of the population. This point has to be stressed because it is not what common sense suggests. For a specified degree of accuracy, the same size of sample must be taken whether the population totals 10,000, 1 million or 10 million. In fact, the theory assumes that the population is infinite. This assumption is satisfactory provided the population is larger than, say, 1,000. If it is desired to sample from populations smaller than this, the theory is more complicated and a statistician must be consulted.

Pilot Samples

A pretty dilemma arises in that the formulae for determining the size of sample, Formulae 2 and 4, depend on knowing the

standard deviation in the first case or the proportion in the second. And these cannot be estimated until a sample has been taken.

The way of overcoming this is to take a pilot sample and estimate the required figure from it. From this the size of sample can be calculated. A pilot sample should never be fewer than fifteen items and should preferably be larger. The standard deviation or proportion should be calculated again for the proper sample as a check.

How to Take a Sample

In taking a sample the random selection of items is essential. This means that whether a particular item is selected or not is determined by chance, and that the sample is not biased by any subjective or objective influence. For example, if estimating the average height of men, the sample should not be taken from the Brigade of Guards. If estimating the proportion of the electorate that will vote Conservative, the sample should not be taken from the floor of the Stock Exchange. Both results might be misleading.

There are various ways of avoiding bias. For example, if a sample of three thousand was required from a ledger of thirty thousand cards, it would probably suffice to take every tenth card. It would be necessary, however, to check that there was no peculiarity about the filing of the cards, which might cause bias. Thus, if the system provided for an active record to go on two or more cards, the straight selection of accounts by taking every tenth card would cause bias, because the more active accounts would have a greater chance of being chosen.

Lots could be drawn from a well-shaken-up hat with slips of paper representing the items, but this method is not normally convenient in the office. Its practical equivalent is a published table of random numbers.[1]

Homogeneity

Populations from which samples are taken should be homogeneous. If, therefore, a population contains two or more well-defined categories, it is best to divide it up into these categories and sample from each one separately. For example, if studying

[1] E.g. *Random Sampling Numbers* by L. H. C. Tippett.

absenteeism amongst the employees of a company, it is better to sample the sexes separately because the distributions of absence rates are likely to be different. This is known as 'stratifying' the population, i.e. dividing it into strata, each of which can be regarded as a homogeneous population.

Applications of Sampling

The two main fields in which O and M can apply statistical sampling are:

In obtaining quantitative data during a survey, for example, to estimate the proportion of purchase invoices of value less than £50.

In replacing comprehensive statistics by sample statistics in a routine administrative system, for example, statistics relating to the absence of employees due to sickness.

A number of examples of applications have been referred to briefly in the text. Wherever quantitative information is required about a population of any considerable size, sampling should be considered. Certain other special applications of interest to O and M have developed within recent years, particularly in connection with activity analysis and work measurement. These are described briefly below.

Work Sampling (Activity Analysis)

The proportion of total working time devoted to certain jobs is often required. For example, in a sales office, how much time a clerk spends editing orders, how much time he is speaking to customers on the telephone, and how much time is devoted to other work. This sort of problem can be solved by taking a random sample of moments of time and observing, at these moments, the activity of the clerk. This is exactly comparable to taking a sample of orders and the same analysis applies; the only difference is that one is sampling from a population of moments of time instead of from a population of pieces of paper. Provided a large enough sample is obtained (determined by Formula 4), the proportion of observations of any one activity will reveal the proportion of total time spent on that activity within calculable tolerance limits.

Work Measurement

When a time study is being made of a clerical job, an operation is observed on only a limited number of the many occasions on which that operation is performed. How many observations should be taken? Here an average time is required as an allowance for doing the job. By analysing the results of a pilot sample, the total number of observations (i.e. size of sample) required to determine that average time within specified tolerance limits can be calculated.

Work Throughput

The load of work on an office may be determined by observing the work, or assessing it from past records, for a limited period only, and by drawing conclusions which are reasonably applicable to the future so that the number of staff required can be stated. Here working days are sampled; knowledge about the average load on the office may be required, or as to how often a peak of work is likely to be reached which will involve overtime or the creation of a backlog. Statistical analysis can also be applied to this type of problem, but care should be taken to beware of any seasonal fluctuations or long-term trends.

Suggested Reading

Allen, R. G. D., *Statistics for Economists*, Hutchinson's University Library, 1951.

Connor, L. R. and Morrell, A. J. H., *Statistics in Theory and Practice*, Pitman, 1957.

Huff, Darrell, *How to Lie with Statistics*, Gollancz, 1954.

Moroney, N. J., *Facts from Figures*, Penguin, 1956.

Office Management Association, *Control of Quality in the Office*, O.M.A., 1958.

Management Information

The Need for Information

Information is the life blood of management; it is the essential basis of sound management decisions. When factual information is not available management's actions and decisions have to be based on unsupported impressions and guesses. The need for

careful preparation and communication of information to management has grown with increased competition, the complexity of modern industry and commerce, and the trend towards larger business units. Thus, today, many administrative systems are directed not merely at meeting a company's legal obligations (such as producing a balance sheet and profit and loss account) or at dealing with outside contacts (through invoices, and purchase orders), but exist essentially to provide management with the information it requires to make both day-to-day and long-term decisions. The efficiency of an organisation may well be governed by the pertinence and the regularity of the information supplied to its managers, and the effectiveness of of this information will in turn depend upon the form and timing of its presentation.

There are two extreme schools of thought on management information, with neither of which can the O and M man be expected to sympathise. There are those who believe in having more statistics, irrespective of their usefulness and the cost of their production, and there are those who believe in eliminating practically every management report, because of the cost of producing it. It is necessary to keep a proper balance between these views. The cost of producing information is certainly not irrelevant, but the cost of failing to produce information needed for important managerial decisions can also be high, although it may never show up.

O and M will naturally be concerned with the methods used in producing management reports, and with the organisation surrounding these methods. These aspects have been dealt with in other chapters, since they are problems common to any administrative system. In this section the emphasis is on considerations that apply particularly to management information, namely questions or purpose, timing and presentation.

Purpose

There would seem to be a common misapprehension in business that a multiplicity of reports, each containing a considerable amount of detail, is synonymous with supplying full information to management. Yet it is frequently possible to reduce the volume of data reaching a manager while at the same time increasing its cogency. The experience of one

American company which made a thorough examination of its routine reports is of interest. The number of reports was reduced from 560 to 140, and the number of copies from 2,800 to 460. In particular, the number received by the president of the company was reduced from 83 to 18. The president claimed: 'I would guess that, as a result of what we have done, almost 75 per cent of the figures have been taken off my desk. And yet, for the first time, we have confidence that all the important bases are covered and that we are getting the vital information we need to run and build our business.'

To achieve this increase in usefulness while reducing volume, the first task must be to ascertain what information the manager needs, and why. This must depend on the ultimate use to which the figures are put. Purposes cited such as 'for the record', or 'for historical purposes' are not satisfactory. The investigator must be concerned rather with the action decisions by management that will emerge from the use of the figures. He must try to define first what action decisions can be taken, and then the criteria which will determine whether or not action should be taken. Once these criteria are identified it becomes obvious what figures are relevant, and a long step has also been made towards realising the presentation that will show up forcibly the presence or otherwise of such criteria.

This is the hardest part of the task in planning management information systems. It must be realised that neither the O and M man nor the accountant can dictate to management what information they will have. It must always be the manager who is to use the figures who decides what he needs to do his job properly. However, the O and M man may have the opportunity to act as a sounding board in discussing a manager's needs with him.

This study of the use to which the figures are to be put will also help to avoid wrong emphasis in the presentation. When figures are wrongly emphasised, it is easy for misinterpretation to follow. For example, in a haulage firm, an emphasis on the reduction of cost per mile might easily lead towards an increase in the dead mileage. Or in a purchasing concern, undue emphasis on stock reduction might lead to buying at uneconomic prices, or increasing the staff expenses through the processing of an excessive number of small orders. Wherever possible

related figures should be presented so as to make the relationships clear.

The degree of accuracy in the figures also depends on their purpose. Complete accuracy is seldom required in business, and where approximate figures will suffice it may be possible to use sampling techniques, which would both reduce the cost of preparing the information and also make it possible to be produced earlier. For example, one large company which used to prepare exhaustive statistics of sickness and absence amongst employees finds that a 10 per cent sample yields figures which are sufficiently accurate for all the decisions that depend on them. The same company has found that in the field of sales statistics, there are some figures which it is most important to obtain 'hot', even if they are approximate, in order to keep the finger on the pulse and serve as a basis for day-to-day decisions; whereas with other figures they desire accuracy, even if their preparation takes time, as the basis of their long-term decisions.

Thought should also be given as to who requires the information. In industry the circulation of management reports is frequently far wider than the people who can make use of them. By removing from a manager the burden of seeing reports which are useless to him, he is enabled to be free for study of the information which has relevance to his job. Here again, however, the manager must be the arbiter of his own needs. Where information on the same topic is required by different levels, the degree of detail required may vary with the level. For example, the salesman may require details of sales by customer, since his actions will be related to individual customers. His Area Sales Manager may require only details of sales by representative, if his task is to see that no representative is having poor results. The Sales Manager's interest might be in the figures for areas.

O and M must take particular care to avoid the production of reports which have little or no purpose. This might seem an unnecessary caution, but it is a danger which exists, particularly where there is a high degree of mechanisation. An extra report may be readily available as a by-product of another operation, or there may be 'spare capacity' begging for use; both of these can be snares for the unwary. The merits of a report must always be weighed against the costs of preparing it and sub-

sequently interpreting it, costs which may not always be obvious.

Timing

Once the ultimate use has been established, questions of timing must be resolved. There are three main aspects of timing:

Frequency of presentation.

Period covered.

Delay before presentation.

The frequency of routine reports is dependent largely on the timing of the effective action which may result from them. Against this, however, must always be weighed the cost and effort involved in preparation. Reports that influence day-to-day decisions are obviously required with much higher frequency than those which influence long-term decisions. A sea captain may require a report on the cargo only once per voyage, but he will want weather reports much more frequently; should a squall set in, the frequency of weather reports would probably be increased. Industry has its parallels. Thus the frequency of reporting depends on the subject matter, and its current importance, both of which must be seen in the light of the actions they can affect.

The period covered by a report may depend on a natural time cycle. Where there is any choice in the period of coverage, however, care should be taken that the period is not so short as to make random fluctuations look significant, nor so long as to obscure significant fluctuations. Again significance is related to the purpose served by the report. For example, in any markedly seasonal trade such as ice-cream manufacture or the hotel business, to prepare a Profit and Loss account covering short periods such as a week or a month could easily be misleading, in so far as it was used to judge the prosperity of the concern. Yet for the ice-cream firm to judge requirements of cold storage, production and distribution, or for a hotel to gauge requirements of food and staff, figures for a week or a month would still be useless, but this time because they covered too long a period.

Speed of presentation is another important factor. Speed has little value for its own sake but rather for its bearing on decision making. The essence of management control is corrective action based on feed-back of information about departures from the

normal. If the feed-back of such information is delayed then the corrective action may also be delayed, at high cost. Where this is true, speed, in presenting management information, is obviously of the utmost importance; it is more important where the actions resulting are short-term rather than long-term changes. It is tolerably true to say that in most of British industry the production of management information suffers too great a delay for the best use to be made of it.

Presentation

The successful communication of information depends upon its being presented in a form which will be easily absorbed by the recipient. Since management is composed of human beings of various temperaments and outlooks, it is undesirable to advocate uniformity in presentation. The personal preference of the user should be a prime factor. The higher the level of management, the more personal will be the kind of information needed and its form.

Management reports should always be brief, simple and clear. Detail should be at a minimum. All too often reports fail to convey their important news content to managers because the issue is confused by too much detail. One form of detail which is rife is showing more digits than the manager can possibly absorb and use. In general, human capacity is no greater than two digits. Quite apart from the inability of people to treat much more than two digits, very often there is a wholly spurious accuracy about the many digits shown in management reports. An example of this, from Hansard, was the reply to a parliamentary question which gave the approximate number of Muslims in the Empire (in 1945) as:

India	92,000,000
Dominions	161,750
Colonies	13,325,000
Total	105,486,750

The first figure was rounded to the nearest million. It is not merely a wast of time to show the last six digits in the total; it is positively misleading. The sum should be given as 105 millions approximately.

The units used should be easily understood. For example, a

report for foremen on the factory floor who think in terms of cases of product should be expressed in terms of cases and not in terms of units of weight. The language should be that of the user.

If possible, the principle of reporting by exception should be applied, so that reports mention only departures from normal which may therefore require management action. For example, one engineering company, anxious to have profit margins which are sound but not excessive, produces a report of all sales transactions where the margin is outside the desired limits.

Significant information or trends should be made to stand out. Various forms of presentation are possible — figures, graphs, planning boards and other pictorial aids. The choice will largely be governed by what it is desired to show up and also the personal preference of the user. Some people like graphs, but to others they are anathema. Graphs are particularly useful where it is important to show up trends. Management should never have to leaf through past records in order to recognise a trend. Even where presentation is by means of figures, sufficient figures should appear on the current report. This sounds extravagant in preparation time but there are in fact many devices for getting around this, such as photocopying from translucents with merely the addition of one new set of figures. There are many types of proprietary planning board on the market. Though they tend to be expensive, these can be useful in presenting information, particularly when they can be made an integral part of the system rather than an adjunct to conventional presentation. One successful application of such a device is described below.

The Sales Manager of a firm manufacturing a range of some fifty seasonal products had been receiving a daily tabulation of forecast sales, actual sales and stock for each product. Analysis revealed that the actions open to him were:

To attempt to stimulate sales and/or recommend a curb in production, when sales had fallen below the forecast and the stock had become excessive.

To recommend an increase in production and/or institute a quota system, when sales had exceeded the forecast and the stock had become inadequate.

He had, however, to do a considerable amount of examining,

relating and even calculating with the figures to decide whether any of these actions were necessary.

Today, the information is presented to him on a planning board, with a horizontal line of colour for each product, and a date scale along the top. Where sales equal the forecast exactly, there is a green line as far as the current date, followed by a yellow line to the date to which stock is expected to last. Where sales fall short of the forecast, the deficiency is shown in red. Thus the manager need only look for bands of red, indicating that the product should be considered for stimulation of sales or reduction of stock, or exceptional bands of yellow, too long or too short, requiring a recommendation for the production programme. The benefit is that the relationship and interpretation of the figures has largely been done for the manager in advance. The items which are going satisfactorily can be ignored; those requiring attention are shown up clearly in a way which indicates the action required.

This example has been described at some length because some of its characteristics could with advantage be adopted in other reporting systems, quite independently of the use of planning boards.

A management report should in general show:

The date on which it is rendered.

The period of time to which it relates.

The units in which any quantitative information is expressed.

The source of the document.

Its circulation.

Dynamic Information

The business environment is changing constantly and any dynamic business must change with it. This means that the decisions required of managers will change, and so therefore will their information needs.

Thus management information should be examined at frequent intervals to see that it is satisfying the current need. New reports may be required, others altered and some eliminated. It is important that some one, be it the O and M Department or some other department, should be charged with this task.

The Work Place

Design of Office Buildings and Environment

Ideally, a new office should be built in such a way as to make the work that will be carried out on each floor easy to perform. The architect trying to do this may find that no one in the company is in a position to give any detailed description of what the functions, processes and other requirements of the business are likely to be, say, ten years ahead. He may also find difficulty in ascertaining what provision, if any, is required for expansion. Accordingly a great deal of foresight is required in such important matters as flexibility of office layout and mechanical and electrical services.

The Problem

In evolving the shape of the building the architect has to contend with site conditions, planning restrictions (e.g. imposed design and 'plot ratio', the ratio of gross floor space to site area), height limitations, fire regulations, building bye-laws, entrances and exits to surrounding thoroughfares, and also have regard to the views expressed by such bodies as the Royal Fine Art Commission. He also needs to know at a very early stage the company's basic design requirements, because of their repercussions on the structure. Amongst other things coming under this heading are the following:

The nett useful office space requirement.

What is required in the way of ancillary areas other than corridors, stairs, lifts, lavatories, etc.

For example, conference/committee rooms, lecture rooms, exhibition rooms, cinema facilities, workshops and stores, and employee facilities, including catering, recreational rooms, lounges, etc.

When planning the original construction great stress must be given to the importance of arranging for easy and economical future maintenance. A higher initial capital cost may in the long term be profitable when continuous savings are achieved on maintenance and running costs. The subjects for consideration are: the comparative

durability of materials; of decorative finishes; the ease and economy of cleaning; the type of flooring and of floor covering, varying according to volume and nature of traffic; accessibility and type of heating; floor channels for water, drainage, wiring and other services.

The type of heating, ventilating and/or air conditioning system to be installed, as this may affect floor to floor height and the amount of space required for mechanical plant.

Whether accommodation is to be reserved for any special departments, e.g. photographic, film, medical and computer, which will require abnormal floor loading, plumbing, electrical or other services.

The floor loading required throughout the general office or other areas.

The lavatory standards to be employed. Lavatory standards in the original architect's proposal are usually inadequate. They often afford insufficient washing facilities and frequently forget drinking water and space for the cleaner's bucket.

Whether or not any mechanical mail or other distribution system is to be incorporated.

Whether false ceilings are required (this may or may not be allied to heating, ventilating and/or air conditioning) to accommodate flush tungsten or fluorescent fittings, or for acoustic purposes. False or suspended ceilings can carry noise from room to room and nullify the insulation offered by partitions. In the search for flexibility, the location of lighting points and switches and the position of surface central heating units are often the most restricting elements.

What facilities are required for the loading and unloading of goods, etc.

Whether any Civil Defence provision is to be made. Fire fighting equipment is required by law, and this should be considered together with CD provisions.

Whether flush inner surfaces of external walls are required, to enable partition sections to be of standard dimensions. Partition sections cannot be of completely standard dimensions unless the ceiling beams are also flushed.

The reduction in number and careful siting of interior support columns is important.

Whether the extent of the car parking areas likely to be imposed by the planning authority is adequate and if any service or repair facilities are required therein.

The extent of mechanisation in the office, since this will determine the necessity or otherwise for an underfloor duct system and the screed depth required to house it. A modern office must have cable ducting because surface wiring imposes too much restriction on flexibility. Ducts should provide three separate but adjacent channels, either in the floor or built into the inside of exterior walls. One duct is for power supplies, one for GPO telephone wiring, and one for internal signalling, bells, synchro-clock wiring, etc. The siting of distribution boards, fuse blocks, etc., should be carefully planned to permit future maintenance without disturbance of office floor space.

Whether provision is to be made in the design of the external wall to accommodate telecommunication junction boxes, amplifiers, speakers, etc.

Faced with the difficulties mentioned in the second paragraph and the basic design requirements of the company, the architect has an extremely complicated and delicate jigsaw to assemble and, in so doing, he has to seek a balanced compromise between aesthetic and functional requirements. In the latter connection he should be governed by considerations of maximum flexibility, economy in space utilisation and economy of construction. He should also have in mind convenience, economy and efficiency of operation and maintenance.

In establishing his overall plan to achieve these ends he is concerned with arriving at a building 'envelope' and arrangement of windows, which will give flexibility and economies within a structural grid, and can be subdivided into a basic office unit and building module. He is then concerned with positioning his main ancillaries, e.g. lifts, stairs, lavatories, plant, etc., in such a way as to maintain the best possible circulation, at the same time making it possible to partition up the available office space into rooms of varying depths to provide for both private and general offices. In all large buildings the need exists

for a goods lift. Unless the architect is reminded, this may be overlooked. The lift is required for furniture, cleaners' and decorators' materials, canteen materials, etc., as well as normal goods.

Most companies who try to lay out their offices efficiently find that, due to the structure, there are many limitations on their organisation and on their ability to install machinery or processes. Rooms are too small; rooms are too large and are made of such material that the noise of office machines is very difficult to silence; the size and shape of windows make it difficult to partition an open office in the way that the work demands.

Is there any compromise possible in this apparent impasse? Can the architect help the office manager, and can O and M help both? Here we are not concerned with the actual layout of desks within an allotted floor space; this will be discussed in the next section of this chapter. The immediate questions for consideration are:

How can the architect help the economical layout of modern office processes?

How can O and M help the architect by giving him information not yet available?

The Contribution of the Architect

Some of the matters in which the architect can greatly assist the future uses of the building are:

Designing the dark part of the building for office services such as lifts, lavatories, stairways, etc., and leaving the space with natural daylight for working positions (fire stairs will, of necessity, be positioned on an external wall or adjacent to an internal well). Consulting and providing for strong rooms, chutes, conveyors, etc., in the centre of the building — again to make the best use of daylight for working space.

Designing the building so that the distance between its outer walls is divisible into usable portions, i.e. office, corridor, office, or providing offices and an open office, without an unnecessary corridor — fire regulations permitting. There are differences of opinion about this. The maximum useful width of an office between exterior

windows is 40 feet. Allowing a central access corridor width of up to 6 feet this provides an inside office distance from window to corridor wall of 17 feet. Experience suggests that because of daylight penetration a depth of 17 feet is the maximum useful size for a general office, and is not too unreasonable for private offices and other purposes. This width is readily adjustable provided the open length of any section is in excess of 60 feet without being broken by stairs, lifts, lavatories, etc.

Avoiding deep rooms and dead space in the centre of the building.

Matching window modules to requirements. The window module is defined as the space from centre mullion to centre mullion, i.e. a 6-foot window space could mean a 1-foot mullion followed by a 5-foot wide window. The ideal in a general office is to equate natural lighting for each seated position. A desk situated side-on to a window occupies 2 feet 6 inches; a further 3 feet 6 inches must be provided for seating and access to the seating position. Therefore the ideal window module in general offices is 6 feet. A 4 feet 6 inches module, for instance, does give greater flexibility for smaller offices, but it also gives a 'spotty' external appearance of a large building with this module. The reduction in natural daylight, and the additional cost of providing and cleaning more windows, has to be considered. For a big building the 6-foot module is best, unless it is known at the outset that it will largely be used in individual small offices, and that exterior architectural appearance is unimportant.

Providing for any special requirements of floor loading to take office machinery or other heavy loads and to avoid using materials which cause echoes or other acoustic difficulties.

Consulting and providing entrances for staff and goods that can be economically guarded for security purposes.

Considering the requirements of staff for heating and ventilation.

Where regulations permit and opportunity offers, using balconies in wells to increase the size of corridors and so turn them into working space.

The Contribution of O and M

The way in which O and M can help is by:

Devoting some serious thought to the size of the open office required. Some companies do not want more than thirty people to work in the same room under visual supervision; above this figure too many distractions arise for concentration to be maintained, and supervision becomes too loose to allow efficient working. Very large general offices can be divided by comparatively inexpensive 7-feet high self-supporting semi-glazed movable partitions with access openings instead of doors. This permits great economy of floor space, at the same time avoiding overlarge numbers of staff in the same room. Flexibility must be provided for future needs.[1] What size of office will be required in five or ten years' time for such work as is best done in open offices?

Considering the requirements for units of private offices opening out of a general office. Some companies have found that in certain functions of business, for instance, purchasing and accounting, much expense is saved by using small offices for senior staff — too small to permit the building up of private records — and by allowing the general office to absorb the private records of perhaps twelve seniors, pooling them and running them with possibly two instead of twelve personal assistants. But the architect cannot possibly guess what these requirements may be, and O and M must look at the work of a headquarters' office and plan the working units, not only in terms of staff but of their organisation and working requirements in terms of actual process.

Where executives require secretaries, considering the experience of some companies, who have divided a wing into fair-sized offices and medium-sized corridors. The corridors have been extended by building on balconies, so that the whole becomes a unit of perhaps eight executives served by six secretaries sitting in the balconies in full view of the doors leading to the executives' rooms. By this means the disadvantages of the pool are avoided and considerable advantages — the saving of staff and

[1] See section on 'Functional Furniture', page 377*ff*.

tightening up of security measures — become apparent, while there is increased flexibility, through the partial pooling of staff, to cope with lunch hours, holidays, illness and the absence of executives on tour.

Paying particular regard to the question of the allocation of particular floors to particular forms of office work. On what floor should a computer installation be housed? If a computer is installed, should arrangements be made to house special communications close to it? Which is the best floor for directors and executives? Where should the mail room be? Which office can most conveniently be sited in proximity to it? Which is the best floor for canteens (to avoid unnecessary transport in the removal of waste or entrance of food)? In a London building, the best location for canteens, which are specially ventilated, is the ground floor. This floor is uncomfortable for most office work because of the small quantity of natural daylight, the nuisance of street noise and traffic fumes and the feeling of being overlooked by passers in the street. These defects do not affect canteen use and the ground floor saves unnecessary transport of personnel, food and waste. The prime cost is expensive because of the cost of a thorough heat and smell extraction plant for the kitchens.

Deciding whether intercommunicating offices could be of advantage. Some companies have intercommunicating offices for executives and directors in order to gain in cooperation and coordination; some will have as many as six adjoining rooms with intercommunicating doors so as to encourage informal consultation and prevent the waste of time of attending formal meetings. Other companies place a high value on privacy.

Considering whether a large committee room can be designed to serve also as a Board Room, with suitable facilities for the change of furniture, thus increasing the use of valuable office space.

When small offices are used there is a need for interviewing rooms for buyers and others. O and M should be able to work out the requirements and save unnecessary waste of space or queueing for this facility.

Deciding what height the rooms should be for, firstly, private and general office use, and secondly, open offices and offices containing machinery. A minimum height for normal rooms is 10 feet, but in long rooms this height should where possible be raised. Economy may well dictate the height, economy in capital cost per cubic foot and in maintenance, decorating, etc.

Paying attention to locating light fittings in relation to positioning of demountable partitioning. Where there are deep rooms the use of separate switches for lights more often needed should be taken into consideration.

Remembering a possible disadvantage of steel frames in that they become sound conductors without special ceilings and floor coverings to damp down reverberation.

Allowing floor space according to the process to be carried out. For instance, in the United States, rooms with natural daylight are allocated to those doing clerical or machine operation. Higher executives are accommodated in air-conditioned and specially lit interior rooms without windows.

Consideration of the use of noise absorbent tiling for corridor floors; and the possibility of building cupboards and other fitments into movable office partitions.

Apart from the considerations mentioned experience shows that the number of specialists is increasing. The allocation of floor space to these specialists needs co-ordination in the interests of economical layout. This may be work for O and M.

It is not possible to lay down a blue-print for a model office, for although all offices are engaged on similar work, there are so many individual processes employed in each that standardisation is not possible, even if it were desirable. This section has not, then, told anyone exactly what to do, but its purpose will have been served if ideas are suggested for the closer cooperation of the various experts named, so that the greatest possible use can be made of increasingly valuable working space.

Notes on Environment

Various factors in office surroundings can, on occasion, influence the work, together adding or subtracting from the extra ounce of effort that may be given by the staff. Men and

women are most adaptable and adjust rapidly to conditions, good or bad. The adjustment itself may, however, prove costly in output. Four obvious conditions influence working conditions:

Matters affecting sight, which are not of lighting alone. Of some importance also are the distribution of brightness and colour. Seeing becomes easy, and errors should diminish correspondingly with the correct quantity and direction of light, a good background without glare or specular reflection, or too vivid a contrast of luminance or colour. These conditions aid good concentration.

Acoustics, in a large open office where sound absorbing material mostly in the ceiling may be needed to reduce disturbance. Complete silence, however, may itself prove disturbing.

An even working temperature, which is conducive to good work.

Ventilation and elimination of draughts.

When planning new offices, as high a lighting level as 30 foot-candles may be recommended, but office managers are warned that standards are rising and that they would be well advised to settle for an installation whose level of lighting can be again raised from 30 to 50 per cent. Because of a need for flexibility by partitioning of offices, the planning of cables and lighting points needs to be incorporated by the architect; so does the acoustical treatment of ceilings, etc. Decorations contribute to lighting and must be chosen to blend with whatever natural light is available or whatever artificial light is provided, and with both during the winter months.

This section handles a highly complex subject with the utmost brevity. To embark upon the technical details of lighting, colour and ventilation systems would encourage the writing of a further book. Sufficient may have been said to encourage the office manager to consult a technical expert in one or other of these specialised fields.

An example of the Adaptation of an Old Building for Modern Offices

A Preliminary Survey

There will usually be limits to the standard of office accommodation which can be provided in an old building. Before any

decision to convert is made, the considerations raised below should be regarded.

Cheap basic rents for old buildings often offer an illusion of economy. The ratio of useful office space to the gross area can be half that in a well designed modern office building. To obtain a true cost comparison *full* estimated annual costs of accommodation should be added together — including the *annual value* of capital expenditure required on modifications and an adequate allowance for the higher maintenance and upkeep costs of old buildings — and divided by the nett useful office area. The annual cost per square foot should then be compared with local costs of modern office space.

Lease or freehold restrictions may control freedom of action or change in occupational use. Consents may be required from landlords and local authorities.

The location vitally affects these essential requirements:

Can the staff eat locally, or must the building provide meal facilities?

Is public transport adequate, or must car and cycle space be provided?

What are the standards of office amenities needed to compete in the local labour market?

Characteristics of the building should be noted, such as:

The load carrying capacity of floors 50 lb. per square foot is the absolute minimum for office use. This figure is inadequate when heavy safes and office equipment are needed in special areas.

What degree of restriction in use is imposed by interior immovable load bearing walls, pillars, and other obstructions to free planning?

Are the windows adequate in size and position, with regard to both daylight and ventilation, for office use?

Is lavatory accommodation adequate?

Can adequate entrance and reception areas be provided economically?

What is the state of essential services? Is electrical power adequate for foreseeable requirements? Plumbing extension or replacement may be necessary; some modern office processes need acid resisting drains.

Can convenient internal communications be arranged?

Old buildings with tortuous interiors can waste management and clerical time.

Can an adequate standard in safety regulations be achieved?

Is a lift service necessary? If so, consider the type of lift to be installed.

Finally, consider whether the altered building will be of the right size for present and foreseeable requirements. If the nett office area available is in excess of 70–80 square feet per head the building may fit after conversion.

A preliminary survey on these lines will indicate the possibilities inherent in the situation. A rough indication of the order of expenditure required will have been established, having regard for what are recognised reasonable working conditions.

If the effective nett office space is tight for the number of staff proposed, means of space-saving must be explored, such as built-in units, sliding doors, the use of rooms for dual purposes, and the reduction in the number of private offices by sharing, or by using half-height partitions in general office areas to maintain a degree of management privacy.

Layout Planning

Detailed planning of a new layout for the building, on the lines indicated by preliminary survey, must comply with bye-laws. It will be helpful to draw up an ideal plan layout, within the shape of the building but ignoring other considerations. This plan will aim at establishing the ideal position and space requirements of individuals and units in their correct relationship. The layout is then adapted to the building. It is frequently found an advantage to remove most of the existing walls forming offices and to replace them with movable partitions.

The adaptation of the provisional layout to the existing building will generally be primarily governed by the position of windows to provide natural light and air.

Decor and furnishings will have a considerable effect on lighting efficiency, both from the reflective value of the materials and shades chosen, and from the kind of stimulus provided by them.

Ventilation, without draughts, can be improved by fitting plastic air flow ventilators in the windows, extractor fans, or input/extract fans in the windows or adjacent wall spaces.

The allocation of space should be based preferably on the nature of the work done. Draughtsmen, typists and clerks handling a great deal of close paper work obviously require more light than most managers. Store rooms, filing rooms, etc., should of course, be placed in any interior spaces without windows.

Consideration of Details

The following brief notes discuss various matters of detail which it may be profitable to consider:

Windows: Light efficiency; traffic noise; ventilation; heating.

Electrical System and Lighting: Possible electrical re-wiring; provision of ducts for communication wiring.

Heating: A heating engineer should be consulted. If power is inadequate much can be done by reducing heat losses, for example, by fitting vacuum sealed double glazing units in existing window frames and phosphor bronze strip sealing to frames (both of which will also reduce trouble from traffic noise).

Interior walls and doors: The higher initial cost of removable partitions is generally compensated by increased flexibility and subsequent savings when alterations are required. Alterations are made more quickly, quietly, economically and with less interference with office working conditions. The positioning of doors should be considered carefully in relation to possible future requirements, as well as present desk positions.

Traffic and other outside Noise: Means of reducing interference from outside noise have already been mentioned, namely phosphor bronze strip around window openings, double glazing, and acoustic treatment of ceilings.

Corridor Flooring: A quiet durable, non-slip finish is required. Suitable coverings include rubber linoleum and cork tiles.

Other floors: Toilets should have impervious flooring, for instance, quarry tiles, terrazo or other similar material. Woodblocks are generally considered the most suitable and durable for flooring offices but rubber linoleum is a

good alternative which can be easily applied to any type of existing floor.

Decorations: Consideration should be made of the effect on staff, and ease and economy of maintenance. Inadequacy of window areas is also partially compensated by the use of brighter, lighter colours, which will also obtain full benefit from increased standards of artificial lighting. Emulsion paint is very suitable for ceilings, but oil paints in semi-gloss or eggshell finish (to limit glare and reflection) are more suitable and durable for walls and doors which are liable to finger marking.

Motion Economy

Most office work concerns the mind as much as the hand, and the motions of the mind are difficult to observe. The techniques of motion study have been developed in factories to record, measure and study operations of a physical kind and therefore these techniques, where they apply in the office, do so more in principle than in practice. Wherever numerous repetitive operations are found, for instance, the mailing room, the duplicating room or the despatch room, an opportunity arises to study the motions used and to eliminate unnecessary movements and work.

Apart from operations-studies other opportunities to apply the common sense of motion economy are present, in the design of buildings, the layout of offices and the design of office furniture to suit the process carried out upon it. These applications are discussed in separate sections of this chapter and this particular section summarises the principles that govern the elimination or reduction of the extent of physical movements and their combination in a sequence that is economic of effort.

The general principles of Motion Economy may be summarised as follows:

Motions which are unnecessary are eliminated.

Those which remain should as far as possible be combined.

They should be in a correct sequence.

They should be reduced to their simplest form.

In the implementation of these principles, repetitive motions should, where possible be of minimum length; symmetrical, simultaneous, rhythmical, natural, and habitual. The number

of directions of motions should be limited, and they should be smooth and curved rather than straight-line motions with sharp changes. The rules of motion economy have been classified under three headings for clerical work. These classes of rules, which will be examined separately below, relate to:

The working area (an important factor in Motion Economy).

The individual motions of parts of the human body.

The general examination of the individual motions of parts of the human body made within its working area.

The Working Area

The Chair. To permit of good posture, the chair should possess the following features:

An upright but easy sitting position. Some support for the lower spine, together with a back rest which is adjustable both vertically and horizontally, will be helpful. Without these tiredness and loss of efficiency may result.

The correct height, so that when a person is sitting at a desk or table the elbows are slightly above the level of the top surface. For example, with a desk 29 inches high the elbows should be 30 inches from the floor. The operator should be able to rest both feet on the floor and, where necessary, a foot-rest should be provided as part of the desk or work table. The height of the seat should be adjustable, and the front should be about 1 inch higher than the back.

The right design of seat, so that the weight of the body may be evenly distributed, possessing sufficient width for that weight, but not more than 15 inches from front to back. The framework should be strong, preferably of steel, although a wooden frame may be preferred for comfort.

Location of Materials. Although the office is less closely concerned with the movement of materials than is the factory, on occasion the positioning of forms, etc., is important. These should be located close to and directly in front of the operator; where possible they should be within the normal grasp area. In any working area the natural positions of work are in sectors enclosed by lines, which are arcs of circles. There are grasp areas for each hand separately, and for both hands working

together. For both hands there is an inner and an outer grasp area, the inner being that which can be covered with the elbow remaining stationary, and the outer that which is covered by the arm outstretched. Figure 52 below illustrates these areas; no dimensions are shown since operatives vary considerably in stature and this affects areas.

In general, the inner grasp area is the better one for positioning of work but within it there are certain positions which are awkward, for example, the areas to the extreme left or right of the arcs, or the area immediately in front of the body at the edge of the desk, where operatives need to rest their forearms. The parts of the outer area immediately in front of the operative are more convenient than these.

The best positions for materials are within the area bounded by the lines marked LYMON on Figure 52. Any grasping by either hand of an article outside the grasp area involves disturbance of posture and consequent fatigue. All unnecessary reaching should therefore be eliminated.

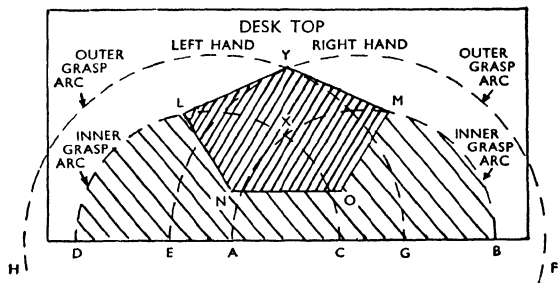


FIG. 52

Pre-positioning of Materials. Equipment — pens, stamps, stitching machines, etc. — and materials should be pre-positioned in fixed places to permit a proper sequence of motion. The forms or equipment required at the beginning of a cycle should be next to the point of release of the completed work from the previous cycle. The material to be used should be pre-positioned so that it is immediately available the next time it is needed. An example of pre-positioning is a stitching machine, or a telephone so placed that it can be readily grasped the next time it is required.

If materials are to be delivered by gravity feed to the

working area, and removed as finished work in the same way, the delivery and release points should be placed so that the hands make minimum motions from the point of release to the point of grasp.[1]

Relating to Body Members

Although movement of the body is of much less importance in the office than in, for instance, foundry work, there are jobs where failure to observe the rules established in the factory can cause unnecessary expenditure of effort in the office. When physical movements are limited to a minimum, maximum performance may follow at the cost of the least possible fatigue. This common sense approach does not, however, relieve O and M from ensuring that any equipment or materials used are placed so as to limit movement to the lowest practical class in the following table, not forgetting, for instance, that right-handed people need their telephone on the left side of the desk.

Kind of Motion	*Example*	*Classification*
Fingers	Typist striking the keys of a typewriter.	Class I
Fingers and Wrist	Dialling telephone numbers.	Class II
Fingers, Wrist and Forearm	Handwriting, turning hand-operated duplicating machine.	Class III
Finger, Wrist, Forearm and Upper Arm	Grasping telephone or opening a drawer	Class IV
Finger, Wrist, Forearm, Upper Arm and Trunk	Telephone Switch-board operation.	Class V

In certain cases these rules can be misleading; for example, the motion of the forearm is sometimes far less fatiguing and more accurate than that of the fingers. This occurs in writing and in moving fairly heavy objects. Also in certain cases the motions of the wrists and elbows are better than the motion of fingers or shoulders. In most clerical operations there is little difference in the fatigue involved between Classes I, II and III; the same can be said of Classes IV and V.

In any manual work when both hands begin and complete

[1] See section on 'Functional Furniture' and the 'Mail Sorting Unit'.

their motions simultaneously, and are not idle except during rest periods, maximum performance is approached. Not many people have learned to use both hands; in most cases one serves as a holding device, but with proper training and layout of the work both can be used provided the movements are simultaneous and rhythmical. When motion of the arms is made simultaneously, for instance, in collating, in opposite directions over symmetrical paths, natural and habitual rhythm develops. The sequence of motion in a cycle should be identical, and one cycle of motions should be followed by another which is exactly the same, and the working area should be laid out to accommodate these motions.

General Considerations

Every new set of motions in repetitive work should aim at establishing a rhythm, with the body members moving easily and naturally in a balanced pattern. Any delay resulting from bad or faulty material, or bad placing of equipment, results in a greater loss of time than is actually warranted because of the break in rhythm. An example of avoiding the break in rhythm is the pre-stuffing with carbon paper of a multiple set of forms by a junior, so that the typist and her machine are used to the greatest advantage.

In writing, the right hand naturally starts at the left and moves across the body to the right. Any apparent awkwardness of left-handed writers is due to this natural motion being disturbed. Motions of the hands and arms should not be straight-line movements, but should be curved, and made symmetrically, simultaneously, and in opposite directions. Operatives should work as far as possible with motions which are symmetrical about an imaginary centre line through the centre of the body. The resulting balanced posture reduces the fatigue which comes from the muscular effort needed to balance motions that are not symmetrical.

Simultaneous motions are necessary to avoid losses which occur when hands move alternately. Every time a body member has to change direction, or change parts of its motion, it has to decelerate and then accelerate again. Therefore, the number of changes in direction should be kept to a minimum. Hesitation and delays should be examined to establish the cause. Hesitation

may be due to either lack of experience of the operative, or the need for mental decision. Delays may be due to rest for overcoming fatigue, a fault of the operative, or to some cause outside the operative's control.

Where operations are precisely measured any variations in times for the same operation should be examined. The cause should be established, and if necessary the motion pattern adjusted. Variations may be due to an additional element which does not occur in every cycle. An attempt should be made to establish whether this additional element occurs after a set number of cycles, or whether it is of indeterminate frequency. In the first case a proportion related to the recorded frequency should be added, and in the second the element should be catered for in the contingency allowance.

The cycles with the fewest motions and the best sequence should be selected. The sequence with the fewest motions is almost always the best, except in those cases where apparently unnecessary motions improve the rhythm and ease the work of the brain.

Two-Handed Charts. These charts are simple and may be used in the office for the examination of motions of the hands. They are drawn following direct observation of the operation:

To find a better motion pattern.

To train new operatives.

To remind operatives of the actual sequence of motions.

To record motion sequence for future use and to make information available in another office.

An illustration of a simple two-handed chart, indicating the patterns involved in placing three imprints on a form using a hand-operated addressing machine, is illustrated below in Figure 53. The first half of the chart shows the chart as drawn by the observer and second half shows the chart redrawn for examination. When examining the chart the aim is to simplify work as follows:

Balance. The chart shows that the right hand does more work than the left hand, so that consideration should be given to transferring some work from the right hand to the left.

Elimination. There is some possibility for elimination where one hand is merely acting as a holding device for

the other. It may be necessary for a simple holding device fixture to be designed to free this hand for useful work.

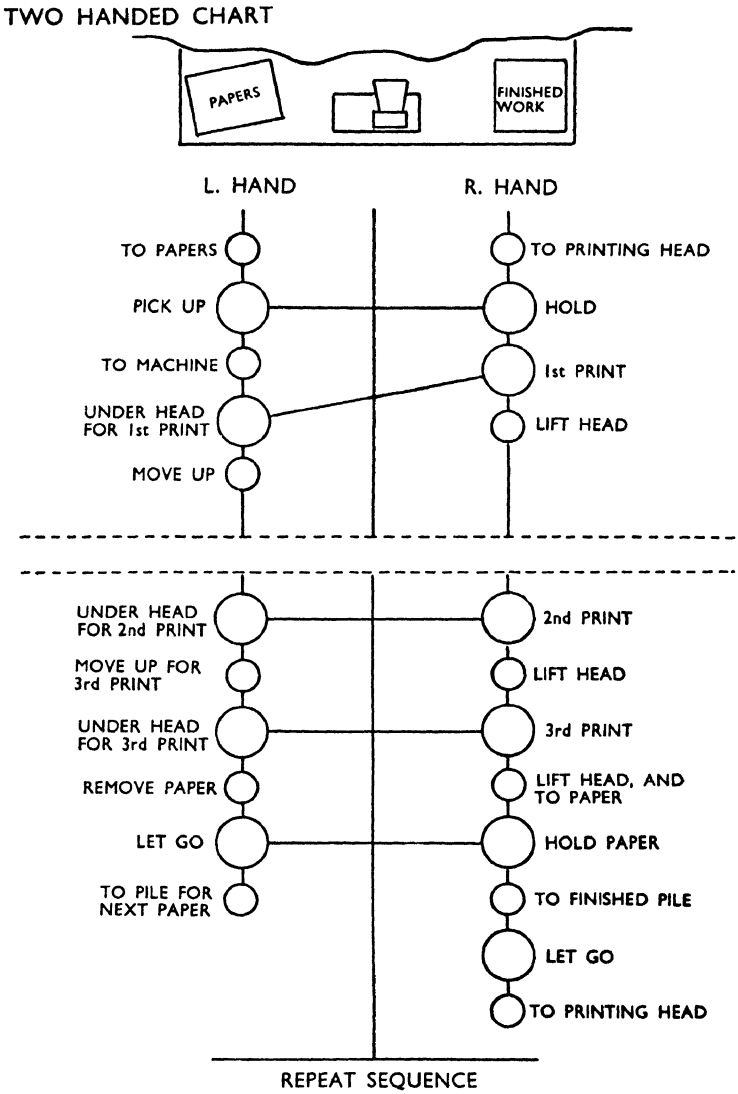


FIG. 53

The application of Motion Economy has obvious savings in the design of a procedure in which a study is made in considerable detail. Apart from this, there are broad advantages which accrue from re-examination of the workplace in terms of unnecessary movements of papers or staff between operators, branches or departments.

Office Layout

The contribution of the architect to office layout has already been discussed in a previous section, where some mention was also made of the need for O and M to help the architect by deciding what really is required of him inside the building. Not many employers are able to design and build their own offices; many have to be content with premises that are quite inconvenient; others are tenants only of new offices built as a speculation, without any particular regard being paid to special requirements of future tenants.

In this section the assumption is made that the architect has done his best and that someone, possibly the O and M man, has been asked to study the existing layout and see what improvements can be made that will speed up the flow of work, or in a number of different ways permit staff to work more effectively and efficiently.

Area Standards and the Allocation of Space

The amount of space required for staff will vary between different companies and the figures given below are intended more as a guide than a measure, especially since space will in the end be allocated according to need. Examples are:

Clerk in large general office	50–60 square feet
Typist	50 square feet
Draughtsman	100–120 square feet

More senior staff will be given space to conform with prestige, conference requirements, etc. The types of rooms that may be required in an office block include:

A private office for one or two people, with or without communicating doors to other private offices or a secretary's office.

A very small private office deliberately kept small to prevent the building up of records.

A small clerical or general office to take from four to ten staff.

A large general office to be used by from ten to thirty staff (generally offices of more than thirty are to be avoided although there will be exceptions for specialised work).

Arrangements of Departments

Some thought and research are needed into the question of the optimum size of departments within a business, with the idea of creating units of private rooms and general offices that will form a composite whole and are interchangeable as units with other departments in the business. Some companies find that there are a number of different departments in the same business that require the same accommodation in terms of the work, and that if this work is laid out on the basis of working space, the proliferation of records can be reduced and departments prevented from unnecessary growth.

Designing a Layout

The objectives in designing an office layout, which are based on the principles of motion economy, are as follows:

To reduce the time necessary to do work by eliminating all unnecessary movement of staff.

To obtain an ordered flow of papers through the office.

To provide working conditions which increase efficiency and reduce strain and fatigue.

To conserve space without cramping operations.

The following general and specific requirements should be considered:

General

An accurate floor plan, showing the position of windows and electricity points; also the height of rooms.

For those who like them, templets of furniture, equipment and machines, to the same scale.

Office Layout

The organisation of the department and its relation to other departments.

The possibility of expansion in the near future.

The procedures to be carried on in the department and, consequently, the flow of work.

Any special requirements of the work, e.g. office machinery and equipment, weight if heavy machinery is in use, etc., quiet, visitors.

The physical limitations of the building, including light, ventilation, heating etc.

Workplace Layout

Minimum movement.

Use of habitual movement.

Minimum expenditure of energy in picking up.

Arrangement of containers or racks so that they are used in succession.

Furniture[1]

Standard desks and tables, designed to meet office requirements.

Standard chairs: the correct type of chair is essential to avoid fatigue.

When the plan has been made the following will serve as a check-list to ascertain whether these requirements are being met in the best way possible:

Is the flow of work as straight as possible, with all back-tracking and cross-tracking eliminated?

Does the flow of work of each unit move continually forward within itself and from unit to unit?

Are supervisory staff situated in the best positions in relation to the sections they control?

Are the best-lighted areas occupied by the people who most need these conditions? Are gangways away from the windows?

Are movement and noise segregated from staff doing mental work?

Are desks and passage ways arranged to give best use of the area?

Are the facilities good for reference to current filing?

[1] See the section below on 'Functional Furniture' for illustration of certain standard working equipment.

Functional Furniture

For the purpose of this section furniture does not include equipment, or, of course, fixtures, but is used to include anything whose main purpose is to provide the office worker with a working surface, e.g. tables, desks, together with associated furniture such as chairs and stools. One of the cardinal principles of work simplification is to make the tool fit the job, and there is a need to modify or redesign office furniture in the same way. Frequently the task of ordering new furniture is not associated with the introduction of a new system, and a purchasing department relies on the standard models offered by suppliers.

Ready-made furniture is usually mass produced and will have been evolved as a compromise between many conflicting requirements; it will be a matter of luck if any particular model happens to fulfil all the requirements imposed by a new system. The O and M departments of some companies have done a considerable amount of work in the provision of new functional furniture, as the following examples will show.

An Office Desk

In one company, where a large number of desks had to be replaced over a period of a few years, the attempt was made to establish the criteria of a good office desk before contracting to buy any particular current model. A committee was set up for this purpose, whose members included a representative of the O and M Department, which also carried out investigations on the committee's behalf. After the criteria were established it was, in fact, found that no current model met the requirements, and three new desks[1] were designed. Prototypes were produced and tenders invited for their manufacture. The more important features of the new designs were:

Dimensions. The starting point of the designs was that the distance between the effective height of the chair seat and the floor should be such that:

The seated person's thighs were parallel with the floor, their weights being borne by the seat, not by the leg muscles.

The person should be able to rest his feet on the floor without the thighs being raised from the seat.

[1] See Plate I, page 378.

The forearms should be free to move forward parallel with the floor and to rest on the desk without lifting or unduly spreading the shoulders.

These conditions were found to be fulfilled for the majority of people by furniture with the following dimensions:

Effective height of chair seat above floor	17 inches
Desk top above floor	28 inches
Vertical clearance (chair seat to underside of desk)	9 inches

This combination can only be attained by constructing a desk without a centre drawer. Otherwise, as with most old desks, the height, with this drawer and clearance for knees, must be at least 30½ inches. Work at such a high desk tenses the shoulder and back muscles and promotes fatigue.

Surface. In general, the cost of a desk rises more than proportionately to the extent of the surface area, owing to the need to construct more rigidly. There is, therefore, a tendency to restrict the surface area to the maximum which can be reached by a seated person without undue stretching, i.e. 54 inches by 30 inches. Larger areas are, of course, sometimes required for special purposes, e.g. for examination of drawings, or for interviewing. The standards adopted for the new desks in this company were:

Management	60 inches by 36 inches
Clerical	54 inches by 32 inches
Typists	52 inches by 30 inches

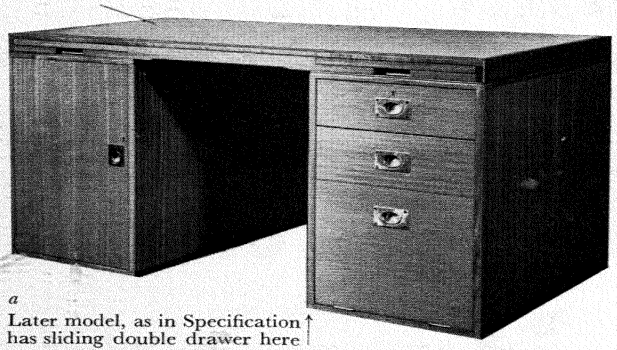
Material. Experience within the company showed that linoleum tops were too soft and were difficult to keep clean. 'Formica' was found most suitable for hard wear and has been used for clerical and typists' desks. Where, however, appearance is most important, as in management offices, leathercloth is warmer and quite durable. Wood was chosen for the structure, being lighter to transport, cheaper, quieter, warmer and more easily repaired. The need for a durable finish is satisfied by spraying on a catalyst-aided resinous lacquer.

Storage Space. The cubic capacity enclosed by the desk was used to good advantage to eliminate the need for additional furniture such as filing cabinets and cupboards. The three types were variously fitted with shallow (5 inch) drawers, deep filing drawers, cupboards (back and front) and trays. The drawers

Front view

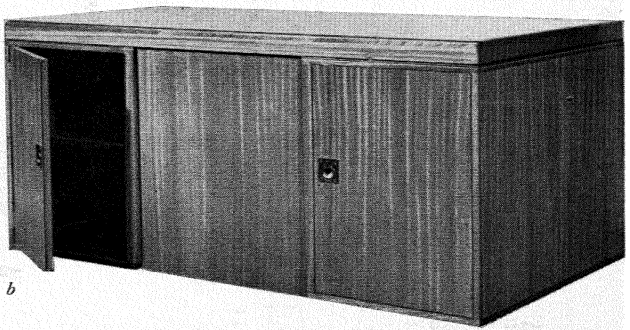
PLATE I

Back view

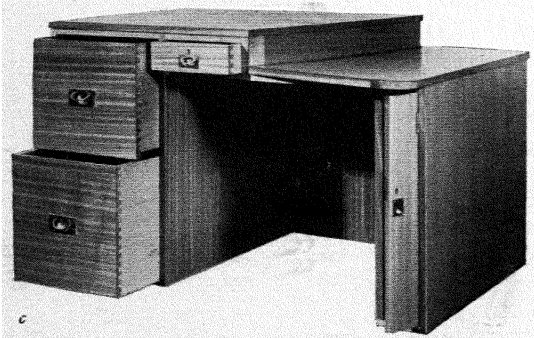


a

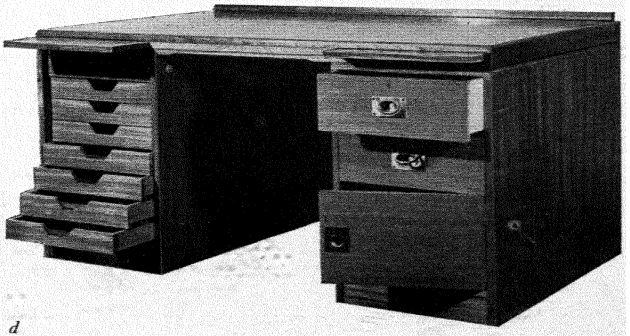
Later model, as in Specification ↑ has sliding double drawer here ↑



b



c



d

a and *b*. New Clerical Desk. All storage covered. Height 28″. Natural light colour of wood. All corners rounded. *c*. New Comptometer Desk. Solid construction. Height of platform 26″. Height of desk 30″. *d*. New Typist's Desk. Height 28″. Left-hand flap pulls out and down to cover paper drawers.

were wide enough to take foolscap paper laid across the drawer. In the typist's desk the pull-out flap on one side dropped to form a cover for the stationery trays. The pedestals extended to the ground so as to give the maximum storage space and simplify office cleaning. All shelves were covered to avoid collection of dust and dirt.

General Features. Where possible and to protect clothing the drawer and cupboard handles were recessed and all covers and edges, including the knee-hole, were rounded. A removable front draught and modesty panel was provided for the clerical and typists' desks which were likely to be used in general offices. The sectional construction, i.e. separate top, pedestals and draught panel meant easy moving and compact storage, and allowed interchange of differently equipped pedestals. Great importance was attached to the correct choice of colours, especially for the desk top, where it is necessary to avoid harsh contrasts.

Two Special Purpose Desks

Various standards for office desks have been determined by, and for use within, different companies. Many of these were for the most part of a conventional pattern. Two exceptions were 'a desk suitable for most typists' and an 'L'-shaped desk for housing some seven thousand record cards measuring 5 inches by 8 inches, see Plate III, facing page 384 and Figure 56, page 384.

The development of this latter desk was based on a methods investigation of sales systems, which showed that order clerks constantly have to refer to record cards for customer information. These cards are usually housed in various kinds of cabinets and trays, sometimes placed on top of the order clerk's desk, where they reduce useful working space. At other times the cabinets are located in odd corners of the office, making for a generally untidy office, waste of working space, a good deal of walking about, and poor accessibility to the records. The desk (Figure 54) cost less than the combined cost of an ordinary desk and the necessary filing cabinets, and overcame the drawbacks already mentioned.

A Typist's Desk

Another example of special design arose as a direct result of Work Measurement studies of typewriting — because of the

many different ways noticed of collating and decollating papers and carbon papers. Three main reasons seemed responsible for this:

Lack of teaching of any particular method during typing training.

Varying sizes and types of paper and forms.

Lack of sufficient or efficient storage space for papers in a variety of typists' desks in use.

The standard desk then in use was redesigned, but prior to that a teachable method was established for collating and decollating within a measured standard time, and an enquiry was set on foot as to the types and sizes of stationery in use. First attempts involved movable partitions of thin plywood to assist in separating stationery, but this did not accommodate all the requirements of stationery. Slotted drawers were tried next and, although an improvement on the movable partitions, were still inadequate for the possible range of stationery.

Following these experiments a complete break away from tradition was made in the shape of a separate typewriting stand with an attached stationery cabinet.[1] The cabinet would contain most stationery requirements of any particular typist, but in cases where a very large range of stationery was used a separate cabinet was designed, or alternatively a stationery cabinet attached to either side of the stand. One of the disadvantages of the previous standard desk was that the stationery storage was on the right-hand side. This had obvious drawbacks for left-handed typists and sometimes caused complications in space allocation in offices. The new desk overcame this difficulty since the cabinet could be on the left or right as required and had the added advantage of occupying less floor space. Adequate room was provided for the typist's personal property below the stationery storage rack and a mirror was provided on the hinged lid to discourage using the typewriter as a prop for a hand mirror and to avoid powdering the machine.

This prototype was sent out on field trials to test its practical value and furniture manufacturers were then called in to incorporate the trial results in a new design. Like the original, this is based on two separate units — a typewriter stand and a stationery cabinet fastened together by a swivel joint locked with a wing nut. The cabinet can be placed on the left or right

[1] See Plate II, page 382.

of the typist and angled to the most comfortable working position.

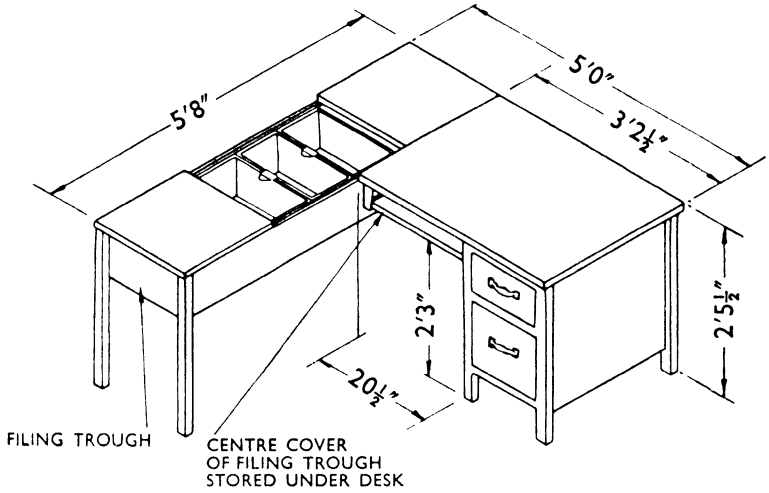


FIG. 54. 'L'-shaped desk for record cards

Description

A 2 drawer pedestal is assembled with a filing trough fitted with 5 sliding filing trays suitable for 5″ × 8″ cards.
Trough capacity — 7,000 cards.
The pedestal may be replaced by a second trough with a connecting table.

Optionally, a 'V' wedge is available to fill in the gap between the stand and the cabinet, although this means that the angle has then to be fixed. Features of the stand are as follows:

Height	27¾ inches
Width	23 inches
Depth	18 inches
Knee-hole space	25 inches high by 20 inches wide.

The back and sides are enclosed. The top has a back lip to prevent the typewriter being pushed over the edge, although with a grooved rubber or microcellular mat this is unlikely to happen. A shallow drawer under the front top edge of the stand takes pencils, rulers, pins, shorthand notebook, etc. A hinged mirror when in use rests against the front of the typewriter. Trays are of a vertical pattern, allowing sufficient depth for 'Emidicta' folders. When the cabinet is on the right the trays are fitted into slots on the left, and vice versa.

The outside dimensions of the cabinet are the same as those of the typewriter stand. This unit is enclosed with a drop roll shutter. At the bottom is a large personal drawer ($16\frac{3}{4}$ inches by $16\frac{3}{4}$ inches by 6 inches internally) with locks. Above is a removable stationery compartment designed to meet the requirements of the majority of typists and sloped to facilitate collating. Sixteen shelves take large foolscap paper and two double foolscap. Each shelf has an adjustable back divider for small size envelopes. Eight shelves have front dividers to adjust for paper widths between $2\frac{1}{2}$ inches and $7\frac{1}{2}$ inches (see Plate II*a*). Instructions for adjusting the compartment sizes are pasted on the top of the removable stationery compartment.

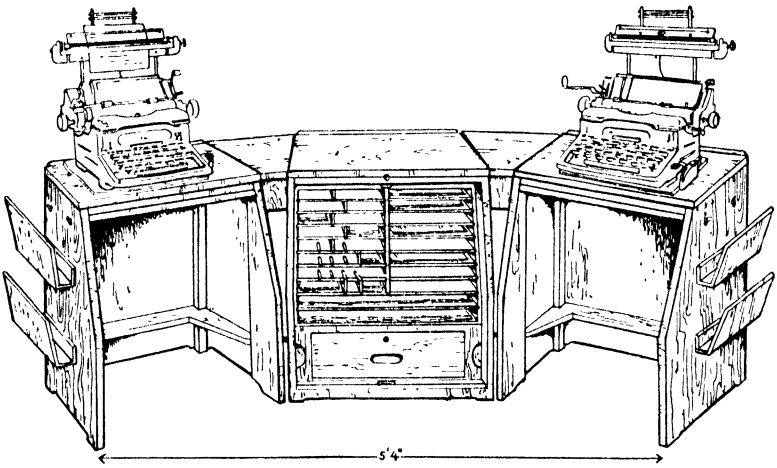
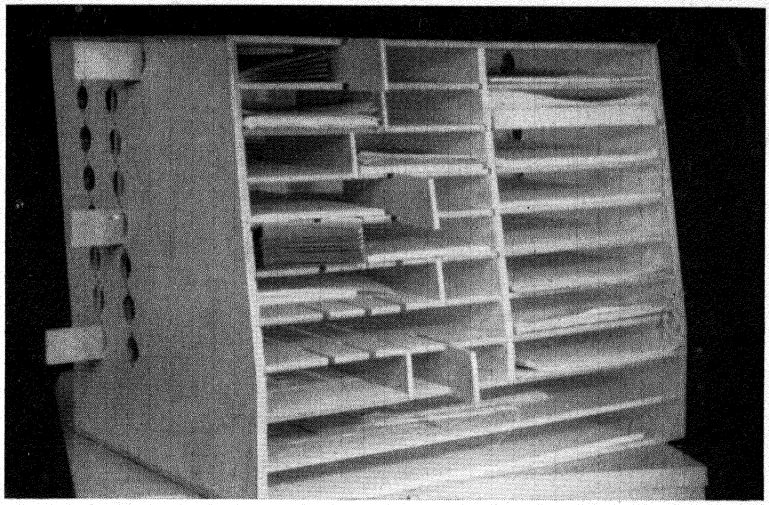
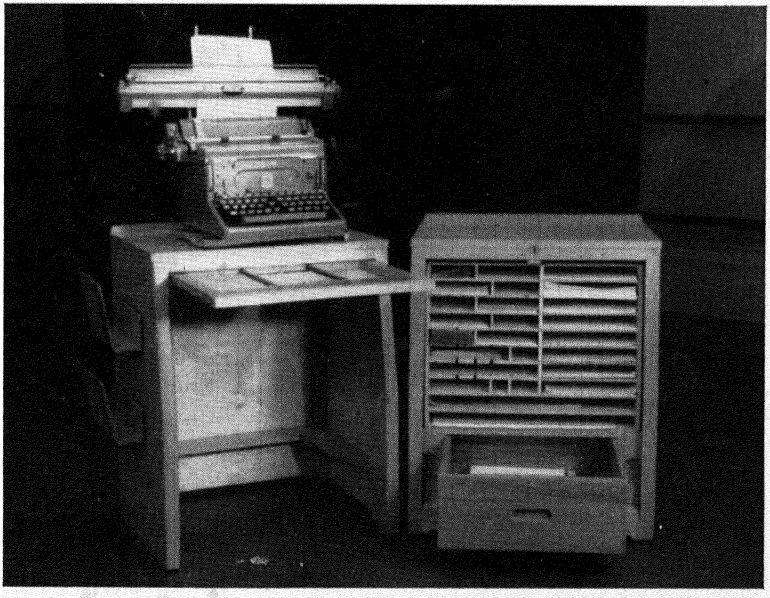


FIG. 55. Units assembled with 'V' wedge fitments

A typist will normally be equipped with a complete unit consisting of stand, stationery cabinet and trays. Each part is available separately; thus a secretary or clerk with a table or desk who also uses a typewriter, can be supplied with the stand by itself. Similarly, the stationery cabinet can be used for holding and collating forms, e.g. for use with spirit duplicators and system addressing machines. Units are available in light oak and mahogany with a natural finish, but may be fitted with a plastic top. In congested offices two typists, each with a stand, may share one cabinet (see Figure 55). The 'V' wedge fitments allow



a. Stationery Cabinet with adjustable dividers



b. Typist's Desk and Stationery Cabinet

a reasonable working area. The arrangement allows adequate distance between the typists.

Development has been closely associated with Work Study so that training schools may now be able to teach a standardised and better method for collating papers and carbons, in addition to typing and shorthand.

Other Examples of Particular Design

Another company has designed a range of office furniture comprising:

A typist's desk (see Plate III *a* and *b*).
A 'visible' stationery unit (see Plate III *b* and *c*).
A clerical worker's desk.
A comptometer operator's desk.

The typist's desk is also suitable for duplicating-machine work. It is cased in mahogany with a 'formica' top, 28 inches high, 42 inches wide and 24 inches from back to front. The desk is enclosed with a single pedestal on the right-hand side containing, from top to bottom:

An open shelf, for an audio-transcribing machine in a convenient position.
A shallow drawer, for pins, clips, etc.
An open shelf, for folders of finished work.
An open shelf, for boxes of carbon paper.
A deep drawer, for personal belongings (which can have dividers for stationery).

The separate stationery unit has been specially designed to meet the needs of typists or duplicator operators who use a wide range of stationery. It is designed in matching timber to go on the left-hand side of the operator's desk. It is of the same height, but the other dimensions can be made to suit the stationery requirements. Stationery is stored at an angle, in compartments with sloping bases so that individual sheets are slightly offset with their headings visible, making selection and extraction of stationery quick and easy. The dividers are normally fitted at 1 inch intervals, but this spacing can be varied to suit special requirements. The top is removable in two halves which can hang on the side of the unit. Either or both halves can, of course, be left in position to provide additional working surface as required. The same principles have been applied to the design

of other special purpose stationery units. Figures *d* and *e* on Plate III show a pair of units designed to be placed either side of a Flexowriter. Again stationery is stored on edge between sloping

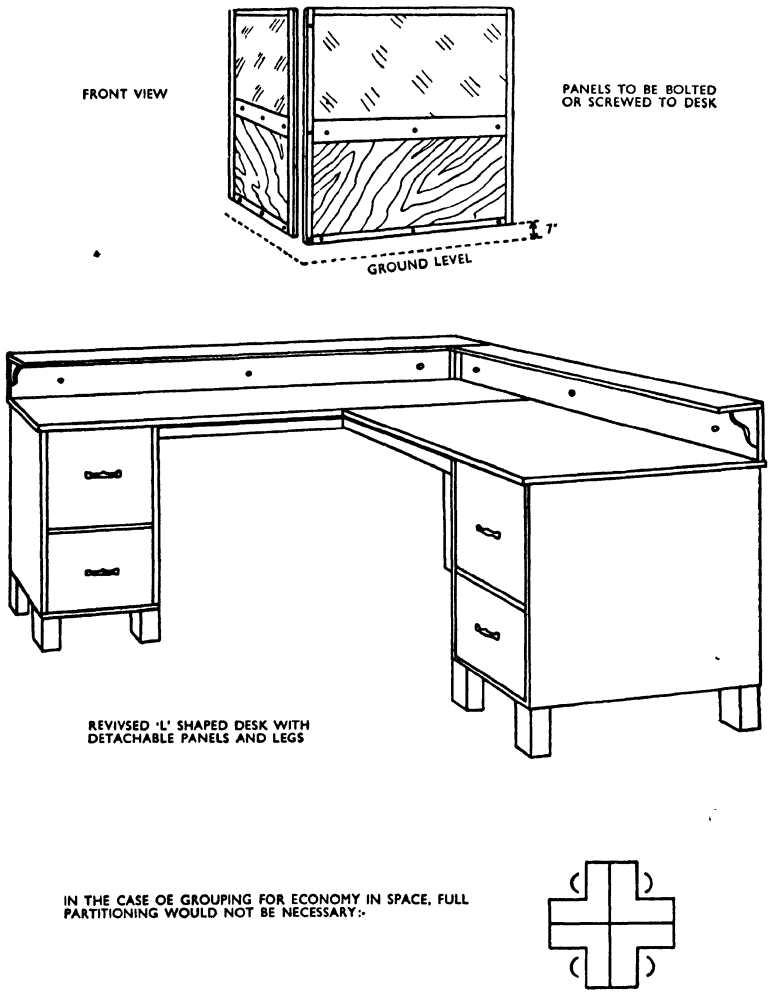


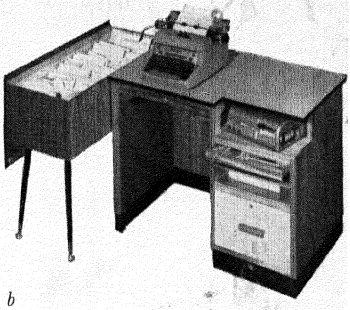
FIG. 56. Sketch of modular furniture

dividers but, in addition, provision is made for storing punched paper tapes and cards. As will be seen, the personal drawer for the operator can be incorporated if desired.

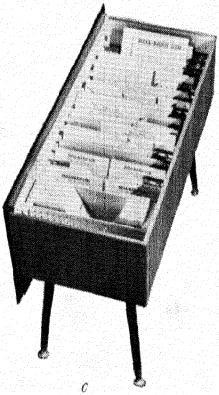
PLATE III



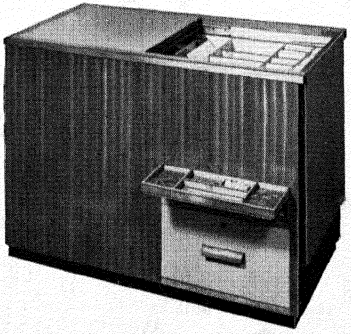
a



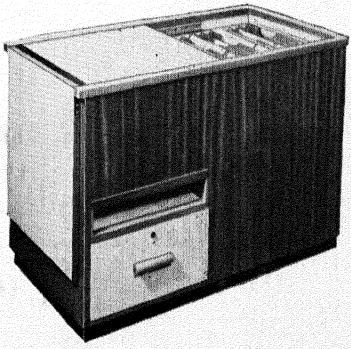
b



c



d



e

a. Typist's Desk. *b*. Typist's Desk with Stationery Unit.
c. Stationery Unit. *d* and *e*. Flexowriter Units

Other desks for clerical workers and comptometer operators have been produced based on the design of the typist's desk, suitably modified to meet the special needs of the users.

Modular Furniture

In a large open office where some measure of privacy is needed a space saving of from 5 to 35 per cent is claimed for the use of modular furniture. In an actual case, an office which would have accommodated eleven persons by conventional partitioning was divided to accommodate fourteen people using modular 'L'-shaped desks, an increase of 27 per cent. Additionally, overall costs of construction and provision of furniture show a saving of approximately 20 per cent per person in favour of modular furniture.

Privacy is complete with the use of obscure glass. Insulation from noise is as good as usual in small offices containing two or three persons, and greatly improved over offices containing ten to fifty. There is an increase over partitioning in the amount of natural light obtainable from both sides of the building. The desk illustrated (Figure 56) is 6 feet by 5 feet, the 5 feet side being 2 feet 6 inches deep and the 6 feet side 1 foot 6 inches deep. This gives an additional working area of 43 per cent over the 5 feet by 2 feet 3 inches table or desk. The whole of the area occupied by the desk, including a 2 feet entrance gangway is 40 square feet; furthermore, over 90 per cent of the whole area is accessible with an arm reach of 24 inches when seated at the normal working position.

Two or more related clerical functions may be brought together at the same time, without the paper work from one activity interfering with the other. Experience shows that discussions by up to three persons are only slightly distracting to persons in the adjacent cubicle, but this type of accommodation is not suitable for persons conducting personal interviews.

Other Specialised Items of Furniture

Conference Table. The semi-hexagonal table suitable for conferences and training is French and useful in awkwardly shaped rooms. The tables and their uses are illustrated in Figure 57.

HALF-HEXAGON CONFERENCE TABLE

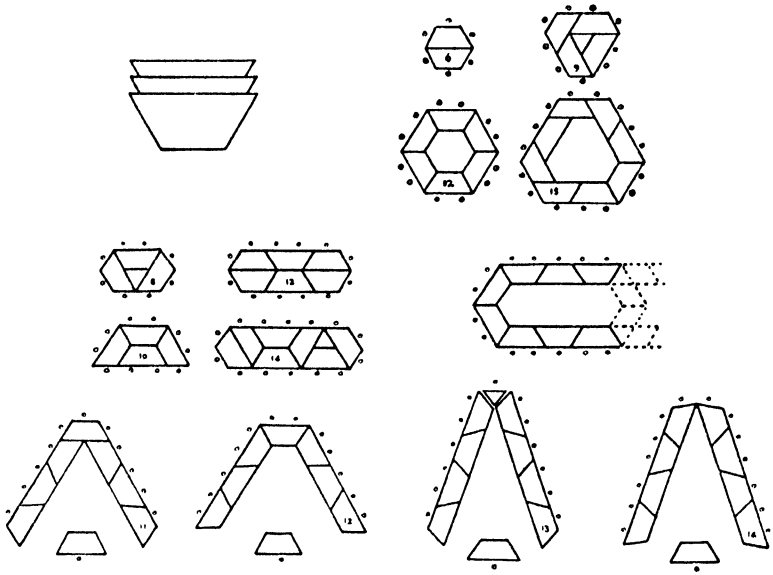


FIG. 57

Mail-Sorting Unit. This item has been designed to reduce the movement of six or seven mail clerks so that they can pass mail among themselves and to primary sorting, opening, final sorting and franking (see Plate IV). The furniture consists of:

A table with a working surface 3 feet high for the first sorting of the mail.

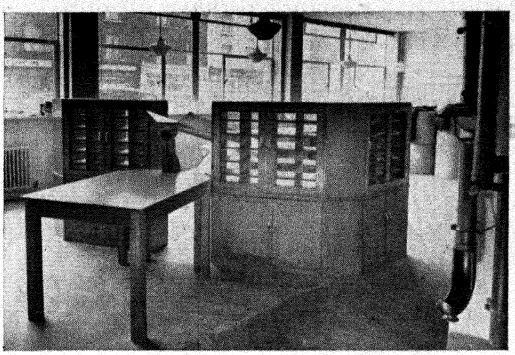
Two-angled banks of pigeon holes, each with forty-two compartments 9 inches by 5 inches. All compartments are within easy reach of the seat. In front of each bank runs a shelf 2 feet 5 inches high. The pigeon holes are backed by wire mesh doors and can be emptied without disturbing the sorters. Under the banks are cupboards which house small canvas bags for the factory mail.

Another table, 3 feet high, for opening letters and franking them.

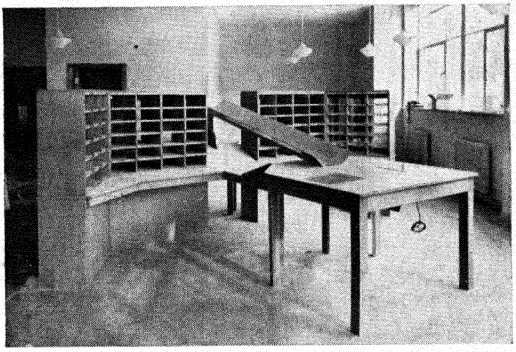
An adjustable chute connecting the two tables, which has a very gradual slope sufficient for mail in envelopes.

The overall size of the unit is 13 feet long, 12 feet wide and 5 feet 6 inches high. Each pigeon hole has a white and blue

PLATE IV



a. Receiving and first sorting side



b. Second sorting and despatching side



c. Mail-sorting unit in operation

label above it. The white labels carry the names of delivery points within the office and are used for the morning post. The blue labels concern outgoing mail. Each delivery point has two pigeon holes, one in each bank, the letters from which are collected together in the mail trolley.

The letters which have to be opened arrive on the second table (Plate IV*b*) from the chute. The envelopes are opened and the contents pushed down a small incline to the sorters. The envelopes are then scanned over a lighter panel and pushed through a slot into waste bins. After the morning post the unit is used for outgoing mail. The blue labels carry the names of factories and sales offices; all the letters for a factory are put into a small canvas bag to save postage.

Since the unit was designed incoming mail has gone up from three to four-and-a-half mail bags. In spite of this, the time of handling has been cut from one hour to three-quarters, and the work is done with one man less. The unit was built to luxury standards, finished in light oak with pale blue 'formica' surfaces and a chute of polished aluminium, but repayed its cost within a year.

Conclusion

The illustrations given will suggest a number of other possible uses in headquarters' offices, stores offices and factory offices; in fact, wherever the work involves machines or repetitive operations. The principle involved is that of simplifying the workplace, so that it will make either the physical work or the mental work easier. Examples of what can be done are built-in sources of reference, the positioning of tools regularly used and, on occasion, the marriage of process, where two or more clerks needing access to the same media can be placed at different angles on one desk so that they can share a single record. Much office furniture has copied the kitchen table without any conscious effort of development. The manufacture of functional furniture represents no more than the coming of age of the office.

COMMUNICATIONS

An office serves a business in numerous ways, not least among which is the conveyance of instructions, messages, and

correspondence, whether outwards or inwards, by hand, machine or electrical systems. The smaller the office the less attention is paid to this work, but in larger offices the time given to improving the speed and accuracy of communication may offer a valuable return.

General Outline of the Field of Communications

Some large companies have set up an office of communications, under the office manager or independently of him, divided into mailing and messenger services, telephones, telegrams, teleprinters, etc. In cases where the importance or the volume of work is great an investigation will show economies from, for instance, an improved layout of the mailing room, paying particular attention to the flow of work at peak periods and to precautions against loss of papers from untidiness, etc. The standardisation of sizes of stationery should be considered, together with the provision of folding machines, franking machines, letter opening machines and sealing machines, if turnover justifies. Apart from the machinery mentioned, which on present salary levels is not difficult to justify, a considerable field of equipment is available that can save time, untidiness and loss — for instance, wrapping-paper roll holders, label-wetting machines, weighing machines, adhesive tape dispensers, various means of inspecting empty envelopes, etc.

Sorting equipment is now widely used in offices. Three types of equipment, are now employed — compartments, flap sorters and transferable suspended files.

In large buildings the provisions for the distribution and collection of mail will also repay study, as will the allocation of space, on alternate floors or each floor, for sub-mailing rooms with or without mechanical transmission to a central mailing room.

Considerable sums of money can be wasted on unnecessary or unsuitable use of telephones, or incorrect use of instruments in parallel, too many or too few exchange lines. A study of use and misuse may suggest valuable economies. The GPO should be consulted on types of switchboards. Internal telephone communication is a developing subject with a considerable interest for O and M, particularly in providing for remote dictation to pools of typists.

Apart from the occasional use of high-fidelity machines for recording speeches, dictating and recording machines are mostly used for audio-typing, with advantages of pooling secretarial work under supervision, eliminating walking to take dictation, waiting and dictating time, and the spreading of dictation time to after hours, in the office and at home, and during travel.

Telegraphy, distinguished from telephony by its automatic recording of the message or data transmitted, is now also in considerable use, having the advantage over the latter of lower cost of operation, together with that of superior speed to postal and messenger services. Assuming the necessary volume of communication to warrant hiring the equipment, installation is accordingly justified by economy in money or time. In the U.K. all circuits have to be rented from the GPO, who have therefore to approve any apparatus connected to them and will advise a potential subscriber on their traffic problems.

In the large company with many branches where standardised systems permit the transmission of orders, for instance, in coded form, teleprinting has developed using perforated tape as the medium for transmitting data to and from a central point. This tape is already in use for a variety of purposes, of which the most prominent of the moment is for input and output with computers. For some years the newspapers have used the telegraph system to transmit photographs, and recently this process has been developed for business purposes. One saving is that symbols transmitted need to be scanned only for legibility and the process of checking for accuracy is eliminated.

The equipment mentioned in this brief survey of the field of communications is considered in greater detail under the headings which follow.

Sorting Equipment

Compartments. Racks of compartments are usually necessary when reducing a large volume into small sorts. Each division should be large enough to accept papers flat, and must therefore be about 10 inches wide. Without trays they should not be less than 8 inches high; a large number will be very cumbersome and will waste space if only a few papers are placed in each; also the top row should not be above eye-level. If double-sided (with

operators working on both sides) trays are necessary to prevent papers sliding out; their use increases the height of each compartment by 3 inches or 4 inches. Trays have, however, the advantage that they may be transferred to a trolley for distribution. Double-labelling (say, in black and red) will permit use of the same racks for different jobs at different times.

Flap Sorters. Flap sorters offer a large number of sorts in a small place, but are not suited to bulky mail. Flaps are, however, usually reversible and can be labelled differently on each side to accommodate two sorts at different times. Various sizes are available, from small desk models about 2 feet long to batteries of flaps fixed to sliding bases, with a seat in the middle. Several hundreds of divisions can then be within reach of one operator.

Suspended Files. Desks for sorting by this method permit an operator to be seated;[1] they also offer a middle course between the bulk accommodated by compartments and the number of sorts possible with flap sorters. As a rough guide, the average thickness of papers in each file should not exceed ½ inch, and with this proviso one operator can reach about one hundred and twenty files. With standard foolscap size files the fittings are cheap, although larger sizes are more expensive since they must be made to order. An advantage of file compartments is that if covered with removable flaps they provide a good working surface for other work. For comfortable use swivel chairs are advisable, the height being 3 inches or 4 inches less than for a clerk's desk (i.e. about 2 feet 2 inches). Finally, a small compartment should be fixed within each file for addressed envelopes or labels.

Mechanical Transmission

Document Lifts. Small hand or electric lifts are cheap and save time and stair climbing. An electric lift between two offices on adjacent floors will be adequate for small documents and costs about £100 to install. A large electric lift to convey trays of mail vertically through an office block and deposit it automatically at any floor, predetermined by pressing the appropriate button, costs approximately £1,000 per floor. These lifts are difficult to install in completed buildings unless a large shaft is available.

Pneumatic Tube Systems. Even the largest size tubes cannot

[1] See also section on 'Functional Furniture' above.

carry such heavy quantities of mail as a lift. However, horizontal as well as vertical traffic can be catered for, and pneumatic tubes are easier to install in an existing building. Tube runs are not decorative and the tubes are best installed with other services during erection of the building. A considerable range in size is available, from 2¼ inches diameter to tubes of rectangular section capable of transporting ledgers.

Pneumatic tube installations have grown from simple point-to-point systems into complicated networks connecting many points and providing inter-connection between any of them through a central 'exchange'. A battery of incoming lines feeds carriers into a trough from which they are routed to their final destinations. This central exchange is usually in the mailing room.

Preselector systems which do not need a central exchange are now used to reduce staff. Numbered rings are set in position on the carrier, which reroutes itself by operating relays en route. These automatic systems have the additional advantage that less tubing is required, because separate outward and inward tubes are not necessary. A disadvantage of pneumatic tubes is their lack of flexibility.

Message Conveyors. Many specialised conveyors are used by such organisations as cable companies and the GPO for carrying single pieces of paper. Commercial companies making a considerable use of teleprinters may need something similar to carry messages within the teleprinter room itself or to a mailing or a decoding room. Pneumatic tubes are well suited to this work and the decision to use teleprinters may suggest a system of tubes to speed up transmission and delivery. Simpler devices should be sufficient within the teleprinter room itself. Some examples are:

Flat Conveyor Bands. Endless bands, 10 inches to 12 inches in width and driven by electricity, which provide the answer if space permits and delivery is required at a single point. Travel cannot vary greatly from the horizontal.

Drag Bands. These consist of a double belt of canvas running in any direction, horizontal or perpendicular, with unlimited change of direction by suitably placed pulleys. Several lines can run together, separating as

desired. They run overhead and space at desk height is only required at terminal points.

Overhead Wires. Small containers can be 'fired' from one point to another by pulling a lever. A modern version has a flat container which returns to the sender automatically after depositing its contents. This system is simple and cheap, but not quite as flexible as drag-bands.

'V'-Belt. This system uses a narrow belt moving under a trough of 'V' section, so that the message travels on its edge. Several can be run together in a fairly small space at desk height, and if necessary some can travel in each direction. Movable blocks can be placed in any trough to stop messages at any desired point.

Internal Telephone Communication

If GPO and internal telephone systems are to be installed separately, a wide range of internal apparatus is available. The three main groups, which have considerable variation in detail but similar general facilities, are as follows:

Master-station Working to Sub-station. A master-station in a senior executive's office will usually take the form of a loud-speaking telephone with key-calling to a number of sub-stations wired to the master. Lamp-signalling is often provided to tell the executive who is calling him. Should he wish his conversation to be secret he can use a telephone handset instead of the microphone/loudspeaker. Loudspeaker master-stations are often built into the desk, or into a special piece of furniture which can include space for the GPO telephone and/or a dictating machine. A conference between several sub-stations and the master is possible.

Press-button Internal Telephones. Small numbers of telephones can be installed to provide intercommunication by non-secret press-button connection. Code-ringing can be used to indicate which individual is being called, and while not providing for secrecy this system is simple and quick. Several people can be interconnected for a conference.

Internal Telephone Switchboards (Private Automatic Exchange, known as the PAX). For large offices the PAX may be

necessary, giving intercommunication by dialling, to hundreds of subscribers. Accommodation will be necessary for the switching equipment in a warm and dust-free room. A PAX may be purchased, or rented, the rental term being usually long, probably fourteen years or more. Additional separate intercommunication links are not normally required with a PAX, for direct access facilities from senior executives to groups of their immediate subordinates can be incorporated into the main PAX system. Remote-dictation to audio-equipment can also be provided through these internal automatic telephones.

Loudspeaker Systems

Although unusual in offices, loudspeaker systems have their place in factories. A master-set in the manager's or supervisor's office provides facilities for calling any or all loudspeakers by keys. Fire alarms can be incorporated. Outstations consist of microphone and loudspeaker, with a press-button to permit calling in to the master, but not to other stations. Loudspeaker systems serve three purposes. Intercommunication, staff location and, on occasion, public address.

Staff Location Systems

In offices this function is performed by the telephone system, whereas in factories lamp-signalling devices are available (sometimes incorporated in clocks) so that from a central position, usually the telephone switchboard, lamps or numbers can be illuminated which indicate by code which individual is being called. A newer system uses radio. Pocket receivers, some flat, some cylindrical, are provided for those persons likely to be out of their offices a good deal; a transmitter emits a signal which will be picked up only by the particular receiver called. Some of these systems require a loop resistance to be wired round the building. Others operate on a pure radio technique, with a range of approximately one hundred yards.

Radio

The use of radio by commercial concerns in this country is limited to work between mobile stations, or from a fixed station

to a mobile on specific bands of VHF. The GPO licenses such use of radio and frequencies have to be shared with consequent risk of interference. The Mobile Radio Users Association defends the interests of companies using radio commercially. Communications managers may need to use radio if their work includes provision for communications in sites, or in large factories. Where line connections to fixed points will not meet the case, portable radio can be useful, particularly in times of emergency, flooding or fire, when normal means are no longer available. The range of these 'walkie-talkie' sets is usually limited to one or two miles.

Sets of greater power fitted to vessels or vehicles can provide a radio-telephone service either to a control office or to each other. The range varies with territory, and twenty miles can be taken as a fair average. A survey is always desirable before purchasing equipment.

Dictating and Recording

Types of Machine and Recording Media

The main types of dictating machines will be considered rather than individual makes, the main classifications being:

Transportable machines used for recording *and* transcribing dictation.

Transportable machines used either for recording *or* for transcribing.

Machines designed for remote control use (basically machines of the first two categories with auxiliary apparatus).

'Pocket' machines of, say, 2 to 3 lbs. in weight.

The choice of recording media is considerable and all the main types, excepting 'pocket' machines, make use of the following:

Magnetic Tape. If recordings are of long duration tape has the advantage over other methods for, with the exception of wire (q.v.), other media seldom record for longer than thirty minutes. This consideration does not usually apply to dictation of correspondence which is of short duration. Magnetic tape can be used repeatedly after erasure or by 'over-recording'. Despite the comparatively high initial cost it is cheap to use.

Breakages are rare and easily repaired. Alterations in dictation can be made by back-spacing and over-recording, although making a note for the transcribing operator will save time. Tapes can be stored indefinitely but are less convenient to post than most other media. Some tape machines are so designed that the two tape spools are housed in a removable section of the machine (called a 'cassette'), which permits very quick and simple reloading. Cassettes are, however, not always completely interchangeable between several machines of the same make. The speed of travel of the tape past the recording head governs the quality of recordings; $1\frac{7}{8}$ inches or $3\frac{3}{4}$ inches per second are usually satisfactory speeds for intelligible speech. Half-an-hour of recording at $1\frac{7}{8}$ inches per second is accommodated on a convenient sized spool of 4 inches in diameter or less. Tapes deteriorate a little with use so that recordings lose quality.

Magnetic Wire. Wire has similar qualities to tape, with the exception that it breaks more easily and is more difficult to repair. Breaks are joined by knotting, and knots can be a nuisance in passing the recording head. A break can also interfere with dictation, since the wire easily tangles. On the other hand wire does not deteriorate with use as there is no magnetic surface to wear. Spools of similar size can also take a longer run of wire than tape. However, the tendency of wire to break has almost an over-riding importance so that it is decreasing in popularity.

Paper Sheets. These are used both with magnetic and with non-magnetic surfaces. Duration of recording is usually short — ten to fifteen minutes. Transfer from one machine to another usually presents no alignment problems, and the medium is, of course, ideal if posting is necessary. A particular sentence or word is easier to locate than with tape or wire, since the recording head moves rather than the sheet itself, as with disc and belt methods. The cost is likely to be higher than with tape or wire, particularly for non-magnetic sheets.

Magnetic Discs. The duration of recording is short — ten minutes or so. Discs may be used many times by erasing or over-recording, and are easily posted if desired. As

with paper sheets transfer from one machine to another is usually easy. Use brings a gradual deterioration.

Non-Magnetic Discs. These are similar to magnetic discs except that they are expendable. Thus overall cost is probably higher.

Plastic Belts. These are non-magnetic, expendable and similar to paper sheets. Recording time is fifteen minutes.

Machines using all of the media described above are obtainable, most of them by either purchase or rental, purchase prices being between £60 and £120, although some makes are considerably cheaper. A recording machine must essentially be reliable and robust, and initial cheapness may prove expensive. It will be moved about a great deal and used by different staff. In choosing a portable machine the recording medium, reliability and ease of operation must be considered. For the same reasons standardisation on a particular make is recommended for interchangeability and the creation of a pool.

The introduction of recording machines provides an opportunity to improve standards of dictation in the office. Those who dictate to tape must learn to be precise and to give full instructions regarding layout, stationery, etc. The successful use of machines for dictation depends very greatly on the quality of the dictation.

As far as 'pocket' machines are concerned, one type of wire recording machine and two tape machines are at present marketed. They use transistors, are battery-operated, two using expendable batteries and the other chargeable ones.

Remote Dictation

Economies can be made through the formation of a central system in a large office using good copy typists. The system may use PAX wiring and instruments or be independent. The advantages of using the PAX are:

Economy: a certain amount of additional equipment may be necessary to connect the recording machines to the board. Assuming a fairly widespread use of recording facilities in a large building, these expenses will certainly be less than that involved in wiring up numerous recording stations to a central pool.

Flexibility; any telephone extension can be used for

dictation; to wire all rooms separately would be prohibitively expensive.

Cheaper Maintenance: an independent system means additional maintenance of microphones, possibly of control boxes and of the second wiring system.

The main disadvantages of using the existing telephone are:

Quality: the microphone used in the standard telephone hand-set is not as good as that provided specially for dictation.

Telephone Availability: whilst dictating the telephone will be occupied for longer periods than for ordinary conversations. This could also interfere with incoming trunk calls.

The balance therefore seems to favour use of the telephones, if PAX type. Even if the GPO later permits, it will probably not be so satisfactory to use PABX (Private Automatic Branch Exchange) instruments and wiring for remote control dictation.

Operating Methods

Most systems provide a bank of recording machines with group-hunting facilities connecting them to the remote instrument, whether this be a PAX telephone or a special microphone. The amount of automation provided varies. It is possible, if desired, to permit the caller to obtain access to a machine, to stop and start it, to replay and listen to parts of his dictation and to mark the lengths of letters and the positions on a scale where corrections have been made. Complete remote control is not an unmixed blessing, since excessive stopping and starting, replaying, etc., causes congestion. Many users insist on a limited amount of manual control by the operators to ensure identification of the caller. This is a useful safeguard against loss of dictation due to mechanical failure.

If recording and transcribing machines are provided at the dictation centre as separate units, labour is involved in transferring tapes or discs from one machine to another, and for small systems it may be better to use the alternative which entails providing each typist with a pair of machines, suitable for both purposes, with switches to isolate either from the line when transcribing. This system also has advantages when teleprinter messages are recorded, since it is easier to provide a speedy service. However, this would prove rather expensive in

machinery in a large installation. In theory two or three transcribing machines will be needed to cater for dictation recorded on a single recording machine, though it is advisable to err on the generous side when deciding on the number of recorders. This will prevent too much irritation being caused to users by failure to obtain immediate access to a machine. In order to economise in machines it may be found necessary to programme their use, though it is better, if possible, to give free access at all times. As it is not necessary for staff to accumulate their dictation until a stenographer is free, a greater spread of work through the office hours is possible; this advantage should be emphasised in instructions. Dictation time can be saved by sending relevant papers to the pool, but there are obvious disadvantages to this practice.

Data Transmission

When a system of data transmission is added to an existing message-handling system standard teleprinter equipment and lines should be used as far as possible.

Sprocket-Feed Stationery

The treatment of orders received in a central office for delivery by distant factories will illustrate some needs.

First, a tape must be prepared using, probably, a hand-written proforma as the master. A type of perforator which gives a local record is best, so that the tape can be checked for accuracy in tabulation before transmission. A check at this stage can save waste of stationery, which can be considerable when multi-part sets are used.

Assuming that more than one copy of the form is required at both ends, both teleprinter machines must be equipped with pin-wheel, instead of standard friction-feed platens, to prevent slipping. This presents no particular problem except in stationery design. The rulings of the forms must be designed in relation to the line-feed and letter-space distances of the teleprinter. The document set must be limited to a maximum of eight parts, or difficulties will occur. If more copies are needed at the distant end, the receiving teleprinter can be combined with reperforating equipment to produce a duplicate perforated tape from which further sets can be produced.

Once this simple procedure is integrated with other stages, particularly with accounting procedure, error liability becomes an important factor.

Errors

If a machine prints a wrong character in a teleprinter message, the context will usually serve as a guide to a correct interpretation of the word. Figures are not likely to be self-checked in this way and are, therefore, collated at the end of the message on the assumption that the same human, mechanical or electrical fault is unlikely to appear in both printings.

If the transmission is mainly one of figures, the insertion of totals at agreed intervals will provide a check. At the receiving end, all figures must be checked back to the totals. The present tendency is towards complete automation, and if the transmitted datum is to be fed as it arrives on perforated tape, either directly into a computer or into a tape-to-card convertor, the ordinary standards of accuracy may not be sufficient. The GPO state that VF (Voice Frequency) telegraph channels are, for one reason or another, likely to have a printed error rate of between 1 in 20,000 and 1 in 40,000 characters. A character comprises seven-and-a-half 'bits'; but to deduce from this that the error rate is therefore approximately 1 in 250,000 'bits' would be unsafe.

Whilst error liability rates in the order of those mentioned may be acceptable for many purposes, where information is transmitted and processed as 'bits' rather than characters, some built-in check will be needed.

With six- or seven-level tape, 'parity' checks of one kind or another are easy to include, because one or even two levels may be used for checking. Thus, working with a seven-level code, a 'fixed ratio' check can be used by establishing that only code combinations with three marking pulses are valid. Or an odd — or even — 'parity' check could be used on the basis that only code combinations with an odd number — or an even number, as the case may be — of marking pulses are valid. Of these two methods, the former is less liable to compensating errors, but it has a greater redundancy. Alternatively, after a given block of information a horizontal check may be inserted so that each level of that block is brought to odd — or even — 'parity' by the insertion of the appropriate character. Such methods are

more suitable to codes such as seven- or six-level, where there is greater redundancy. The limitations of five-level tape may have to be accepted in order to use standard telegraph equipment.

Finally, whereas computers usually transmit within themselves by reading the tape in parallel, the pulses conveyed over a communication line are transmitted in serial form, and any faults that arise are likely to affect two or more succeeding pulses. The best check on computer working is therefore not necessarily the best for transmission over lines.

Transmission Speeds

The work carried out within a computer is performed at very high speeds compared with the standard telegraph speed of approximately fifty bits per second or sixty-six words per minute. Two approaches are possible to overcome this difficulty.

A most practical method is to receive data at normal speeds and accumulate a reserve before feeding it to computers. In many cases existing teleprinter circuits can be used and data transmitted out of normal office hours, in order to use line time previously wasted. For example, data could be transmitted in two or three hours in the late evening for processing on the following day.

Higher speed circuits may be obtained by paying more for them, but such circuits will not be available everywhere, and they do not answer the problem completely. The reason for their higher cost is that a greater frequency band width is necessary to obtain higher speeds. For example, a speech band width circuit of normal GPO type should carry several hundred bits per second. But above a distance of approximately twenty-five miles, high quality circuits become complicated. They involve amplification and may require four or five different kinds of line plant. Generally they are more liable to faults of very short duration than are telegraph circuits, and this is of great importance for data transmission. The rate of error liability on higher grade circuits is still uncertain.

Facsimile Transmission

Facsimile telegraphy avoids the disadvantages experienced with the teleprinter through the use of keyboard characters, in that a limitation is imposed on what can be transmitted, and

the liability of human error exists. The principle is in general to scan the original with a bead of light which is reflected from white and absorbed by black surfaces. The light reflected passes through a selenium cell and reacts upon the current passed to the line. The variations in current are used by the receiving machine to reproduce the original on special paper, by stylus or writing edge.

Definition is governed to a large extent by the speed of scansion. At seventy-five lines per inch, for example, reasonably good copies of hand-written or typed documents would be produced, although fine print might need one hundred lines per inch. Speeds cannot be discussed in terms of words per minute, since it will take a fixed time to scan a given area, regardless of the number of words. Using single-spacing on a typewriter one hundred and fifty words can be typed on the message-blank of one model, which will take two to three minutes to transmit. On the latest models selection is possible of part of the original message to be scanned, the machine being pre-set to stop at a given point.

Although facsimile has some advantages over conventional telegraphy, there are also disadvantages which at present prevent its widespread use. The chief limitation is in distance. Using normal telegraph circuits the effective range is only twenty to thirty miles, although when high-grade circuits are available larger distances are possible, if the high cost can be justified. Copies of facsimile messages are not easy to make. Most machines can produce only one copy directly and additional copies can be made only by expensive photocopying methods.

Since no particular skill is needed to send or receive messages by facsimile machines, they can be successfully employed to feed messages into a teleprinter system from points too small to justify the employment of a teleprinter and a trained operator. For internal use in a scattered group of offices they can also be very useful, particularly as the reproduction of laboratory specifications, sketches, etc., presents no problem.

Other types are now produced which are useful for short messages over short distances. On one machine a message can be handwritten on a length of tape, sent by pressing a button, and received in eighteen seconds. On others a message is

received simultaneously, word by word, as it is written. This type requires a certain amount of manual skill, as the pencil used does not itself write, but is connected to the stylus by levers. A good application is possible in factories, where telephones are difficult to use because of noise.

A machine has recently been developed which combines the attributes of facsimile with those of television. Instant exchange of visual and sound information between interconnected points is claimed for this, on a closed circuit communication system. It transmits and receives facsimile images of illustrations, plans, written messages, 35 mm. slides or films. Combined with television receivers the system provides an internal broadcasting system. Pictures are transmitted by placing transparencies on the screen of a master-unit, films or slides through the use of special projectors built into the hood, and written messages by writing on the screen of the machine with a suitable pencil or pen. A commercial application for such a device might, for example, be that statistics and charts could be viewed by a senior official on a screen in his room, these being automatically selected by a dial or key system.

The commercial applications of closed-circuit television are of spectacular use in many manufacturing processes, where it now becomes possible to see clearly operations which for reasons of temperature, radio-activity, etc., could not previously be seen at all. Office uses are not likely to be so extensive, but can nevertheless be of value. The basic apparatus consists of a camera head, which can be remotely controlled, and a viewing screen. By these means the remote user at the screen may manipulate the camera and read all or selected portions of documents placed before the camera. Bank cashiers, for example, are able to view statements of accounts without leaving their post.

Some Notes on Telephones

Choice of Apparatus

Even small offices, whose requirements are relatively uncomplicated, should be aware of the various kinds of telephones available. The use of parallel machines is often valuable, and these vary considerably, usually in the type of

switching provided with them. Even if the staff of an office consists solely of a man in charge and his secretary, it is wise to decide how the telephone will be used before ordering. For instance, will the man handle all calls himself, switching them to his secretary only when going out, or will she answer them all, passing some on to him? It may also be desirable to use intercommunication locally so that, holding the call, the secretary can ask her chief whether he wishes to take it or not. Office requirements vary greatly, and it is best to consult the experts before ordering, having first decided precisely what is required of the apparatus. The GPO will be able to advise the best solution to each problem, if it is properly defined for them.

In larger offices a considerable amount of inter-communication between staff is also necessary, besides communication with the outside world. The wide variety of grades of staff, and the different requirements of senior officials, add to the complications in the telephone service. There are many refinements available, such as a loudspeaker to avoid the labour of holding a handset to the ear, but many are used only as 'gimmicks' — often to be shortly discarded — and only accumulate maintenance problems. Here again it is essential to consult the experts; it is also unwise to make detailed recommendations about service until after a survey of the work involved has been made.

Switchboards

There is today much controversy over the respective merits of two types of switchboard, the GPO standard PMBX (Private Manual Branch Exchange), which is used in conjunction with a separate internal system, and the PABX (Private Automatic Branch Exchange), which covers both requirements. Both types function with equal efficiency and have many protagonists.

PABX switchboards are available in all sizes from the No. 1, itself in three sizes the smallest of which caters for four exchange lines and fifteen extensions (although House Exchange systems similar in principle can be obtained for only one line and five extensions or two lines and ten extensions), up to an almost unlimited size in the No. 3 range, where up to one hundred exchange lines and six to seven hundred extensions is not uncommon. In any medium-sized office there is little to be said against the PABX No. 1, which is a cordless type, easy to operate,

giving intercommunication by dialling, access to exchange lines without intervention by the operator, and automatic transfer of calls to other extensions. If the operator is at lunch, a night-service key will enable all incoming calls to be automatically routed to a nominated extension, or transferred to another by dialling. Indeed, provided all users dial their own calls (at any rate, calls other than Trunks), operation can become a part-time job. Some users thus operate a permanent 'night-service', and need not employ an operator. This offsets the higher cost of PABX which persuades some users to employ manual methods.

When large cordless PABX installations are available in this country the scales will be weighted much more heavily in favour of the single telephone in large office buildings. At present the only type available is the PABX No. 3, which is a conventionally-operated board. This must be purchased by the subscriber from the supplier, although the GPO will maintain it.

If staff will dial most of their own calls PABX can be used to its full advantage. Allowing staff to dial their own Trunk and Toll calls as well as local ones may increase the telephone call bill, but operators' wages are certain to fall. Recent changes in GPO charges and the promise of more automation to provide trunk dialling throughout the country, argue greatly in favour of increased use of automatic switchboards. A GPO traffic check of recent date showed that one of the largest PABX installations in London (twelve hundred extensions) employed only fourteen operators, whereas PMBX would have required thirty.

The extent to which operators are required will depend on how much servicing of calls is desired. The work, spread over all users, may well be effectively lost. But, on the other hand, senior executives will probably require a check on incoming calls; most firms also prefer a check on expenditure on Trunk calls by permitting them to be obtained only through an operator. Most PABX users usually compromise, and retain some operators for incoming calls and to provide a trunk service. The operator can also be of great assistance when calls clash. With a single instrument, and a PABX No. 3, she can interrupt, but she often does not know the nature of the call she is interrupting, for it may have been dialled on an internal or external line. This can cause irritation, and tends to emphasise the type of service which may be lost through automation.

Telephones can now be adapted, as has been mentioned, to provide direct access facilities, loudspeaking telephones and the like, as well as means for dictation. The case for the adaptation of an internal telephone system to provide facilities for dictation, described in more detail elsewhere in this section, is more debatable when PABX is used. The GPO are currently working on the association of recorders with the PABX No. 3, and thus it is unlikely that their prohibition on connecting them with GPO instruments will be permanent. But the disadvantage of non-availability already mentioned will become more acute when the service is reduced to a single instrument. Dictating may also come into frequent conflict with outside incoming calls, for which the operator will cause an interruption.

Thus it can be seen that both systems of switchboard have their advantages. It can also be understood why some sort of compromise between the rival systems is the most common solution. Whether or not the internal system is combined with the GPO one it is important to avoid multiplication of small local intercommunication systems. It should rarely be necessary for one man to have more than two telephones. It is also important that the wage bill for operators should be kept at a minimum, by retaining them for essential services only.

Telephones for New Buildings

Often luxurious buildings are almost completed before the elementary fact that telephones require wires to connect them, switchboard space, and so on, is considered. The GPO are blamed for the resultant unsightly appearance of their apparatus. Consideration should therefore be given to the service required early in the planning of new buildings. The GPO will supply literature on the subject giving details of rentals and current regulations. Details can also be supplied of the various additional devices available, such as the 'night-service' key on PABX No. 1, which ensures that a bell is rung at a suitable position in the office for late workers to hear it, and enables an answer to be made from any extension. This will enable operators to be dispensed with after office hours. The facility will be provided in the large cordless PABX No. 4 when it becomes available. Automatic answering devices, which will record messages, are also obtainable.

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