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MANAGEMENT OF

INDUSTRIAL ENTERPRISES

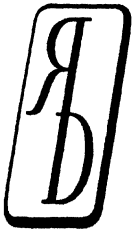
MANAGEMENT OF INDUSTRIAL ENTERPRISES

By RICHARD N. OWENS, Ph.D., C.P.A.

PROFESSOR OF BUSINESS ADMINISTRATION

THE GEORGE WASHINGTON UNIVERSITY

REVISED EDITION



1953

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REVISED EDITION

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PREFACE

THIS SECOND EDITION represents a general rewriting of the text for the purpose of incorporating recent developments and advances in the field of industrial organization and management. In preparing the new edition the author had the benefit of many constructive criticisms and suggestions made by teachers and students who have used the first edition. As a result, it is hoped that this second edition will be found not only up to date but also appreciably improved for classroom purposes.

An important change is the inclusion of 93 short illustrative cases. These cases are designed to illustrate the principles developed in the text. They present specific concrete problems pertaining to the chapters with which they have been related. They may be used for assignments of home work, for classroom exercises, or for classroom discussion. To facilitate their use, two or three questions have been asked in relation to each case. It should not be assumed, however, that the questions given in the book cover all points to be raised in discussion. Both teachers and students will want to raise other questions in the discussion of the situations described. It is hoped that the cases will aid substantially in vitalizing the discussion.

Since the days of Frederick W. Taylor, the literature of management has tended to emphasize the work of the metal-cutting industries, although the Gilbreths had demonstrated at an early date that management principles and methods can be applied in many fields of production. In this revision, an effort has been made to balance the discussion by drawing illustrations from various types of industries and making applications of the principles in many fields of production.

In accordance with the purpose of centering attention throughout upon the problems of organization and management of production, the introductory chapter of the first edition and the concluding chapter on sales have been eliminated.

Despite numerous changes, the purpose of the book remains basically the same. The second edition, like the first, is designed for the student in either business administration or engineering who is interested in attaining an understanding of all phases of the management of indus-

trial and business enterprises. The purpose of the text is to present typical problems which confront the manager in each department and to enable the student to see the interrelationship of the various activities. The book is not intended to develop specialists in any of the fields of management.

Throughout the discussion the author has attempted to do more than merely describe the activities of management and the techniques which have been developed. The relation of the management of an enterprise to the economic system and the social implications of management policies have been considered in many phases of the discussion. Human or worker interests have been discussed in the treatment of many phases of management which are sometimes considered from the technical side alone. This is true for example, of plant location, plant layout, machinery and equipment, working conditions, and motion and time study.

The author is grateful for help received from many sources in the preparation of both the original edition and the present revision. For the first edition, especial acknowledgment is made of assistance received from two of the colleagues of the author: Professor Carl H. Walther, in connection with the chapters on buildings and machinery, and Dr. Frank M. Weida, in connection with statistical inspection. It is impossible to give the specific credit the author would like to offer to the many students and teachers whose suggestions have aided in the work of revision. Acknowledgment is due especially, however, to the following for critical reviews preparatory to the writing of the second edition: Professors Harold M. Haas of Temple University, F. R. Harrison of Cleveland College, Charles E. Landon of Duke University, John F. Mee of Indiana University, William K. Schmelzle of the University of California at Berkeley, Stanley J. Seimer of Northwestern University, and Albert N. Schreiber of the University of Washington.

RICHARD N. OWENS

THE GEORGE WASHINGTON UNIVERSITY
October, 1952

TABLE OF CONTENTS

PART I. THE EVOLUTION OF MANAGEMENT

CHAPTER PAGE

I. THE BEGINNINGS OF MANAGEMENT 3

FREDERICK WINSLOW TAYLOR: Beginning of the Work in Management. The Setting of a Standard for Each Job. Standardization of the Conditions of Work. Methods of Work. Fatigue Study. An Incentive System of Wage Payment. New Method of Organization. Summary of the Taylor Principles. Effect of the Taylor System. THE GILBRETHS: Beginning of Frank Gilbreth's Interest in Motion Study. Developments of Principles. Effect of the Gilbreths' Work. HENRY LAURENCE GANTT: A New Attitude toward Labor. Other Contributions of Gantt. ATTEMPT TO DISCOVER NATURAL LAWS. OTHER LEADERS IN MANAGEMENT.

II. THE DEVELOPMENT OF MANAGEMENT SINCE 1910 . . . 23

MANAGEMENT TO 1920: Adaptation of the New Methods. New Attitude toward Labor. Use of Management Consultants. Society for Discussion of Management Problems. Effect of World War I. Developments after the War. DEVELOPMENTS SINCE 1920: Emphasis on Engineering. Personal Interest in the Worker. Company Unions. Welfare Work. Increased Unionization of Workers. Legislation Affecting Management. Management at the Higher Levels.

PART II. ORGANIZATION, LEADERSHIP, AND MORALE

III. ORGANIZATION OF THE ENTERPRISE 39

FACTORS INFLUENCING THE TYPE OF ORGANIZATION: Effect of Form of Ownership. Effect of Number of Employees. Effect of Number of Plants. Effect of Number of Products. TYPES OF ORGANIZATION: Line Organization. Line and Staff Organization. Use of Committees. Multiple Management. Functional Organization.

IV. ATTRIBUTES OF ORGANIZATION 60

Adaptation to the Enterprise. Responsibility. Channels of Supervision and Communication. Lines of Promotion. Logical Assignment of Responsibilities. Regard for Personal Capacities. Distribution of Work. Balance. Centralized Authority. Co-ordination. Use of Charts in Organization Planning.

V. LEADERSHIP 73

Nature of Leadership. Qualities of Leadership. Leaders Concerned with General Policies. The Development of Subordinates. Promotion from Within. Judgment by Standards. Action Based upon Information.

CHAPTER PAGE

VI. THE FOREMAN 87

Work of the Foreman. Responsibility for Directing the Work. Responsibility for Employee Relationships. Responsibility for Working Conditions. Co-operation with Others. Maintaining Channels of Communication. Handling Worker Complaints. The Training of Foremen. Foremen's Unions.

VII. MORALE AND THE WORKER 103

Importance of Morale. Pay of the Worker. Security. A Feeling of Belonging. Social Status. Treatment as an Individual. Surveys of Employee Opinion.

PART III. EQUIPMENT AND WORKING CONDITIONS

VIII. PLANT LOCATION 121

Factors Influencing Location. Suburban Location. Decentralization. The Company Town. Choosing a Location.

IX. BUILDING 138

The Decision to Rent or to Build. The Time to Build. The Building Plan. Single-Story Buildings. Multistory Buildings. Number of Buildings. Types of Construction. Floors. Roofs. Employee Comfort. Built-In Safety. External Appearance. Trends in Building Construction. Maintenance Program.

X. MACHINERY AND EQUIPMENT 158

EQUIPMENT FOR PRODUCTION. Manually Operated Machines. Semi-automatic Machines. Fully Automatic Machines. General-Purpose Machines. Special-Purpose Equipment. Factors in the Selection of Equipment. EQUIPMENT FOR HANDLING MATERIALS: Costs Resulting from Poor Methods. Factors in Installation of Materials-Handling Equipment. Types of Materials-Handling Equipment. Overhead Conveyors. Trucks. THE REPLACEMENT OF EQUIPMENT: Policy of Continuous Replacement. Estimating Savings from Replacement. POWER. LABOR AND MACHINE PRODUCTION.

XI. LAYOUT 182

Purposes in Planning Layout. Essentials of Good Layout. Layout by Processes. Layout by Products. Relation of Layout to Other Problems. Making the Layout. Some Examples of Layout Problems.

XII. WORKING CONDITIONS: LIGHT AND COLOR 205

LIGHT: Advantages of Good Illumination. Phases of Illumination. Essentials of Good Lighting. Effect of Building Construction. Cleanliness of Walls and Windows. Methods of Lighting. The Source of Light. Types of Lamps. Maintenance of a Lighting System. COLOR: Some Effects of Color.

XIII. WORKING CONDITIONS: AIR, NOISE, MUSIC, MONOTONY . 218

AIR: Temperature. Humidity. Smoke and Dirt Removal. Removal of Gases and Fumes. Movement of Air. Relation to Building Construction. NOISE. MUSIC AND SOUND SYSTEMS. MONOTONY. FATIGUE. REST PERIODS.

CHAPTER PAGE

PART IV. THE PRODUCT

XIV. PRODUCT RESEARCH 237

Purposes and Types of Research. Who Conducts Research. An Example of Industrial Product Research. Location of Research Laboratory. Research a Staff Function. Planning the Research Program. Budget Control of Research Expense. Patenting of a Product or a Design.

XV. DESIGN OF THE PRODUCT 249

Phases of Design. Influences upon Design. Specifications. Design a Staff Function. Importance of Speed.

XVI. SIMPLIFICATION AND STANDARDIZATION OF PRODUCT . . 260

The Need for Simplification. Costs of Diversity. A Program of Simplification. Government Participation. Commercial Standard. Purpose of Standards. Who Sets Standards. Acceptance of a Standard. Advantages of Commercial Standards. Limits of Standardization.

XVII. INSPECTION 275

Purposes of Inspection. When Inspection Is Done. Who Inspects. How Much to Inspect. Use of Statistical Methods in Inspection. Where to Inspect. Kinds of Tests in Inspection. Importance of Inspection.

PART V. PRODUCTION STANDARDS

XVIII. MOTION STUDY 295

The Purposes of Motion Study. Analysis of Motions Required. Improvement of the Electives of Motions. Therbligs. Principles of Motion. Training the Worker. Economics of Motion Study. Objections to Motion Study.

XIX. TIME-STUDY TECHNIQUES AND PROCEDURES 310

Beginning of Time Study. Uses of Time Study. Relation of Motion Study to Time Study. Beginning the Time Study. Time-Study Equipment. Recording the Element Times. Number of Observations.

XX. SETTING STANDARD TIME 324

Exceptional Observations. Computing the Time for an Element. Adjustment for Skill and Effort. Allowances. Use of Standard Element Times. Methods-Time Measurement. Inaccurate Standards. The Loose Standard. Criticisms of Time Study.

PART VI. WAGES AND INCENTIVES

XXI. THE PROBLEM OF WAGES 341

The Economics of Wages. The Marginal Productivity Theory. The Commodity Theory. The Functional Theory. The Theory of Relative Bargaining Strength. Wage Criteria for the Individual Employer. What Is Necessary to Get Workers. Cost of Living. Ability of the Employer to Pay. Effect of Work Conditions. Nature of the Job. The Ability of the Worker.

CHAPTER PAGE

XXII. WAGE SYSTEMS 355

SYSTEMS WHICH GRANT NO BONUS: Advantages of the Day Rate. Disadvantages of the Day Rate. The Measured Day Rate. Annual Wage. SYSTEMS WHICH PAY A SMALL BONUS: The Halsey Plan. Objections to the Halsey Plan. The Rowan Plan.

XXIII. WAGE SYSTEMS — CONTINUED 366

SYSTEMS WHICH PROVIDE FOR PAYMENT IN PROPORTION TO OUTPUT: Piece-Rate Plans. Bedaux Plan. Group Piece Rates. Attitude of Labor Unions. INCENTIVE WAGE SYSTEMS: The Taylor Differential Wage. The Merrick Multiple Wage. The Gantt Task and Bonus Plan. The Emerson Efficiency Wage. Requirements of an Incentive Plan. Maintenance of the Plan. Evaluation of Incentive Plans. Use of Various Wage Plans. PROFIT-SHARING AND BONUS PLANS: Disadvantages of Profit Sharing. Christmas Bonuses.

XXIV. JOB EVALUATION 383

Information Concerning Jobs. Job Ranking. Job Classification. Factor Comparison. Point System. Disseminating Information as to the Plan. Maintaining the Plan. Limitations of Job Evaluation.

XXV. MERIT RATING 398

Purposes of Merit Rating. Man-to-Man Rating Plans. Plans Which Rate Individual Factors. Graphic Rating Scale. Point Systems. Formulating the Rating Plan. Making the Ratings. Uses of Ratings. Weaknesses of Merit-Rating Plans.

PART VII. INDUSTRIAL RELATIONS

XXVI. THE INDUSTRIAL RELATIONS DEPARTMENT 415

Industrial Relations a Staff Function. Development of Industrial Relations Function. Personnel Activities. Objectives of Industrial Relations Activities. Personnel Policies a Matter of Record. Requirements of a Good Industrial Relations Manager.

XXVII. RELATIONS WITH UNIONS 426

Reasons for Labor-Management Conflict. Importance of Harmonious Relations. Principles of Understanding. The Union-Management Contract. Coverage of the Union Contract. Union Security. The Checkoff as an Aid to Union Security. The Union Shop and Union Security. Worker Security. Security for the Employer. Interpretation of the Union Contract.

XXVIII. EMPLOYMENT PROCEDURES 440

Sources of Labor Supply. The Requisition for Employment. Procedure for Employment. Methods of Selecting Workers. Preliminary Interview. Application Blank. Letter of Application. Employment Interview. Recommendations. Personal Investigation. Mental Tests. Special Aptitude Tests. Trade Tests. Social Interest Tests. Physical Examination. Introducing the Worker to the Job.

CHAPTER PAGE

XXIX. TRANSFER, PROMOTION, DISCHARGE 458

Transfer of Workers. Promotion. The Promotion Chart. Basis of Promotion. Seniority Rights. Demotion. Layoffs. Discharge. The Preclearance Interview. Report of Termination.

XXX. EMPLOYEE TRAINING 471

Need for Training. Purposes of Training. Selection of Persons for Training. Vestibule Training. Apprenticeship Training. On-the-Job Training. Training for Upgrading. Organization for Training. Training of Instructors. Training Instructors in Work Methods. Rewards for Course Completion. Checking the Value of the Training Program.

XXXI. ACCIDENT PREVENTION 485

Accident Costs. Legal Liability of the Employer for Accidents. The Safety Movement. Relation of Layout to Safety. Relation of Machine Design to Safety. Clothing. Unsafe Practices. The Safety Program. Reporting Accidents. Accident Statistics.

XXXII. EMPLOYEE SERVICES 500

Medical Services. Group Hospitalization and Surgical Benefits. Group Life Insurance. Recreation and Clubs. Employee Publications. Plant Cafeteria. Company Stores. Suggestion Systems. Retirement and Pension Plans. Employee Stock-Purchase Plans. Credit Unions. Employee Counseling. Other Services.

PART VIII. PROCUREMENT AND STORAGE

XXXIII. PURCHASING 521

Types of Goods Purchased. The Purchasing Function. Organization for Purchasing. Developing Sources of Supply. What to Buy. How Much to Buy. Records for Purchasing. Qualifications of the Purchasing Agent.

XXXIV. INVENTORY STANDARDS AND CONTROL 535

Kinds of Inventory. Purposes of Inventory Management. Standard Quantities. Determining the Quantity to Order. Reorder Point. The Balance of Stores Record. Pricing of Materials Issued.

XXXV. STORING MATERIAL AND SUPPLIES 546

Essentials of Good Storage. Effective Use of Space. Ease in Finding Materials. Ease in Receiving Stores. Ease in Issuing. Economical Handling and Moving. Protection against Deterioration in Quality. Protection against Damage and Fire Loss. Prevention of Waste and Theft. Prevention of Accidents. Keeping Inventories at a Minimum. Constant Supply of Needed Materials and Supplies. Ease in Taking Inventory.

PART IX. PHYSICAL CONTROL OF PRODUCTION

XXXVI. THE PROBLEM OF PRODUCTION PLANNING 569

Development of Production Planning. What Planning Includes An Illustration of Planning. Advantages of Production Planning Relation to Other Management Problems. Departments Affected by Production Planning. Production Control Methods. Centralized or Decentralized Planning. Effect of Method of Manufacture

CHAPTER PAGE

XXXVII. ROUTING IN DIVERSIFIED PRODUCTION 582

Organization for Production Planning. Phases of Routing. Parts Necessary for Assembly. Sequence of Parts Completion. Materials Necessary. Operations Necessary to Production. Preparation of Forms. Division of Work into Batches.

XXXVIII. SCHEDULING IN DIVERSIFIED PRODUCTION 591

Nature of Scheduling. Purposes of Scheduling. Information Necessary for Scheduling. Bulletin Boards for Showing Machine Loads. Scheduling the Production Order. Centralized or Decentralized Scheduling. Adaptations of Scheduling Methods.

XXXIX. DISPATCHING AND FOLLOW-UP IN DIVERSIFIED PRODUCTION 602

Preparation. Issuance of Orders. Following the Progress of the Work. Recording Changes in Machine Loads. Communication between Departments. Follow-Up.

XL. PRODUCTION PLANNING IN CONTINUOUS MANUFACTURING 611

Characteristics of Continuous Production. Routing. Preparation for Production. Scheduling Production with Demand. Scheduling Monthly Deliveries to Customers. Scheduling the Production of Parts and Assemblies. The Factory Float. Scheduling Daily Runs. Dispatching. Follow-Up.

PART X. FINANCIAL CONTROL OF PRODUCTION

XLI. CONTROL THROUGH THE BUDGET 627

Relation of the Budget to Management. Static or Flexible Budget. Length of the Budget Period. Organization for Budgeting. Preparation of the Budget. The Sales Budget. Manufacturing Budgets. Advertising Expense Budget. Selling Expense Budget. Administrative Expense Budget. Cash Budget. Estimated Financial Statements. Operating the Budget. Advantages of a Budget. Limitations of the Budget.

XLII. CONTROL THROUGH COSTS 642

Purpose of Determining Cost. Kinds of Cost Systems. Elements of Manufacturing Cost. Determining Material and Labor Cost. Purposes of Manufacturing Expense Accounting. The Allocation of Service Department Expenses. Allocation of Expenses to the Product. Seasonal Variation in Production. Predetermined Expense Rate. Normal Rate of Output. Standard Cost. Interest Not a Part of Cost. Differential Cost. Total Cost. Replacement Cost. Opportunity Cost.

INDEX

INDEX 659

LIST OF ILLUSTRATIONS

NO.		PAGE
1.	Simple Organization, Several Persons	41
2.	Organization of American Can Company	42
3.	Line Organization	43
4.	Line and Staff Organization	46
5.	Organization of a Textile Manufacturing Company	49
6.	Functional Foremanship Organization	53
7.	Methods of Communication	68
8.	An Employee Questionnaire	115
9.	Illustration of Plant Expansion	144
10.	Steel-Frame Building under Construction	147
11.	Types of Roofs	150
12.	Interior of a Modern Building	152
13.	A Modern Lathe	162
14.	Movement of Tin Cans to Freight Car by Conveyor	168
15.	Some Uses of Lift Trucks for Materials Handling	170
16.	Use of Lift Truck for Storing Materials on Pallets	171
17.	Workplace with Store of Materials	184
18.	Layout of a Factory by Processes	185
19.	Layout of a Factory by Products	187
20.	Production Line for Assembly of Adding Machines	188
21.	Process Chart Showing Steps in Manufacture of a Product	193
22.	A Three-Dimensional Model of Plant Layout	196
23.	Office Layout before Revision	198
24.	Office Layout after Revision	199
25.	Layout of a Restaurant	200
26.	Textile Mill Which Makes Effective Use of Natural Light	207
27.	Spacing of Light Fixtures	208
28.	A Building with Saw-Tooth Roof	209
29.	A Building Constructed with Glass Blocks	210
30.	Composite View of Foundry Ventilating Equipment	223
31.	Use of Fans for Movement of Air	224
32.	Form for Acceptance of a Commercial Standard	270
33.	Micrometer for Measuring Inside or Outside Dimensions	283
34.	Gage for Inspecting Outside Dimensions	284
35.	Comparator for Inspection of Profile of Parts	286
36.	Device for Testing Tin Cans	287
37.	Workplace Planned for Economy of Motion	303
38.	Decimal Stop Watch	316

NO. PAGE
39. Observation Sheet for Time Study 317
40. Board Used for Making Observation of Times 318
41. Class of Shop Stewards Discussing Time Study 333
42. Job Evaluation by the Point System 389
43. Illustrative Job Evaluations 390
44. Method of Showing Relation of Prevailing Wage Rates and Job-Evaluation Points 391
45. Drawing Used to Explain Job-Evaluation Plan 393
46. Man-to-Man Rating Sheet 401
47. Rating of Separate Factors 402
48. Graphic Rating Sheet 403
49. Rating Sheet for Supervisors 405
50. Organization of Industrial Relations Department 419
51. A Short Intelligence Test 449
52. A Short Clerical Aptitude Test 450
53. A Short Mechanical Comprehension Test 451
54. A Short Personality Test 452
55. Use of Visual Aids for Induction Talk to New Employees . . . 454
56. Promotion Chart for Technician in Telephone Company 461
57. Personal Instruction of Machinist Apprentices 476
58. Safety Clothing Worn by Steelworker 490
59. An Unsafe Practice 491
60. Display of Warning Sign at a Machine 492
61. Foreman's Accident Report 496
62. First-Aid Service in an Industrial Plant 502
63. Balance of Stores Record 541
64. Balance of Stores Record Showing Unit Costs 542
65. Layout of Storeroom 548
66. Storeroom Arrangement Showing Flexible Bin System 549
67. Numbering System for Flexible Bins Showing Row of Bins . . . 552
68. Truck Used for Storing and Issuing Materials on Skids 555
69. Materials Stored in Containers in Which They Will Later Be Issued 556
70. Storage of Materials to Assure Old Stock Used First 557
71. Flow Chart of the Path of a Production Order 572
72. Diagram of Lines for Assembly of a Product 578
73. Organization of Planning Department 582
74. Bill of Materials 584
75. Operation Ticket 585
76. Effect of Dividing Work into Batches 589
77. Scheduling Production 592
78. Monthly Machine-Requirement Record 594
79. Machine-Load Chart 595
80. Machine-Load Bulletin Board 596

NO. PAGE
81. Visible Filing System for Machine Loads 597
82. Diagram of Sequence of Parts Completion 598
83. Lead-Time Chart Used in Scheduling 598
84. Material-Requirement Record 603
85. Bulletin Board for Showing Progress of Work 605
86. Behind-Schedule Report 607
87. Summary of Machine Loads 607
88. Scheduling Preparation for Production 614
89. Estimate of Production 615
90. Scheduled Production 615
91. Daily Run Sheet 618
92. Timing of Automobile Production 619
93. Weekly Production Report 621
94. Monthly Production Report 621

LIST OF CASES

CASE NO.		PAGE
1.	Change in Form of Organization	56
2.	Development of Staff Departments	57
3.	Program of Organization Planning	58
4.	Function of an Organization Department	71
5.	Organization of Work in an Office	72
6.	Proposed Training Program for Executives	85
7.	Different Types of Leadership	86
8.	Supervision of Foremen	100
9.	Informing Foremen of Responsibilities	100
10.	Giving Foremen a Company-wide Viewpoint	101
11.	Comparison of Worker and Company Wants	117
12.	Observance of Birthday Anniversaries	117
13.	Location of a Carpet Mill	136
14.	Change in Plant Location	136
15.	Planning for New Facilities	155
16.	Relation of Building Design, Materials Handling, and Plant Location	156
17.	Savings from Machine Replacement	178
18.	Methods of Materials Handling	179
19.	Use of Disposable Pallets	180
20.	Technological Improvements in the Telephone Industry	181
21.	Use of Process Chart	202
22.	Determining Balance in Layout	202
23.	Process Chart for Fruit Canning	203
24.	Revision of Plant Layout	203
25.	Maintenance of Lighting System	216
26.	Use of Color in the Plant	217
27.	Air Conditioning in a Candy Factory	233
28.	Method of Noise Reduction	234
29.	Planning a Research Program	248
30.	A Co-operative Research Program	248
31.	Development of a Low-Priced Product	258
32.	Problems Arising from Design Changes	258
33.	Standardization of Product	272
34.	Reduction of Product Line	273
35.	Maintenance of Quality Standards	289
36.	Worker Inspection	290
37.	Substitution of Worker Inspection for Professional Inspection	290

CASE NO.		PAGE
38.	Method of Collecting Trash on the Street	308
39.	Method of Collecting Loose Cork	308
40.	Method of Inserting Paper in Typewriter	309
41.	Training in Time-Study Methods	322
42.	Use of Standard Data for Production Standards	336
43.	Correction of Loose Production Standard	337
44.	Territorial Differentials in Wages	353
45.	Share-of-Production Plan of Wage Payment	353
46.	Premium Payments under Halsey and Rowan Plans	365
47.	Guaranteed Employment	365
48.	Efficiency Payment by the Emerson Plan	381
49.	Profit Sharing by Formula	382
50.	Profit Sharing without Formula	382
51.	Launching a Job-Evaluation Plan	395
52.	Operation of Merit-Rating Plan	409
53.	Need for a Merit-Rating Plan	410
54.	Desirable Qualities in Supervisors	411
55.	Scope of Personnel Activities	424
56.	Treatment of Problem Employees	424
57.	Consulting the Union on Layoffs	438
58.	Alleged Favoritism of Foreman	439
59.	Payment of Expenses of Applicants for Positions	455
60.	Interviewing the Job	456
61.	Sizing up Applicants during Interview	456
62.	Contrasting Types of Employment Interview	457
63.	Promotion from Within	469
64.	Communicating with Employees on Work Changes	469
65.	Co-operation with Local Schools	482
66.	Need for a Training Program	483
67.	Accident Statistics	499
68.	Place of Accident Prevention Manager in the Organization	499
69.	Proposed Co-operative Health Program	513
70.	Establishment of a Suggestions System	514
71.	Operation of Suggestions System	515
72.	Relation of Wives of Employees to Company Programs	515
73.	Organization of Open House	516
74.	Scheduling of Purchases	533
75.	Control of Functions from Main Office	533
76.	Charting of Inventory Requirements	544
77.	Charting of Inventory of Parts	545
78.	Use of Storage Methods to Stabilize Production	563
79.	Need for Maintenance Storeroom	564

CASE NO. PAGE

80. Planning for Production 580
81. Routing and Scheduling in Batches 590
82. Division of Work into Batches 590
83. Method of Production Control for Caps 600
84. Preparation of Machine-Load Chart 601
85. Computation of Machine Capacity 601
86. Scheduling of Work in a Garage 609
87. Comparing Quotas with Sales Made 610
88. Use of Labor Pool 622
89. Filling Orders of Customers in a Mail-Order House 623
90. Budgeting Manufacturing Costs 640
91. Desirability of a Budget 641
92. Use of Cost Information 655
93. Place of the Cost Analyst in the Organization 656

PART I

The Evolution of Management

CHAPTER 1

THE BEGINNINGS OF MANAGEMENT

THE STUDY of the principles of organizing and managing a business is a comparatively recent development. Although some attention was directed to the problems of management as early as the days of Adam Smith and some experimentation in management methods was made during the first half of the nineteenth century, the methods of management were never sufficiently developed to the extent that management could be considered a science or a body of principles that were generally accepted. The small beginnings that were made here and there were not integrated, organized, or continuous. Such studies as were made were regarded as isolated and impractical experiments. An explanation for the lack of continuous and serious attention to management may be found in the relatively small amount of capital required by the average enterprise, the small number of employees, the close relationship which existed between the employer and his employees, and the fact the production methods were not highly mechanized.

FREDERICK WINSLOW TAYLOR

The study of management as a continuing, unified, and practical method began with the work of Frederick Winslow Taylor and a group of his associates. [Taylor is often referred to as the father of scientific management, and the methods and procedures which he originated and introduced are sometimes called the "Taylor system."] The work of Taylor and his associates constituted a very significant beginning, although others, also, made important contributions throughout the period in which he worked.

Taylor was born in Germantown, Pennsylvania, in 1856 and died in 1915. He came from a middle-class family of some means. Giving up

his plan to study law only because of difficulties of eyesight, he became an apprentice to a machinist in 1874, completing his apprenticeship in 1878. In the latter year, he entered the employ of the Midvale Steel Company at Philadelphia, where he worker as a laborer, clerk, machinist, and foreman. Taylor's studies in management began at Midvale in 1880 when he was made a foreman; and they continued there until 1890, when he left to work with a number of companies as consultant in management or as manager. From 1898 to 1901 he continued his experiments in management methods at the Bethlehem Steel Company, along with several other persons who had been associated with him at the Midvale Steel Company. Taylor left the Bethlehem Steel Company in 1901 and retired to private life, devoting his remaining years to writing and to the discussion of his ideas on management.[1] Since all of his work is based upon the same philosophy and constitutes a system, no attempt is made in the succeeding paragraphs to distinguish the work at one company from that at another.

Beginning of the Work in Management. Taylor's work in management began with the attempt to get a fair day's work from the men. When he was a clerical employee and later when he worked in the shop, he observed that the men made no pretense of doing a day's work but constantly strove to make the job last. The principal reason appeared to be the fear of running out of work; for without any conscious theorizing on the subject, the men believed in the "lump of labor" theory, which holds that the amount of work available is a fixed and definite amount. [This attitude also reflected a failure of management to determine for itself the meaning of a day's work or to set a fair standard by which the accomplishments of any worker might be evaluated by either worker or management. The employer had also neglected to use worker incentives and had paid no attention to the flow of work to various departments or machines.] Consequently, the fear of the worker that a high rate of production might result only in idleness or unemployment was in many cases based upon his experience on the job.

In the absence of management standards, workers had determined for themselves the fair amount of work to be done in one hour or one day; and they were careful not to do more than that amount. Taylor,

[1] The best known of F. W. Taylor's writings are as follows: "Notes on Belting" (1892), "A Piece Rate System" (1896), *Shop Management* (1903), "The Art of Cutting Metals" (1906), and *Scientific Management* (1911). *Shop Management* and *Scientific Management* were published by Harper and Brothers, New York. The others were papers read before the American Society of Mechanical Engineers and published in its proceedings.

along with other newcomers to the shop, was told how much work he should do; threats were made against any person who did more than the amount informally agreed upon.[2] Taylor says that he observed this attitude throughout the period of his apprenticeship and that it was the general practice in all divisions of the shop.

When Taylor became foreman, the men expected him to attempt to get more work done; and that was his plan. Backed by the management but opposed by the men, who regarded him as a tyrant and an autocrat, he continued the "fight," as he called it, for two or three years before he broke the opposition of the men and won them over to a policy of co-operation. There were, no doubt, many changes in the personnel of the shop during that time.

The details of this controversy are set forth in the writings of Taylor. With the support of the officers of the company, he first urged the men to increase production; and when they refused, he trained new employees in the work after they had promised to co-operate. When they failed to do so, he tried various other devices. The men retaliated by breaking their machines, alleging that the speed was too great. Taylor says that he stopped this practice by levying fines upon the men for the benefit of an employees' association.

The significance of the controversy between Taylor and the men was that the workers thought a limitation upon output was to their advantage. Further, the initial step in the introduction of the Taylor system was met by the opposition of the workers; and many phases of it have been opposed by workers ever since that time. The new system began in an autocratic manner—it was imposed upon the workers. This fact has caused many persons to object to it.

The Setting of a Standard for Each Job. Although Taylor knew that the workers had not been doing a fair day's work, he did not know what was a proper time for each job or what the total production for an hour or a day should be. It was a realization of this fact that caused him to begin in 1881 his work of setting standards by timing workers on various jobs with a stop watch. The timing of the worker on the job led in turn to the study of how the job was done; for if the worker wasted motions in doing his work, he might later eliminate the waste motions and reduce the time required for the job. To the time as observed by the stop watch, Taylor added a percentage to make allowance for unavoidable delays, interruptions,

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[2] See Frank B. Copley, *Frederick W. Taylor* (New York: Harper & Bros., 1923), Vol. I, p. 157.

accidents, fatigue, and other factors. Another percentage was added to allow for lack of skill on the part of workers not yet trained to do the work.[3]

Although the stop watch had been used in industry prior to this time, Taylor is believed to have been the first to use it to time the elementary motions performed in doing factory work. With the aid of E. H. Miller, who was employed in 1883 to devote his full time to the studies, Taylor attempted to set standards of performance for all the jobs throughout the plant.

Standardization of the Conditions of Work. If the standards set by time study were to be fair, it was necessary that conditions in the shop be controlled. The result was that the quest for the standard time led to the setting of standards for all phases of the work. For example, the grinding of tools could no longer be left to the worker as had formerly been the case, since he did not know the best form and shape of the cutting edge. He might even do the work of sharpening a tool in a manner which he knew to be improper, because it was easier for him to do so. In order that the tools would be available when they were needed, a toolroom was established to make or buy tools, to store and repair them, and to issue them to the workers. Standards for materials were set up in order that the materials used on the job would be the same as those used when the standard was set. Taylor also developed a system of classifying materials. Each class was designated by a symbol which was used as a basis for arranging materials in the storeroom, for identification of materials for purchase requisitions and in the shop, and for accounting purposes in charging material costs.

The work of standardizing tools may be illustrated by Taylor's study of shovels. The principal problem was the determination of the proper weight of the shovel load. Taylor concluded that the proper weight was about 21 pounds for the worker best able to do this kind of work. The weight was determined by using what he called "first-class shovelers" who were paid extra wages for doing trustworthy work and for their co-operation in experimenting with various loads. When the proper size of the load had been determined, the type of shovel to be used for ashes, dirt, coal, metal scrap, or other materials was prescribed. The length of the handle and its shape were made the subject of other experiments. The study of shovels illustrates, for a simple tool, a method which may be applied to any type of equipment, no matter how complicated.

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[3] Taylor, *Scientific Management*, p. 117. Also Copley, *op. cit.*, Vol. I, p. 227.

[The system of standardization did not end with tools and materials but was extended to the purchase of machines, to their care in the shop, and to other conditions of work. The machine on which the work was performed had to be the same as the one used in setting the standard, and it had to be in the same perfect operating condition. This fact led to a study of the construction of belts, their tension or adjustment, and their care. Other conditions of work which were standardized or improved were the layout and arrangement of the shop and the individual workplace; the elimination of heavy lifting, where possible; lighting; and air conditioning.]

Methods of Work. Prior to the time of Taylor, the worker had learned how to perform a task by studying as an apprentice, by working alongside another worker in the shop, or by receiving a limited amount of instruction from the foreman. The management had not given adequate consideration to the problem of finding the best way to do the work.

On simple jobs, Taylor had no difficulty in improving the methods of work, but on metal cutting he found a real problem. In a metal working plant, such as the Midvale Steel Company and later the Bethlehem Steel Company, there was a great deal of cutting of metals. The opportunity was open to Taylor to experiment because management was sympathetic, machinery could be used, and an adequate supply of materials was available. [The difficulty was, as Taylor found after he began the experiments, that no one method could be prescribed because the method varied with the quality of the metal to be cut, the thickness of the shaving to be removed each time, the temperature of the metal and the tool, and various other factors.[4] Eventually, Taylor and his associates worked out a series of formulas which could be applied in each case. Methods which formerly had been handed down by rule of thumb from one worker to another were found too unreliable and wasteful.]

Even after the method of cutting steel was perfected, the worker could not utilize the information in the shop because of the complexity of the formulas required in the solution. A quick and easy application of the "new" method was made possible when the slide rule was perfected, many years later.

The experiment of steel cutting illustrates [how the management began to take over the responsibility for discovering the proper method of performing work on the job, instructing the worker in the improved

[4] *Scientific Management*, p. 107.

method, and seeing that the new methods were followed.[5] This same procedure was eventually followed in the study of many other problems which formerly had received no attention from the management but had been left to the traditions of the craft or the ingenuity of the individual worker. The study of methods of performing a task and the prescribing of a detailed procedure represented a further step in the transfer of thought and skill to management.

Fatigue Study. The hours of work during the decade of the 1880's were long, and Taylor recognized the danger that an increased rate of production might result in injury to the health of the worker. In his famous illustration of the work of girls who inspected ball bearings for bicycles, he states that the hours of work were originally 10½ per day. The girls spent much of their time in idleness because they could not work steadily for such a long time. The time was shortened in successive stages to 10, 9½, 9, and 8½ hours, with the pay remaining the same. Production steadily increased during the shortening of the workday. Even with the reduction in hours, the girls became nervous and tense if they were kept at their benches all day; Taylor then introduced regular rest periods at the end of each 1¼ hours. He concluded that the rest periods increased total production and eliminated the danger to health which had existed when the work was continuous.[6]

In another well-known study, Taylor required the men who carried pig iron weighing about 92 pounds to sit down and rest at intervals established after some study and experimentation. Taylor declared that his studies indicated the existence of what he called a "law of fatigue." The law is that a first-class laborer suited to such work as handling pig iron can be under load only 43 per cent of the time and must be free from load 57 per cent of the time.[7] These figures assume a load of 92 pounds. As the load becomes lighter, the percentage of the day during which a man can be under load increases. With a light load the worker can be under load all day without being tired out. In that case, Taylor said, the law ceases to be a guide; and some other law must be found which indicates a man's capacity for work.

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[5] After his retirement from the Bethlehem Steel Company in 1901, Taylor and Sanford E. Thompson made elaborate motion and time studies of methods of performing various jobs in concrete making, excavation and movement of dirt, bricklaying, lathing, plastering, carpentry, slating, and many other trades. Some of the standard times which they established are given in F. W. Taylor and Sanford E. Thompson, *Concrete Costs* (New York: Wiley & Sons, Inc., 1912).

[6] Taylor, *Scientific Management*, p. 92.

[7] *Ibid.*, p. 57.

In the study of the pig-iron handlers, Taylor concluded that the introduction of rest periods enabled the workers to increase production almost threefold. The conclusion that the increase was due solely to the new method of doing work has been questioned, however, because such factors as the introduction of piece rates and the guarantee to the worker that the rates would be maintained regardless of the effect upon his earnings were probably important.

An Incentive System of Wage Payment. Taylor believed that the co-operation of the worker could be secured only through the payment of increased wages for good performance. A system of management such as he devised is expensive, and its effectiveness depends upon production by the worker. If the time of the machine is wasted through lack of attention or care or through the inefficiency of the worker, the benefits of the system are lost. The bench where work is done or the point of the tool is the critical place in the whole process of production. The lack of co-operation of the worker or a lack of efficiency on his part can defeat all of the plans of management.

The Taylor incentive wage consisted of two rates of pay for each job: a high rate which was paid if the worker did the task in the standard time or less, and a low rate which was paid if the worker took more than the standard time. The difference in the rates was so great that the worker could not afford to continue to work at the job if he failed to make the standard, but he was well rewarded if he made the standard. This system of wage payment has been little used because it is generally regarded as too severe on the worker who is slightly below the standard and is particularly discouraging to the beginner. The method of wage payment is important in illustrating the philosophy of the new system of management.[8]

Taylor was undoubtedly interested in promoting the welfare of the workers, and he also recognized the necessity of taking into account their attitudes and prejudices. However, he did not regard them as his equals; and his approach was that of a kindly parent who wished to care for his shortsighted, irresponsible children. In his philosophy, motion and time study were the concern only of management. The co-operation of the worker could be gained by fair treatment, higher wages, and prompt rewards; or if these failed, Taylor was ready to use penalties and coercion. The approach was essentially autocratic rather than democratic. Many statements from Taylor's writings could be given to illustrate this point of view. The following are typical:

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[8] For further discussion of the plan, see Chapter XXIII.

The worker who is best suited to handling pig iron is unable to understand the real science of this class of work. He is so stupid that the word "percentage" has no meaning to him, and he must consequently be trained by a man more intelligent than himself into the habit of working in accordance with the laws of this science before he can be successful.[9]

When men [of this caliber] receive more than a 60 per cent increase in wages, many of them will work irregularly and tend to become more or less shiftless, extravagant, and dissipated. Our experiments showed, in other words, that it does not do for most men to get rich too fast.[10]

The average workman must be able to measure what he has accomplished and clearly see his reward at the end of each day if he is to do his best. And more elementary characters, such as the young girls inspecting bicycle balls, or children, for instance, should have proper encouragement either in the shape of personal attention from those over them or an actual reward in sight as often as once an hour.[11]

By way of expiation, it should be said that the general level of education and training in 1880 was much lower than it is today. Immigration was not restricted, and grade-school and high-school education did not reach nearly so large a percentage of the people then as it does now.

[To get the co-operation of the worker, Taylor found that the management had to keep the worker busy all the time. Unless this was done, the worker could see no good reason for making an effort to complete the job to which he was assigned.] Prior to the work of Taylor, the foreman had been responsible for keeping the workers in his department provided with work. Through no fault of the foreman, who had many other responsibilities, the worker spent much time waiting to be told what he should do next. To correct the situation, [the management was required to institute a system of planning the flow of work and assigning each task to a department and a certain machine. Work was planned ahead for each workplace to assure both foreman and worker that congestion at any machine or in any department would be eliminated and that the worker could begin a new task as soon as he had completed any piece of work. Planning the work required provision for the purchase and allocation of materials to the work planned, the purchase or manufacture of machine tools, the maintenance of equipment, the scheduling of the work, the assignment of tasks to individual workers, and control of the flow of work to see that schedules were maintained.]

Taylor's frequent references to a "first-class worker" have often been

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[9] Taylor, *Scientific Management*, p. 59.

[10] *Ibid.*, p. 74.

[11] *Ibid.*, p. 94.

misunderstood because it has been assumed that his system made provision for only a small percentage of workers of exceptional ability. By first-class worker, he meant a person who was especially suited for the task. He insisted that each worker should be selected on the basis of his qualifications for the particular kind of work. To qualify for a job, the man should meet the requirements for physical strength, skill, experience, manual dexterity, or other trait. To qualify for some types of work, the first-class man might have low mental ability and high physical stamina. For example, in speaking of the man who was best adapted to the work of carrying pig iron, Taylor has this to say: "He was a man so stupid that he was unfitted to do most kinds of laboring work, even. The selection of the man does not involve finding some extraordinary individual, but merely picking out from among very ordinary men the few who are especially fitted to this type of work."[12]

New Method of Organization. The Taylor system of management placed a great many new responsibilities upon the executives and particularly upon the foremen. The shop supervisors were not usually highly skilled in methods of organizing and planning the work or in training and supervising employees. Consequently, they were not able to take over the numerous new duties which the new system required. Taylor met the situation at first by providing the foreman with an assistant and later with several assistants. As responsibilities of management in the shop were further increased, the assistant foremen were finally made full-fledged foremen. The Taylor system provided for eight such foremen, each in charge of one activity or function and with each worker subject to the jurisdiction of each of the foremen. For example, if his machine was in need of repairs, the workers reported the matter to the foreman in charge of maintenance. While the worker was adjusting his machine or changing machine tools, he was under the jurisdiction of the gang boss. As soon as he began work on the job, he passed under the supervision of another foreman, known as the "speed boss." This system did not mean that the number of foremen was increased eightfold, since the entire shop was reorganized.[13] There may have been some increase in the number of supervisors, however, for the system of Taylor meant that management was doing many things which it had formerly left to the workers.

Summary of the Taylor Principles. While Taylor summarized his

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[12] *Ibid.*, p. 62.

[13] The form of organization is shown in Figure 6 on page 53.

principles in several different ways, the following is a suggestive statement taken from his writings:

1. "The substitution of a science for the individual judgment of the workman." This means that a careful study is made of the method of performing each task. The order of work to be followed by the worker and the motions made in doing the task must be precisely as prescribed by management.

2. "The scientific selection and development of the workman." Each man should be studied, taught, and trained, and one may say experimented with, instead of allowing the workmen to select themselves and develop in a haphazard way.

3. "The intimate co-operation of the management with the workmen, so that they together do the work in accordance with scientific laws which have been developed, instead of leaving the solution of each problem in the hands of the individual workman." This principle means that the management does the planning and the mental work, leaving the worker to do as he is told.[14]

Taylor's explanation of the name of the system is as follows:

The development of a science . . . involves the establishment of many rules, laws, and formulae which replace the judgment of the individual workman and which can be effectively used only after having been systematically recorded, indexed, etc. . . . All of the planning which under the old system was done by the workman, as a result of his personal experience, must of necessity be done by the management in accordance with the laws of the science.[15]

In his testimony before a committee of Congress in 1912, Taylor gave this explanation of the new system:

The task idea — the idea of setting a measured standard of work for each man to do each day — was the most prominent feature, and for some time . . . the system was called the "task" system. The word "task," however, had a severe sound and did not at all adequately represent the system; it sounded as though you were treating the men severely, whereas the whole idea underlying our system is justice and not severity. . . . Finally the name was agreed upon which I think is correct and which does represent the system better than any other name yet suggested, namely, "scientific management."[16]

Effect of the Taylor System. Taylor believed that his system would bring industrial peace. He held that there was no reason for conflict between management and workers and that they should work

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[14] Taylor, *Scientific Management,* p. 114.

[15] *Ibid.,* p. 37. A recent authority defines scientific management as "the use of experimentation, collection of data, analysis of data, and the formulation of principles based on such analysis, rather than reliance on experience and custom." E. H. Anderson, "The Meaning of Scientific Management," *Harvard Business Review,* Vol. XXVII (September, 1947), p. 678.

[16] *Hearings before the Committee to Investigate the Taylor and Other Systems of Shop Management, House of Representatives, 62d Cong., 1st sess.* (1912), Vol. III, p. 1378.

together in harmony. This could be accomplished, he believed, through the discovery of the natural laws of work, such as the law of fatigue and the laws pertaining to the method of performing each job and to the proper time to complete the work. The workers and the management would both benefit through the establishment of a harmony of interest and through co-operation to attain a common objective. In most cases, however, there remains the suspicion which the workers have of the fairness of management and also the unwillingness of the workers to permit management to decide what are the laws of work, even though the existence of the laws is admitted. Any system of management today depends for its success upon the confidence which the workers have in management and upon the willingness of management to consult workers on those problems which vitally concern them.

The general acceptance of the Taylor system and of other improved systems of management was delayed not only by objections to certain features of the system but also by the manner in which Taylor described his methods and his objectives. He did not attempt to conceal the fact that his studies had been started in an effort to eliminate loafing on the job. His writings contain frequent references to individual soldiering and systematic restriction of output by groups of workers. He said that limitation of output by workers was almost universal. Many of his statements could be used to prove that the increased production would result from speeding up the worker rather than improving work methods and making other changes in the working conditions. The following statement is an example: "The tendency of the average man (in all walks of life) is toward working at a slow, easy gait, and it is only after a good deal of thought and observation on his part as a result of example, conscience, or external pressure that he takes on a more rapid pace."[17]

The introduction of the new methods was also delayed by the opposition or the inertia of managements. Many of them found it easier to follow traditional methods rather than to develop the new techniques or to understand and apply the philosophy of the new system.

THE GILBRETHS

Two other persons who made outstanding contributions to the development of management are Frank Bunker Gilbreth and his wife, Lillian Moller Gilbreth. Frank Gilbreth was born in Fairfield, Maine, in 1868. He attended high school in Boston, where the family lived

[17] Taylor, *Shop Management*, p. 30.

after the death of his father. In 1885, he accepted a job with a building contractor for the purpose of learning the trade of bricklaying and the business of contracting. He became foreman and then superintendent. Later, he became a contractor on his own account. In 1904, he married Lillian Moller, who had recently graduated from the University of California. Mrs. Gilbreth immediately became interested in her husband's work and took an active part in it. After 1911, they devoted their time exclusively to consultation and research in management, first at Providence, Rhode Island, and later at Montclair, New Jersey. They worked with the managements of hundreds of factories in various industries, including foundries, machine shops, laundries, textile mills, jewelry factories, and powder mills. They demonstrated that management methods could effect economies in any kind of work. After Mr. Gilbreth's death in 1924, Mrs. Gilbreth continued until her retirement the work as consultant, advocate, and teacher of the economies of motion study and other management methods. During recent years, she has continued to make significant contributions to management through her writing, lectures, and service on various committees.[18]

Beginning of Frank Gilbreth's Interest in Motion Study. When Frank Gilbreth started to learn the trade of bricklaying in 1885, his supervisor placed him between two bricklayers who were to teach him as they worked. He immediately observed that the bricklayers taught different methods. Much confused, he changed his position to work between two others; and he was surprised to find that they used methods which were different from those of either of the first two. Moreover, he observed that the bricklayers did not themselves follow the methods which they had explained. In fact, each bricklayer used three sets of motions—one when he was working slowly, a second when he was working rapidly, and a third when he was teaching someone. Gilbreth reasoned that the three sets of motions could not all be correct; and since other workers used still different sets of motions, it was possible that no set of motions made by any worker was best. His investigations soon convinced him that this was the truth, for every worker made some unnecessary and wasteful motions.

Gilbreth first undertook to find out why so many sets of motions

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[18] The best treatment of the work of the Gilbreths is Edna Yost, *Frank and Lillian Gilbreth, Partners for Life* (New Brunswick, N.J.: Rutgers University Press, 1949). An interesting popular account is Frank B. Gilbreth, Jr., and Ernestine Gilbreth Carey, *Cheaper by the Dozen* (New York: Thomas Y. Crowell Co., 1949).

were used.[19] He found that the bricklayers did not think of their work as consisting of a series of motions or motion elements. Their emphasis was upon the quality of the work. They had been taught such things as the proper consistency of the mortar, the amount of mortar to spread on the wall, the way to break a brick, and the way to keep the wall plumb. They had not been taught a set of motions, and no one had made an effort to standardize the motions or to find their proper sequence. The motions made when the worker was working rapidly differed from those made when he was working slowly because of the difference in the tension of the muscles and because of the effect of centrifugal force, inertia, and momentum. Gilbreth found that the motions made while the bricklayer was working rapidly were usually the most efficient.

Gilbreth found that one part of the job could not be perfected without standardizing the entire system of work. First, the scaffold on which the bricklayer stood while working was changed to enable the helper to raise it without interfering with the progress of the work. He could do so by turning a crank. Then the scaffold was so constructed that the helper could walk on the side opposite the wall, and he could place bricks on a board which ran parallel to the platform on which the bricklayer stood without interfering with the work. The bricks were properly positioned so that the bricklayer did not have to stoop to pick them up or turn them over to examine their edges for defects. The helper was also instructed to keep the mortar at the right consistency and to see that there were no lumps in it. Other improvements were the selection of the worker, a standardization of the motions performed, and the training of the bricklayer in the improved methods. Incentive methods of wage payment were also used to secure worker co-operation.

Development of Principles. Gilbreth did not confine his work to a study of bricklaying but improved the methods of work in all branches of the construction industry and other industries. He developed new devices for mixing, conveying, and reinforcing concrete. As a contractor, he built dams, canals, factory buildings, and other structures. As consultants in management, the aim of the Gilbreths was always "the quest for the one best way."[20]

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[19] Frank B. Gilbreth and Lillian M. Gilbreth, *Applied Motion Study* (New York: Sturgis & Walton Co., 1917). Also Frank B. Gilbreth, *Bricklaying System* (Chicago: M. C. Clark Publishing Co., 1909).

[20] Lillian M. Gilbreth, *The Quest for the One Best Way* (New York: Society for Industrial Engineers, 1925).

The Gilbreths introduced the practice of taking motion pictures of the worker as he performed his task. The motion pictures could be projected on the screen, rerun as many times as necessary, and stopped at any point for study. A clock which recorded time to fractions of a second was shown in the picture. This made possible an accurate check on the timing of the operation. The picture machine was also improved to show more frames per second. Still cameras were used to make time exposures on a plate showing the path followed by the hand in the performance of the task. The path of the hand was recorded on the plate by using a small electric light attached to the hand. The light was equipped with an interrupter to break the current. The result was a line of dashes on the plate, the length of the dashes indicating the speed of the hand. After the job had been perfected and the worker had been photographed while he was using the standard methods, a motion model was made. The motion model was a representation of the motions made by the worker in performing the task. It consisted of a wire which was attached to a wooden platform. The course of the wire on the motion model indicated the path of the hand of the worker. The model was also equipped with an upright cross-sectioned board at the back which was used to indicate the height of the hand above the level of the bench or machine when the work was being done. The model was used to instruct workers in the proper way to do the job.

Improvement of the motions performed at one task required attention to the operations at other work stations preceding and following any operation and to the methods of moving materials and work in process of production. The Gilbreths therefore studied the layout of the plant and the flow of work from one department to another for the purpose of eliminating unnecessary operations, combining and simplifying different tasks, reducing the distances required for the movement of materials, and perfecting better methods of materials handling. They originated the method of listing on a summary sheet of paper all operations performed in processing the material, including transportation, inspection, and storage. The list of operations and the incidental activities is called a process chart. This method of studying the flow of work for the purpose of introducing improvements has now received general acceptance.[21]

The Gilbreths made extensive studies for the purpose of eliminating unnecessary fatigue and providing ways for overcoming unavoidable fatigue. They devised improved footrests and chairs, comfortable

[21] For illustration of the process chart, see Figure 21, Chapter XI.

shoes, and clothing which gave freedom of movement to the arms and other parts of the body. They experimented with rest periods and provided comfortable rest rooms. They improved the workplace to eliminate unnecessary bending or twisting of the body, made provision for proper heating and air conditioning, and eliminated or reduced fire and accident hazards. One purpose of controlling accident hazards was to reduce fatigue by relieving the mind of worry. To control fatigue, every phase of plant activity was studied and brought under control.

Effect of the Gilbreths' Work. The Gilbreths demonstrated that economies could be introduced into any operation and any industry by making individual tasks and manufacturing processes the subject of special study. Although their methods required the co-operation of the worker, they encountered little opposition from either workers or unions because they emphasized the elimination of waste motions and the improvement of work methods rather than the elimination of soldiering or the requiring of harder or faster work on the part of the worker. Many of their techniques that formerly were regarded as costly or impractical are now commonly used. Examples of such techniques are the use of motion pictures and electric recording devices for motion study and the use of motion pictures for teaching new methods to workers. They created and perfected motion study as a management device.

HENRY LAURENCE GANTT

One of the associates of Frederick W. Taylor who later introduced the new system in various factories and who also developed several new features was Henry Laurence Gantt (1861–1919). Gantt was born on a farm in southern Maryland. He graduated from Johns Hopkins University in 1880 and later studied engineering at Stevens Institute at Hoboken, graduating in 1884. Taylor invited Gantt to assist in the work at Midvale Steel Company in 1887 when Taylor was attempting to work out a solution to his formulas for metal cutting; here Gantt developed a solution through the use of logarithmic charts. Gantt also worked at the Bethlehem Steel Company, where he assisted in further experiments in metal cutting. Subsequently, he was connected with several large companies, including the Ingersoll-Rand Company and the J. H. Williams Drop Forge Company.

Gantt introduced the Taylor system of management in many companies. A part of his contribution was expressed by himself in the following statement: "We have today so much undigested and unutilized knowledge that I am inclined to think that the man who shows

us how to use it satisfactorily is quite as important as he who discovers it."[22]

By his discussion, as well as by his introduction of the system, Gantt did much to show industry how to use the new methods and the new spirit of investigation of industrial problems.

A New Attitude toward Labor. Probably because of his trouble in making the proper approach to foremen and to workers, Gantt believed that the establishment of a relationship of trust and confidence between management and the worker was essential to the success of every company. He advocated equal opportunity for all workers, the abolition of special privilege, and democratic instead of autocratic methods. His ideas are set forth in the following statements:

> The general policy of the past has been to drive, but the era of force must give way to that of knowledge, and the policy of the future will be to teach and to lead, to the advantage of all concerned. . . . People learn but little from what they are told, but they readily imitate what appeals to them. If, therefore, a man would be a leader, he must know thoroughly the people whom he would lead, and be able to shape his actions in such a manner that he will not only be understood but thoroughly appreciated by his followers.
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> Twenty years ago the financier thought he had found a panacea for most of the evils which the new developments began to show, in his combination of industrial plants into large organizations. . . . But the most important problems, those concerning the relationship of employer to employee, have not been solved any better by the large corporation than by the individual employer. In fact the large corporation seems in many cases to have accentuated the troubles which had arisen.[23]

Although the establishment of personnel departments was due to the efforts and studies of many persons, it must be attributed in part to the influence of Gantt.

Other Contributions of Gantt. Among the other features of management systems contributed by Gantt were the following:

An Incentive Method of Wage Payment. The method is known as the "Gantt task and bonus plan." It provides for a guaranteed hourly wage but increases the pay by 25 per cent of the wage for the standard time at that point where the work is completed within the standard time. There is no increase for any further reduction in the time; after the worker meets the standard, he is paid for standard time plus a bonus of 25 per cent. In effect, it is an hourly rate for the

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[22] Henry L. Gantt, *Industrial Leadership* (New Haven: Yale University Press, 1916), p. 7.

[23] *Ibid*, p. 2.

worker who requires more than the standard time and a piece rate for the worker who can do the task in the standard time or less. It provides a substantial reward for the co-operation of the worker but protects him against serious penalty in case of failure. Because of worker and union opposition, the Gantt plan of wage payment is not widely used.[24]

A Chart for Control of Production Schedule. The Gantt chart has horizontal lines only, no vertical lines. The spaces on the scale represent the months or weeks and the quantity planned for sales, production, orders to be received from customers, or other data. The actual data are recorded on the same chart in a heavier line, and the chart is brought up to date from time to time. The planned and the actual data are shown for comparative purposes in such a manner that management can easily compare plans with accomplishment.[25]

The Recognition of the Cost of Idle Machine Time. In cost accounting, one of the problems of figuring the cost of the product is the determination of the proper amount of manufacturing expenses to include in the cost. When the plant stands idle a part of the time or is used to only part of its capacity, the question of how much expense to include as cost of the product is not easily determined. To illustrate, suppose that the plant operates for seven months of the year and is closed down for the other five months because of a lack of orders. Gantt argued that the cost of the product manufactured during the seven months should include only the expenses incurred during that time and that the fixed expenses incurred during the five months of suspension, such as property taxes, insurance, depreciation, and maintenance, should be charged to idle time rather than to the cost of the product. This theory is now generally accepted by cost accountants.

ATTEMPT TO DISCOVER NATURAL LAWS

Taylor, Gilbreth, and Gantt, as well as other pioneers in management, contended that there are natural laws which govern industry and the relations between worker and management. The conflict which prevails between the two and the drive to form labor unions were believed to be due to the fact that the laws had not been discovered. Once the principles of such laws were established and formulated, they would be no more a subject of controversy than is the strength of a piece of

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[24] For further explanation of the plan, see Chapter XXIII.

[25] The chart is described in Wallace Clark, *The Gantt Chart* (3d ed.: New York: Ronald Press Co., 1942). For illustrations of the chart, see Chapter XXXVIII.

steel or the weight of the roof of a building. Taylor, Gilbreth, and Gantt believed the discovery of the laws would lead to harmony in industry. The following statements indicate the new philosophy. Frederick W. Taylor said:

> Scientific management substitutes exact knowledge for guesswork and seeks to establish a code of natural laws equally binding upon employers and workmen. . . . Scientific management guards the workers against overspeeding and exhaustion nervously and physically: (*a*) by substituting exact knowledge for guesswork in the setting of the task; (*b*) by careful studies of fatigue and the setting of the task on the basis of a large number of men of different capacities and with due scientific allowance for the human factor and legitimate delays. . . . Scientific management insures just treatment of individual workers: (*a*) by substituting the rule of law for arbitrary decisions of foremen, employers, and unions; (*b*) by giving the workers in the end equal voice with the employer. Both can refer only to the arbitrament of science and fact.[26]

The Gilbreths have summarized the principles of management in the following statement:

> Scientific management is based upon actual measurement. . . . Its fundamental principles have the exactness of scientific laws which are open to every one. . . . It applies to all fields of activity, mental and physical. Its laws are universal, and, to be of use in any particular field, require only to be translated into the vocabulary of the trained and progressive workers in that field. . . . Its fundamental aim is the elimination of waste, the attainment of worthwhile desired results with the least measure of time and effort. . . . Its primary aim is conservation and savings, making an adequate use of every ounce of energy of any type that is expended.[27]

Gantt said of scientific management: "It is the substitution of the scientific method of determining what can be done as a basis of action instead of records of what had been done, or opinion of what can be done, that marks the new industrial spirit."[28]

No attempt is made at this time to evaluate the new method and the new attitude toward the problem of industrial relations. The purpose here is only to indicate the philosophy of the management movement.

OTHER LEADERS IN MANAGEMENT

In the present chapter the work of only four of the most influential

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[26] Testimony before the United States Commission on Industrial Relations, reprinted in Robert F. Hoxie, *Trade Unionism in the United States* (New York: Harper & Bros., 1917), pp. 299–302.

[27] Frank B. and Lillian M. Gilbreth, "What Scientific Management Means to America's Industrial Position," *Annals of the American Academy of Political and Social Science*, Vol. LXI (1915), pp. 208–16.

[28] Gantt, *op. cit.*, p. 72.

persons in management has been considered. It is not to be inferred that others did not make significant contributions, for there were many notable persons in the field. Preceding Taylor was Henry R. Towne; and well-known collaborators of Taylor were Carl G. Barth, Dwight V. Merrick, and Sanford E. Thompson. Another well-known person was H. K. Hathaway, who worked with Taylor at the Midvale Steel Company and then went to the Tabor Manufacturing Company to introduce the new methods. Later he became the vice-president of the company. Harlow S. Person, who was for many years director of the School of Business Administration at Dartmouth University, took a conspicuous part in the development of the new techniques in industry. He made numerous contributions to the literature of management and became managing director of the Taylor Society.

When the management movement began to be popularized after 1910, the leaders included Richard A. Feiss, general manager of Clothcraft Shops; Ernest M. Hopkins, manager of the employment department of Curtis Publishing Company; Harrington Emerson, consultant in management; Meyer Bloomfield, director of the Vocational Bureau of Boston; Morris Llewellyn Cooke, director of the Department of Public Works, Philadelphia; and Henry S. Dennison, treasurer of Dennison Manufacturing Company. The work of some of these men will be referred to in later chapters.

QUESTIONS

1. Why did not manufacturers immediately adopt the principles of management as developed by Taylor?
2. What is meant by "scientific management"? Is it really scientific?
3. Summarize the principles of the Taylor system in three or four statements.
4. Why did Taylor begin his studies with an attempt to set a standard time for a task?
5. Why would the worker object to the setting of a standard time? Could he be expected to gain by it?
6. What preliminary work did Taylor find necessary before he could set the standard time?
7. What is the significance to management of Taylor's study of shovels? Can the methods used in the study of shovels be used for studying other kinds of tools and equipment?
8. What is the significance of Taylor's study of metal cutting?
9. What was the primary purpose of Gilbreth's studies of motions? Was the purpose to eliminate fatigue, to reduce cost by saving time, or to set a standard time for purposes of wage payment?
10. How did the Gilbreths attempt to overcome the effects of fatigue?

11. How did Gantt's attitude toward labor differ from that of Taylor?
12. Explain how the cost to manufacture one unit of a product would be determined by Gantt in each of the following cases and how it would be determined if all expenses were allocated to the product in each case. If more than one cost figure is possible, explain which is of most value to management. In every case, material cost is $5.00 per unit; and labor cost is $3.00.
    a) Company A owns a factory in Illinois. The taxes, depreciation. insurance, maintenance, salaries, and other factory expenses total $9,000. The factory is operated at capacity, and the total production is 3,000 units.
    b) Company B owns a factory in Illinois having the same expenses and the same production as the plant of Company A. Company B also owns a factory in Texas. The Texas plant incurred expenses of $9,000, but the plant was completely closed during the entire year.
    c) Company C owns two plants in the same city in Illinois. Expenses and production were the same as those of Company B. One plant produced 3,000 units, and the other plant was kept closed.
    d) Company D owns two plants, with expenses of $9,000 each. Production was 1,500 units at each plant because each was closed half the time.

CHAPTER II

THE DEVELOPMENT OF MANAGEMENT SINCE 1910

THE WORK of Taylor, the Gilbreths, and Gantt constituted only the beginning of business management, although the Gilbreths and Gantt carried it far beyond what might be called the pioneering stage. [Management methods have expanded to include many features not included in the Taylor system, such as budgeting, sales management, advertising, standard cost accounting, and personnel work.] The methods have been popularized through public discussion and periodical literature. Many books dealing with the subject have been written, and the study of management has been introduced in schools and colleges. Several societies have been organized for the exchange of ideas on management. These developments have come largely since 1910.

MANAGEMENT TO 1920

The year 1910 became a landmark in the development of management as a result of the publicity resulting from hearings before the Interstate Commerce Commission in that year. Testifying before the Commission concerning an application for increases in freight rates, Louis D. Brandeis, later a member of the United States Supreme Court, presented much data in support of the argument that the railroads would not need the increases if they would adopt the new principles of management. Harrington Emerson, who had done some pioneering work in management with the Santa Fe Railroad Company, estimated that the railroads could reduce their operating expenses by $1,000,000 per day if they would eliminate waste in materials and labor.[1] The hearings were widely publicized at the time. Taylor's *Scientific Man-*

[1] Henry S. Dennison *et al.*, "History of Scientific Management in America," *Mechanical Engineering*, Vol. LXI (September, 1939), pp. 671–75.

agement appeared shortly thereafter, first in a popular magazine by installments and later (1911) in book form. Widespread interest was immediately manifest.

Adaptation of the New Methods. In the United States prior to World War I, the number of companies using scientific management methods was not large; and most companies using the system adopted only certain parts of it. Writing in 1916, Robert F. Hoxie estimated that not more than two hundred shops scattered through various industries and in various sections of the country were using scientific management.[2] He believed that relatively few of the companies using the system would be regarded by the followers of Taylor as valid examples of the new system. Hoxie, who was by no means an advocate of the new methods, declared that the significance of the movement could not be measured by the number of shops using the system, for he found that its principles and methods were permeating the whole business world. This seems to have been a correct appraisal. In a report prepared for the International Management Congress in 1938, Henry S. Dennison (chairman) stated that all the basic technique and a large part of the original technique were used daily in most of the well-established plants in America.[3]

[The methods used included time study, planning, scheduling, inventory control, and the new manner of organizing the departments or divisions of the business.]

Employment departments began to be established in a few companies about 1911. In that year, an employment managers' association was organized at Boston.[4] Its purpose was the discussion of methods and problems arising in the selection of workers at the employment office. However, many companies were slow to take away from the foreman the right to hire and fire. The following statement was made in a symposium on management methods in 1919:

> The best selection method from all standpoints is to let the applicants "sell themselves" by direct personal appeal to the foreman under whom they are to work. Let him take them on trial. A well trained, responsible foreman will keep the ones he wants and will know how to direct the others into the arms of one of his fellow-foremen, or out through the front gate of the plant, as may be best for all concerned. . . . Select your workers by the ordinary common sense

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[2] Robert F. Hoxie, *Scientific Management and Labor* (New York: Harper & Bros., 1917), p. 296.

[3] Dennison, *op. cit.*, p. 672.

[4] Meyer Bloomfield, "The Aim and Work of Employment Managers' Associations," *Annals of the American Academy of Political and Social Science*, Vol. LXV (1916), pp. 76–87.

method of clean cut, personal contact between the man who will rank next above the applicant and the applicant himself.[5]

Even where employment departments had been established, selection in the days preceding World War I was often made on the basis of palmistry, phrenology, hunches, general impressions, and other unreliable methods.

New Attitude toward Labor. Labor has sometimes been thought of as a commodity to be bought and sold. At other times the worker has been treated as if he were a machine which is subject to natural laws and which exists primarily to do work. The new attitude is that the worker is a human being who differs in important respects from every other person. Each worker has his own likes and dislikes, his prejudices, his beliefs, his fears and suspicions, and his individual points of weakness and of strength. Each one wants to feel that he is important to the company and that he is a part of the organization. He wants to know that his merit will be recognized and appreciated. The new point of view was stated in 1919 by a progressive businessman as follows:

> Income without satisfaction in work means labor instability, unrest, and lowered output; and satisfaction in work is hardly possible without recognition by management of the human elements involved. Like all other human beings, the worker is a bundle of instincts. He wants to create, to possess, to gain power, to have his work and merit properly recognized, to play, to protect himself and his own. He wants to learn new things, to vary his occupation so that it does not get on his nerves. He wants the satisfactions which make life worth living.[6]

Use of Management Consultants. Frederick W. Taylor was consultant in management for several companies during the years 1890–98. Gantt and other associates of Taylor advised with various companies on their management problems at a later date, and the Gilbreths did much consulting work after 1911. In time the work of the management consultant came to be recognized as valuable not only in the field of production but also in such fields as sales, organization planning, budgeting, finance, accounting systems, personnel and labor relations, and office management. Many consulting firms are nationwide or international in their work.[7]

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[5] James M. Boyle, "The Selection, Discipline, Training, and Placing of Workers," *Annals of the American Academy of Political and Social Science*, Vol. LXXXIII (1919), p. 113.

[6] A. Lincoln Filene, "The Key to Successful Industrial Management," *Annals of the American Academy of Political and Social Science*, Vol. LXXXV (1919), p. 9.

[7] For discussion of the methods of Wallace Clark as consultant, see Pearl Franklin Clark, *Challenge of the American Know-How* (New York: Harper & Bros., 1948), pp. 61, 94.

The consultant can often render valuable services to management because of his detached position. He can look at problems from the point of view of the company as a whole rather than a single department of the company. He has the time to study management problems because he is not subject to the pressure of routine duties and responsibilities. In many cases, he can obtain more information about the attitudes and opinions of employees and persons in the management than would be available to a member of the company. His work with many companies equips him with a varied experience and assists him in advising with managements. For these reasons, consultants have assisted in improving management methods and techniques.

Society for Discussion of Management Problems. Until 1910 the principal forum for the discussion of management problems was the American Society of Mechanical Engineers. It was before that society that the papers of Taylor, Gilbreth, and Gantt were read. In 1910, several members of the mechanical engineering society began to meet separately for the discussion of management problems; the group included Gilbreth, Barth, Cooke, and Hathaway. In 1912, out of this society, the Society to Promote the Science of Management was formally organized. In December, 1914, it began the publication of a bulletin. The membership of the society increased to more than a hundred by 1917. During World War I the name was changed to the Taylor Society, and in 1936 the Taylor Society amalgamated with the Society for Industrial Engineers to form the Society for the Advancement of Management. The American Management Association, another society, was formed in 1922 as a consolidation of three previously existing organizations. In the meantime, several other societies had been formed in related fields, such as personnel, safety, and industrial research.

Effect of World War I. During World War I, government, industry, and labor were alike interested in increased production, the elimination of waste in manpower, and the saving of materials. Consequently, the introduction of management methods, including motion and time study, was generally encouraged. Many companies adopted the new methods for the first time under the guidance of consultants in management. By the close of the war, many additional companies were using such management methods as incentive wage plans, balance of stores record for the control of inventories, purchasing according to the requirements of the manufacturing department, planning of production, and motion and time study. The greatly increased turnover of the labor force caused many companies to establish employment departments, and some organized full-fledged personnel departments.

Probably the greatest effect of the war was the development of methods of dealing with personnel. The first such development was a better method of selection and training, which was emphasized by practices in the armed forces. The government wished to speed the movement of troops to France, and it could not move combat units until they were fully serviced. Every division in the army required a large number of specialists or technicians, such as electricians, linemen, cable splicers, switchboard operators, telegraphers, telephone repairmen, automobile repairmen, machinists, truck and tractor operators, and carpenters. Fully trained men in sufficient numbers were not available, and it was necessary to devise some method of quickly selecting the men who had the mental ability and the aptitude to develop the skills. The selections were made through specially designed trade, mental, and aptitude tests; and training programs were quickly devised and put into practice. The success of the program indicated that such tests were valid for selection and that the long period of apprenticeship formerly required could be dispensed with in many trades, if management made proper selection and provided effective teaching. Similar methods were, in fact, used in many war industries, particularly shipbuilding. Riveters, for example, were trained within a few weeks instead of the years formerly required.

The second management development advanced by the army was in methods of rating people. The army instituted a plan for rating officers on the basis of loyalty and certain other qualities. The method was man-to-man rating, that is, the comparison of one officer with another. Points were assigned on each of the various qualities. Rating systems had been used before, but the difference was in the number of persons rated and the number of persons who became acquainted with the technique. Improved systems have since been developed and are now widely used in industry.

Developments after the War. Management methods were widely copied after the war. The new techniques included parts of the Taylor system and also various tests for the selection of workers. Many systems were introduced without the necessary modification to suit the requirements of individual companies and without regard for the wishes or attitudes of foremen and workers. Gantt and Gilbreth had both observed in 1916 and 1917 that poor methods were sometimes introduced as scientific management. In an address at Yale University, Gantt characterized the persons who were calling themselves efficiency engineers as mere "stunt peddlers." He declared that time studies were made of jobs which were being improperly performed. This, he

said, was sheer folly. He said that clerks with stop watches were allowed to go into factories to study operations about which they were entirely ignorant. This practice, he said, should be severely condemned, for it was largely responsible for the storm of opposition to the stop watch on the part of the workmen.[8] Such unsound practices greatly increased in 1919 and 1920, and the criticism became greater. The name "efficiency men" is still associated with the mistakes of that period.

The use of tests for the selection and placement of workers had a similar development. Too much was claimed for the tests; and when the performance of workers on the job did not correspond closely with their test ratings, managements were inclined to reject the whole idea of tests for selection and placement. Time was required to establish the fact that tests are of much value, provided that they are properly designed and used.

DEVELOPMENTS SINCE 1920

Management methods have greatly improved since 1920. Great strides have been made in such fields of management as personnel, industrial research, economy of materials, design of the product, budgeting, and marketing. The developments referred to in the paragraphs which follow indicate only the general trend.

Emphasis on Engineering. Engineering has continued to make significant contributions to methods of production and to the various phases of industrial management. Its contributions include improvements in the design and efficiency of the product and reductions in cost of manufacture. Cost reductions have been effected by elimination of waste in materials, the development of new types of alloys and other materials, improved plant layout, the design of more efficient machines and equipment, more efficient methods of handling materials, and improvements in methods of production.

Personal Interest in the Worker. In an effort to narrow the gulf which had admittedly come to exist between top management and employees, many companies undertook extensive investigations of their labor problems. Typical of the new point of view was Whiting Williams, who gave up his position as personnel director of the Hydraulic Pressed Steel Company to live among workers. Keeping his identity a secret, he lived and worked with day laborers in steel mills, coal

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[8] Henry L. Gantt, *Industrial Leadership* (New Haven: Yale University Press, 1916), pp. 45, 46.

mines, and factories. He described his experience and his observations in a book entitled *What's on the Worker's Mind,* published in 1920.[9] Williams declared that it was impossible to see industrial problems from the point of view of the worker without seeing the world through the eyes of the man to whom the daily job means daily bread and daily hope. He described the feelings of the worker who stood before the factory gates in the cold of a February morning, the heartsick dejection of the worker who was looking for a job, the demoralizing loss of standing as a man, and the paralyzing fear of the bread line which filled the mind and soul of the man who had no job and no hope of finding one. Williams found that three things were uppermost in the mind of the worker: first, the security of the job, which meant his daily bread; second, fatigue, which resulted in a constant effort to stretch out the work and to make the job last; and third, uncertainty as to the future plans and purposes of the employer. The observations which a person would make under similar circumstances at the present time would probably be different, particularly because hours of work have been shortened and machines have lightened the manual labor required of workers. The investigation made by Williams is significant in indicating the growing recognition of the importance of personnel problems and a new spirit of inquiry.

The effort to discover facts as a basis for personnel policy was manifest in elaborate studies made by the Western Electric Company in co-operation with the National Research Council and a group of psychologists and technicians. In 1924 the company began to experiment to determine the effect of changes in illumination upon production and fatigue. The scope of the inquiry was broadened in 1927 to include many other phases of production and also of personnel. At its plant in Cicero, a suburb of Chicago, the company tried out the effect upon production of changes in the hours of work, the introduction of rest periods of varying length and at varying intervals, the providing of refreshments at rest periods, and other such changes. At times the workers were told that they would be given more illumination or less illumination when one light bulb was replaced by another of the same wattage. The peculiar feature of the research was that two groups of workers were used in the experiments. Conditions were

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[9] Published by Charles Scribner's Sons, New York. Later Whiting Williams made a similar study of conditions in western Europe published under the title *Horny Hands and Hampered Elbows: The Worker's Mind in Western Europe* (New York: Charles Scribner's Sons, 1922).

changed for one group, called the "experimental group," and were kept unchanged for the other group, called the "control group." The experiments, usually referred to as the "Hawthorne experiments" from the name of the plant, revealed that the innovations in the methods in work caused relatively little variation in the production rate as between the experimental group and the control group but that both groups substantially increased production. The conclusion was that illumination, rest periods, midmorning or midafternoon refreshments, and other conditions of work are not the only important factors in the job but that the attitude of the worker is equally important. Slight variations in working conditions are important only to the extent that they indicate that the management is interested in the welfare of the worker and that they succeed in gaining his co-operation. The workers in the Hawthorne experiments were willing to co-operate because they were the center of attention from top management and from the persons in charge of the experiments, because they were made to feel important, because they believed that increased production was to their personal advantage, and because they themselves were interested in the experiment. Production increased in the control group because the workers in that group wanted to show that they were as good as those in the experimental group.[10] In both cases, the human element was the controlling factor.

The Hawthorne experiments, like the studies of Whiting Williams, are significant both because of the factual knowledge of worker feelings and attitudes which they indicated and because of the new method of approach to personnel problems which they represent.

Company Unions. The decade of the 1920's was marked by the growth of the company union, a labor organization in which membership was restricted to the employees of one company. The union was usually formed as a result of the suggestion and encouragement of management. It provided sick or other benefits for the members to which the company made a financial contribution. Joint relations between the company and its employees concerning wage rates, hours, conditions of work, employee grievances, and other personnel problems were conducted between the management and the officers of the

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[10] The Hawthorne experiments are described in National Research Council, *Fatigue of Workers in Its Relation to Industrial Production* (New York: Reinhold Publishing Corp., 1941); Elton Mayo, *The Human Problems of an Industrial Civilization* (New York: Macmillan Co., 1933); F. J. Roethlisberger, *Management and Morale* (Cambridge, Mass.: Harvard University Press, 1941); F. J. Roethlisberger and W. J. Dickson, *Management and the Worker* (Cambridge, Mass.: Harvard University Press, 1939).

union. Company unions of this type are not permitted now by federal law. The National Labor Relations Act of 1935, sometimes called the Wagner Act, made it an unfair practice for the employer to dominate a labor union or to interfere with the unionization of its employees. The same provision was included in the Labor Management Relations Act of 1947. It is interpreted to mean that the company cannot contribute financial or other support to a union. The establishment of company unions was a part of the growing desire of managements to learn of the grievances of the workers and to give them a voice in matters closely concerning themselves. It also reflected in many instances an attempt to head off the increased unionization of workers by outside unions.

Welfare Work. Beginning in the early 1920's, many companies adopted plans for medical service, athletic teams, company stores, country clubs, and other forms of services for the benefit of employees. The calling of such programs by the name "welfare work" was unfortunate, for it indicated that the programs were motivated by a feeling of charity and that management was taking a paternalistic attitude toward its employees. Where this was the case, the programs usually failed. Workers refused to participate in activities where they were made to feel that they were the objects of commiseration. The worker believed that he was worthy of his hire and that contributions to charity should be made elsewhere. Although many of these same activities are now conducted under the name of "service work," the motive is not the same as that which prevailed in the welfare work.

Increased Unionization of Workers. During the decade of the 1930's, after the enactment of the National Industrial Recovery Act in 1933 and the National Labor Relations Act in 1935, membership in national and independent unions increased rapidly. This was significant for management in that many companies which had not previously bargained collectively with their workers were now compelled to do so. Equally significant, however, was the fact that the unions demanded a voice in decisions and questions of policy which managements had previously thought were their own prerogatives. Union contracts contained clauses relating not only to wages and hours but also to promotions, layoffs, spreading of work during slack periods, methods of handling grievances, the introduction of laborsaving machinery and other technological improvements, motion and time study, and accident prevention. Unions were also demanding a voice in plant location and other problems. Formerly, many employers voluntarily

consulted their employees on many of these questions, but they now had to do so by necessity.

Legislation Affecting Management. The requirement that managements do certain things in the interest of the health or safety of their workers is not a recent development. Many years ago the states established maximum hours of work and minimum wages for certain industries. The railroads, for example, have been required to grant relief for trainmen after a limited number of hours of work or after the train has moved a stated number of miles. However, the trend toward the regulation of industry by government has been sharply accelerated since 1933. Some of the more significant federal laws relating to personnel relations are:

Social Security Act of 1935, which provides for old-age and survivors' benefits and unemployment compensation. This law was amended to increase the benefits and extend the coverage in 1939 and again in 1950 and 1952.

Walsh-Healy Act of 1936, which provides minimum wages and maximum hours and prohibits child labor for work on government contracts of more than $10,000.

Fair Labor Standards Act of 1938, which provides minimum wages and maximum hours and regulates child labor in industries in interstate commerce. Both the Walsh-Healy Act and the Fair Labor Standards Act permit labor in excess of the hours specified, provided overtime payment is made.

Labor Management Relations Act of 1947 (Taft-Hartley Law), which regulates certain phases of the relations of management and labor.

In the field of industrial marketing, the significant federal laws are:

The Antitrust Act of 1890 (Sherman Act), which makes illegal any combination in restraint of trade or monopoly in interstate commerce.

The Clayton Act of 1914, which strengthens the Sherman Act and prohibits certain commercial practices.

The Federal Trade Commission Act of 1914, which makes illegal any unfair method of competition.

The Robinson-Patman Act of 1936, which prohibits discrimination between customers in sales in interstate commerce.

In addition to these laws, the federal government has enacted many laws relating to financial practices of corporations, such as the Securities Act of 1933, the Securities Exchange Act of 1934, and the Trust Indenture Act of 1939. The states and municipalities have numerous laws relating to safety, sanitation, health, building requirements, fire protection, wages, hours, the closed shop, and other such problems. The trend is likely to continue in the direction of closer government supervision and regulation of many policies which were formerly considered the sole concern of management or of management and its employees.

Management at the Higher Levels. The early attention to management problems was confined largely to the levels of the foreman and the worker, although Gilbreth's book on *Field System* in 1904 summarized the work of much of his organization. Beginning about 1940, an increasing amount of study and research has been devoted to the problems of organization and human relations at the higher levels. Such studies attempt to show the functions of the chief executive and the heads of the major divisions of the enterprise, methods of achieving co-operation among the executives, the training and development of executives, and the relation of top executives to the lower levels in the organization.[11]

Since 1940, managements have been under increasing pressure to adopt and perfect the new methods and techniques for the purpose of effecting economies in manpower and increasing production. During World War II, many new plants were built and additions were made to existing plants. The induction of men and women into the armed forces and the various agencies of the government resulted in the disarrangement of the labor force and the employment in industry of millions of people who had not worked before. The shortage of critical materials required managements to develop substitute materials and to change the design of many products. Problems of conversion to war production, then to peacetime production, and subsequently to production for defense called for improved organization within the enterprise and greater co-operation with other companies and government agencies. Specifically, some of the problems which required the attention of management were:

The Location of New Plants. Management did not decide this problem alone, for the government was interested in having the new factories located away from the coast and away from congested areas.

The Development of New Products. Some of these were guns, tanks, planes, tents, and other equipment and supplies for the armed forces.

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[11] Among the more significant publications in this field are the following: Robert A. Gordon, *Business Leadership in the Large Corporation* (Washington, D.C.: Brookings Institution, 1945); Paul E. Holden, L. S. Fish, and H. L. Smith, *Top Management Organization and Control* (New York: McGraw-Hill Book Co., 1940); E. P. Learned, D. N. Ulrich, and D. R. Booz, *Executive Action* (Boston: Harvard University Graduate School of Business Administration, 1951); Myles L. Mace, *The Growth and Development of Executives* (Boston: Harvard University Graduate School of Business Administration, 1950); Melvin T. Copeland, *The Executive at Work* (Cambridge, Mass.: Harvard University Press, 1951); and Ralph C. Davis, *The Fundamentals of Top Management* (New York: Harper & Bros., 1951).

The Development of New Materials. High octane gasoline, synthetic rubber, and plastics were some of the discoveries.

Joint Committees with Union-Management Representation. These committees were formed to help eliminate waste, increase production, and prevent accidents. Such committees were particularly active during World War II.

Research. This included research in pure science, such as atomic energy, the properties of gases, and air pressure. It also included research in the application of science to industry.

Substitution of Machinery for Manpower. This, one of the oldest problems of management, has received renewed attention since 1940 because of the pressure for increased production.

Improvements in Conditions of Work. The improvements resulted in better factory layouts, work simplification, and the installation of air conditioning and public address systems.

Greater Attention to Personnel Problems. Management took more interest in employee morale, grievances, health, and accident prevention.

Employee Counseling. Employees were given advice on transportation, housing, and other personal problems and were also assisted in mental adjustment to factory work. Dismissal interviews constituted another phase of this work.

Employee Training. This always becomes a problem when large numbers of people join the ranks of factory workers.

Job Evaluation. This management device represents an attempt to determine the pay of various jobs by making proper allowance for differences in conditions of work or skill required to do the work.

Merit Rating. The rating of employees is a method of rating individuals on the basis of merit. Employee rating was introduced during the 1920's. Many companies now rate their employees as well as supervisors and others in the management.

The foregoing list is not intended to be a complete catalogue of management methods. It is designed to indicate something of the development of management in recent years.

QUESTIONS

1. Why was industry slow to adopt the new management methods prior to World War I?
2. What events in 1910 and 1911 stimulated interest in management methods?
3. Why were the first personnel departments concerned principally with employment methods and procedure?

4. Why has the adoption of management methods usually been speeded up by war? Is increased production for civilian requirements in time of peace as desirable as increased production for war?
5. If a long period of apprenticeship is unnecessary to learn a trade, why would any one attempt to prevent the use of new methods of training?
6. What was the basis for Gantt's charge that the efficiency engineers were "stunt peddlers"?
7. Why was the approach of Whiting Williams to labor problems significant? How was it different from the approach of Taylor?
8. What was proved by the Hawthorne experiments?
9. Contrast experimental work in the field of human relations with laboratory experiments in the physical sciences. Can the laboratory method be used in personnel work?
10. What is the objection to the company union?
11. Why should labor unions object to welfare work? Why is welfare work not a good policy from the point of view of management?
12. Explain how federal laws relating to the following may be justified:
    a) Employment of children in factories.
    b) Payment of time and a half for hours worked in excess of forty hours per week.
    c) Requirement that the employer bargain with representatives of a labor union.
    d) Requirement that membership in a labor union not be made a condition of employment.
    e) Taxation of employer to pay old-age benefits or unemployment compensation.

PART II

Organization, Leadership, and Morale

CHAPTER III

ORGANIZATION OF THE ENTERPRISE

MANAGING an enterprise includes a number of varied but closely related activities. Management has a responsibility for determining the objectives of the enterprise, determining the activities necessary for the accomplishment of the objectives, establishing an organization, providing the physical facilities, providing the personnel, and supervising day-to-day activities. A most important phase of the work of management pertains to the assignment of duties and authority of various positions and in building up the organization.

FACTORS INFLUENCING THE TYPE OF ORGANIZATION

No two business may be expected to adopt or to employ exactly the same organization. To some extent the organization is a matter of chance development because it is expanded according to the apparent needs of the time and the persons available to fill the various positions. Basic differences between the organizations of enterprises are due to differences in legal form, in number of employees, in number of plants, and in number of products.

Effect of Form of Ownership. A business enterprise may be conducted as a single proprietorship, a partnership, or a corporation. In the single proprietorship, one person owns the assets and assumes personal liability for the debts incurred. He usually would personally supervise the activities of the business. If the enterprise is large enough to be organized into divisions and departments,[1] he would designate the

[1] The words "division" and "department" are often used interchangeably. In this book, "division" refers to the major activities of the enterprise; and "department" refers to a part of a division. For example, the sales activity constitutes a division. The sales division may be organized into such departments as sales management, advertising, sales promotion, and customer service. A department may be subdivided into sections.

persons to occupy the principal positions; and he would hold them accountable to himself. He would occupy a twofold position in that he would determine the principal objective and supervise the work of accomplishing it.

If the enterprise is conducted as a partnership, the partners would play a significant role in the organization. At the time of the launching of the business, they would determine its objective, size, location, and other basic features. They would review the objectives and policies from time to time and change them when necessary. The function of chief executive might be assigned to one of the partners or assumed by him as the senior partner. In other cases the functions usually performed by a chief executive are performed by the partners as a group or as a committee. Responsibility for various activities of the business, such as production, purchasing, sales, finance, engineering, or public and personnel relations, might be assigned to the individual partners. In small enterprises, partners agree through consultation upon a method of handling new problems as they arise.

Small as well as large enterprises may be organized as corporations. The law assumes that corporate objectives and basic policies are determined by the stockholders. To a board of directors elected by the stockholders is assigned the responsibility of conserving the corporate assets, appointing corporate officers, determining a wide range of policies, approving an annual or other periodical budget, and reviewing the results of operations. The board of directors legally has the power to adopt a form of organization for the enterprise which would provide for the allocation of duties to the major or top positions. While the responsibility for management actually held by the board of directors varies from one company to another, the board frequently leaves the active management to the chief executive and other officers. It may confine its work largely to that of critically examining and approving proposals submitted to it by the officers, reviewing the results of operations, and making suggestions to the officers for improving the finances, market position, or other phase of the business of the company.

Effect of Number of Employees. Organization problems are simple in a business that is operated by the owner and a small number of employees. If the number of employees is no more than five or ten, the owner or manager may be able to supervise the activities of all of them directly. He may employ an assistant to assume responsibility for certain detailed problems and to relieve him during vacations or other

enforced absence from the business. As the number of persons increases, the manager must devote more time to general problems, policy making, and administrative duties; and he may find it necessary to employ supervisors to direct detailed activities and to attend to routine matters as they arise. He will be able to organize the activities of large numbers of persons only by utilizing the services of others. The situation is portrayed graphically in Figure 1.

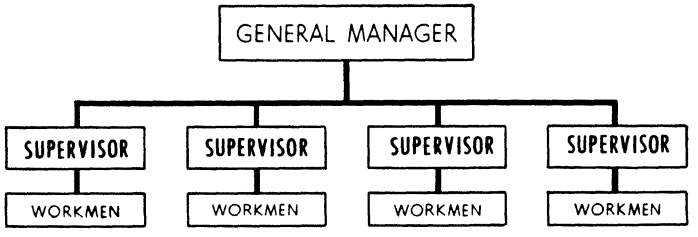

FIG. 1. Simple Organization, Several Persons

Effect of Number of Plants. A single-plant company would employ a different type of organization from that required by a multiplant company. If the company has only one plant, the activities may be centralized, with an executive in charge of each principal activity. If the company has a number of plants which are located in various sections of the country, some activities or functions may be centralized at the main office, while other activities must be conducted at the local plant level. A large company with a main office in New York, for example, might have at the main office the principal executives, who would exercise control over such matters as engineering, product research, product design, personnel, purchasing, accounting, finance, and sales. At each plant there would be a plant manager and also executives in charge of local problems pertaining to maintenance, personnel, storeroom management, production control, costs, and the like. The organization of a company having several plants is shown in Figure 2. Provision for making general company programs effective through local executives of many plants constitutes the chief problem of organization in a multiplant company.

Effect of Number of Products. Organization necessarily depends upon the variety of products made and sold. A few companies produce a single product or one line of closely related products. Examples are sugar, soft drinks, college textbooks in business, and lumber. In such companies, one person may be placed in charge of each major activity, such as sales, production, purchasing, engineering, and finance. Some

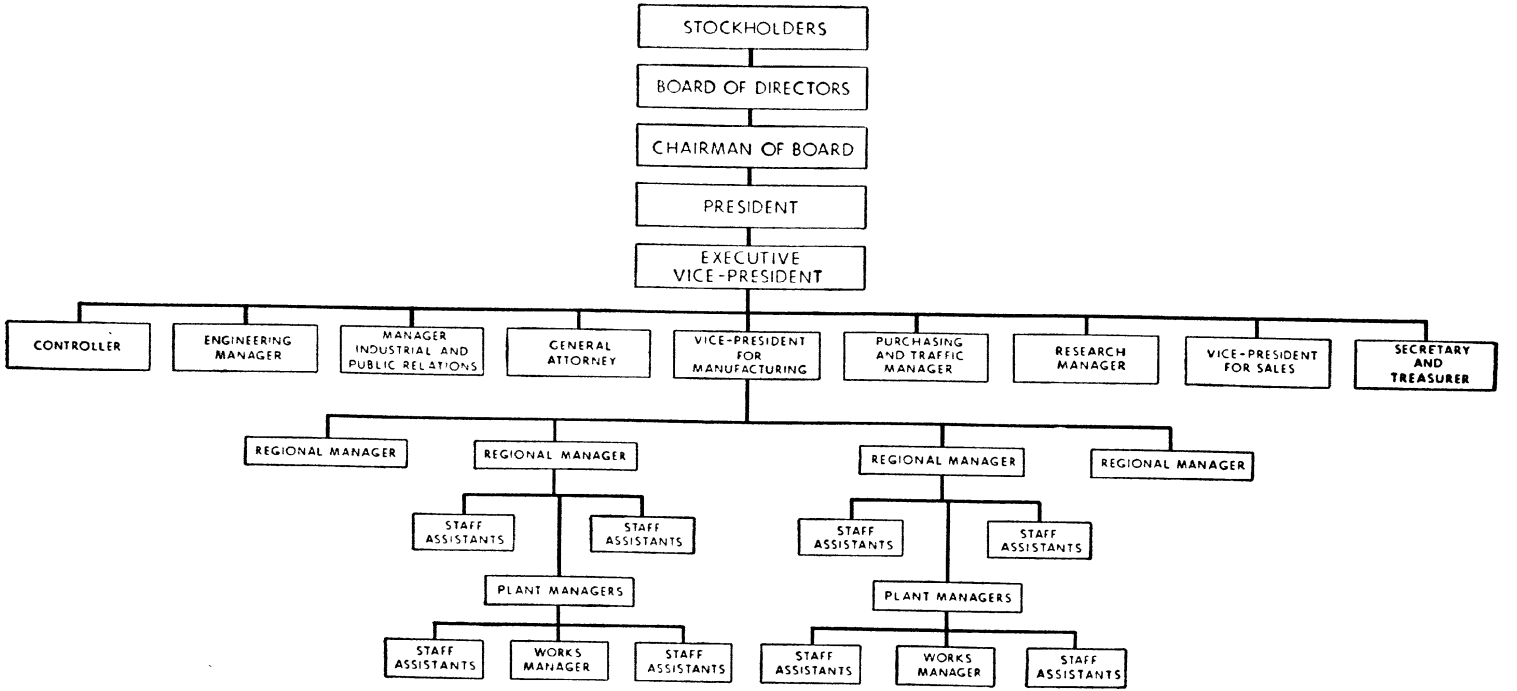

FIG. 2. Organization of American Can Company

companies produce a variety of products. One company, for example, might produce and sell coffee, salt, frozen foods, gelatin, margarine, and other food products. In such a company, any one of several methods of organization is possible. The organization might follow the lines previously suggested for a company having a single product; or one person might be placed in charge of the production and sale of each product, together with related activities such as engineering, purchasing, and product research. Another possible organization is for sales to be organized by products, with all production activities centralized under one executive. Still other methods will be found in some companies.

TYPES OF ORGANIZATION

In the following discussion, it is assumed that the company makes a limited line of products in a single plant. There are three methods of organizing the activities of persons who are associated in such an enterprise. They are (1) the line organization, (2) the line and staff organization, (3) the functional organization.

Line Organization. A line organization is based on relative authority and responsibility rather than on the nature of the activities. In the line organization, authority flows directly down from one level to another; and each person is responsible to the one directly above him in line. The name of this type of organization is borrowed from the military services, which designate the fighting branches as the line organization. However, military organizations also provide for staff services in addition to the line. Staff divisions in military organizations include medical and sanitary service, supply, and engineering. The pure line organization is now seldom found in industry except for very small enterprises. A line organization for a manufacturing business is shown in Figure 3.

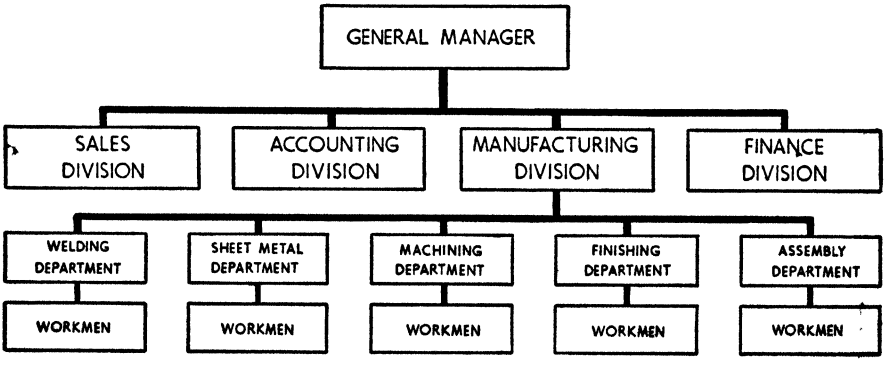

FIG. 3. Line Organization

Advantages of the Line Organization. The advantages of the line organization result from the fact that each executive has complete authority over the work assigned to him, subject only to the control exercised by the executive next in line above him. He assumes responsibility for the results achieved. The advantages of this arrangement are:

1. Lines of authority are defined. Each person in the organization is responsible only to his immediate superior. He looks to one person for orders and directions, and he reports only to that person. Final authority is centralized in the position of general manager.

2. Lines of promotion are indicated. Each person knows the requirements of the job next above him and can direct his training accordingly.

3. Responsibility is fixed. Shifting the blame for poor results in a department is not possible.

4. The organization is easily understood by all employees. Misunderstandings as well as conflicts in authority are reduced to a minimum.

5. Each executive receives a broad and diversified experience which trains him to assume greater responsibilities.

6. The line organization is effective in time of emergency. Each executive may take whatever action is necessary to meet new developments without the necessity of consulting with any person except his immediate superior or his subordinates.

Limitations of the Line Organization. The principal disadvantages of the line organization are as follows:

1. It makes no provision for specialists. Each executive may be required to handle such problems as repairs and maintenance, hiring, training, transfers and promotions, recreation of workers, and production planning.

2. The line organization tends to overload executives. This weakness was pointed out by Frederick W. Taylor with reference to the foremen in the shops. Among the activities of the foremen at the Midvale Steel Company were the following:

Hiring and training new men.
Assigning jobs to the men.
Interpreting drawings and specifications.
Being able to show each man how to do the work.
Seeing that materials, supplies, and small tools are available.
Providing for repairs to machines, belts, and equipment.
Inspecting completed work.
Superintending the movement of materials from one machine to another and into and out of the shop.

Preventing waste of materials.
Reporting to the plant superintendent on the progress of the work.
Keeping time records for cost purposes.
Planning for completion of the work and figuring delivery dates on work planned.
Maintaining discipline.
Reporting absences and keeping personnel records.
Arranging for transfers of men.

The duties of the foreman were so numerous and so varied that he was required to leave workers to their own devices in such matters as methods of work, care and maintenance of equipment, and economy of materials.

3. The executives necessary for a line organization are difficult to find. Taylor listed nine qualities of a good foreman, some of the qualifications having to do with training and some with personal traits and qualifications.[2] The foreman should have education, technical knowledge, and manual dexterity. Necessary personal traits, according to Taylor, are brains, tact, energy, grit, honesty, judgment or common sense, and good health. Taylor said that it was difficult to find a man who had as many as five or six of the necessary qualities and impossible to find anyone who had all of them.

4. The line organization emphasizes individual action to the neglect of co-operation.

5. The line organization makes the selection of leaders in large part a matter of chance. Promotion is to the job just ahead, since transfers are seldom made. While the foreman is interested in holding his best workers, he is careful to see that a worker does not take his own job until he himself is promoted. Consequently, a worker might be held back indefinitely if his foreman is not capable of further advancement.

Line and Staff Organization. The line organization has gradually evolved to become the line and staff form. This change was accomplished by the development of separate departments headed by specialists to assist in the technical and specialized phases of the work. The staff departments now perform activities for which the line executives formerly were responsible. The line and staff form of organization for a manufacturing enterprise is illustrated in Figure 4. The chart is designed to show only general and typical relationships.

The Staff Departments. A study of the chart will indicate the staff departments usually found in the line and staff organization of a man-

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[2] F. W. Taylor, *Shop Management* (New York: Harper & Bros., 1903), p. 96.

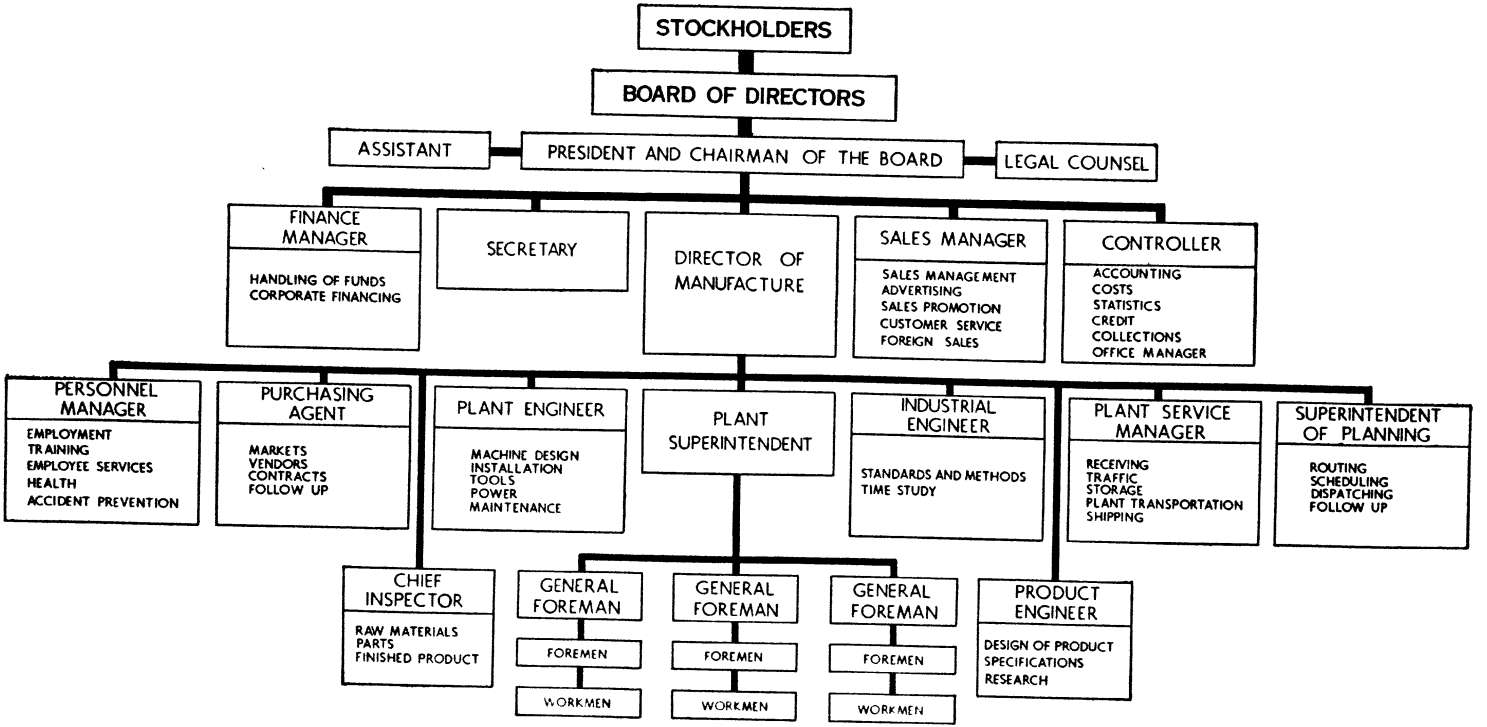

FIG. 4. Line and Staff Organization

ufacturing enterprise. A brief statement is given here of the work of each staff department.

The personnel department has been developed to assist in the work of employee activities and employee relations. The work of the personnel department includes the following:

Interviewing, testing, and investigating applicants for employment.
Organizing training courses for employees, foremen, and executives.
Providing various services for employees, such as recreation, sports, food service, and plant magazine.
Organizing work for health and accident prevention.[3]

The work of purchasing materials, supplies, and equipment is done by a purchasing department under the direction of the purchasing agent. He is responsible for knowing markets, interviewing salesmen, making purchase contracts, and following up the purchase order to see that deliveries are made on time.

Inspection work is done by an inspection department headed by a chief inspector. This department inspects purchased materials and supplies, purchased parts, work in process of manufacture, and finished products.

The plant engineer is responsible for machine design, the selection of machinery for purchase, the installation of machinery and equipment, and the replacement of machines. He supervises the operation of the power plant and the toolroom which stores, repairs, and issues tools for use in the manufacturing departments.

The industrial engineer determines the methods by which work is to be done at the machine or workplace. By means of time studies, he sets standards for the various tasks.

The product engineer is responsible for the development of the design of the product. He prepares drawings showing the parts of the product and their dimensions and establishes specifications for each part. The various phases of engineering activity are sometimes combined under the authority of a chief engineer or a vice-president in charge of engineering.

The plant service department under a plant service manager performs the following services:

Receiving and unpacking incoming shipments.
Routing freight shipments, checking freight bills, and tracing delayed or lost shipments.

[3] In many companies the personnel function is considered a major activity. It is headed by a personnel director who is under the supervision of the president. In such companies, personnel would be considered a division rather than a department.

Storing materials, parts, and supplies.
Issuing stores upon requisition.
Transportation inside the plant.
Shipping goods to customers.

The planning department is responsible for routing production orders through the plant. It determines the department and the machine to which the work should be assigned. It schedules starting and completion dates at each phase of production and also final completion dates for finished products. The department dispatches the orders to workers through the office of the foreman, and it follows up the work to see that the schedules are met or that appropriate corrective action is taken.

The Line Departments. The line organization as shown in Figure 3 is composed of those divisions and departments which are characterized by the chain of authority extending downward from the higher levels. Line authority is exercised by the finance manager, the director of manufacture, the sales manager, and the controller. The word "line" is also used in a more restricted sense to refer to the chain of authority which exists within the manufacturing division and extends downward from the plant superintendent to the foreman and the worker.

The line departments are characterized, first, by authority over persons and, second, by emphasis on relative authority or position. While the workers whose activities are supervised by one executive or foreman would usually be engaged in similar activities or would operate similar machines, the organization emphasizes control over persons. Each worker is responsible only to his immediate superior. Relative authority or relative position means the relation of each person to the persons above him at the higher levels and to persons below him at the lower levels.

Levels of Authority. In a large organization, members of the executive or supervisory group may be classified into five important levels, as follows:

Top executives or top management. This group includes the directors, the president, the secretary, and the vice-presidents in charge of the major divisions, such as sales, finance, and manufacturing.

Senior executives, including the chief engineer, the plant superintendent, the purchasing agent, the plant service manager, and others at the same level.

Intermediate executives, who assist the senior executives and are next in rank below them.

Junior executives, who are next in rank.

Supervisors and foremen, who are in immediate charge of employees.

Figure 5 shows the actual organization of a textile manufacturing company. This chart shows how one company has organized its major activities and indicates the levels of authority above the mill managers. Each mill would provide its line executives and its staff departments, with decreasing authority at the lower levels.

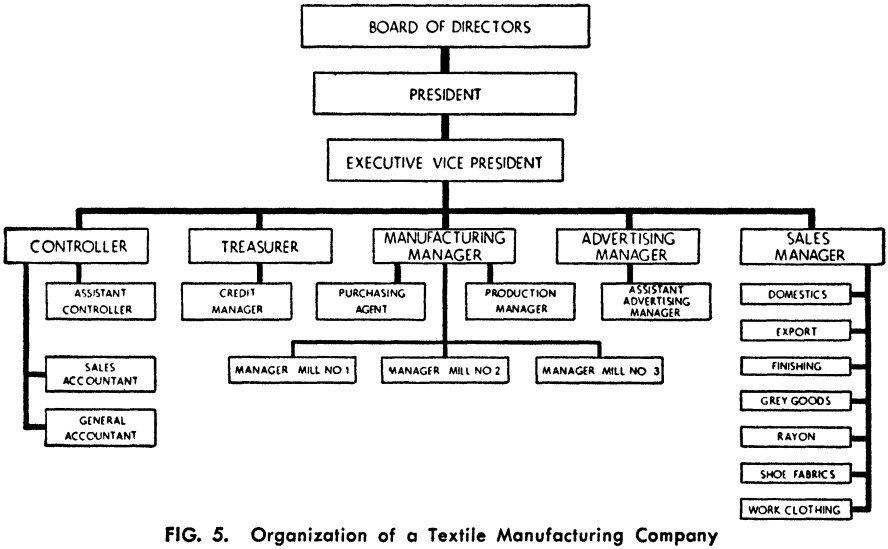

FIG. 5. Organization of a Textile Manufacturing Company

Relation of the Staff Departments to the Line. The purpose of the staff departments is to render service, to give advice, or otherwise to aid the manufacturing departments. They do not participate directly in manufacturing operations, and they do not give orders to foremen or workers. They recommend rather than direct. For example, the employment department may recommend that certain applicants be hired; but the recommendation is usually subject to the approval of the foreman. The safety department may recommend that a practice be changed to eliminate an accident hazard. The change is made by the manufacturing department in which the hazard exists. The product design engineer recommends but does not prescribe changes in the design of the product. Misunderstandings between the staff departments and the manufacturing or line departments are adjusted by conferences between executives who are in charge of the departments concerned. If necessary, differences may be carried to the executive at the next higher level. The lack of authority by executives of the staff departments, except over employees in their own departments, frequently requires understanding and tact in overcoming objections made by executives in the line departments.

Functional Control and Line Control. The line and staff organization provides for both line control and functional control. Line control means authority to direct persons. It is exercised by the head of each department, who controls or directs the subordinates in his department. The head of a staff department has line control over the persons in his own department.

Functional control means authority to recommend or to direct how an activity shall be carried out rather than authority to direct or supervise the individual who does the work. For example, a worker in a manufacturing department is under the line control of the foreman, who is his only boss; but he must also conform to the rules and regulations prescribed by such departments as safety, health, repairs and maintenance, production planning, and standards and methods. Instructions and orders to the worker would go to him through the office of the foreman. Questions concerning the interpretation of such instructions and disciplinary measures for violation would also be handled by the foreman. The department which prescribes the methods or the regulations controls the activity but not the worker.

Use of Committees. Provision is frequently made in the line and staff form of organization for committees of executives to co-ordinate the various activities and to keep all executives informed of the work of other departments. Such committees may be set up at each level in the organization. For example, the American Can Company, whose organization is shown in Figure 2, has organized committees of the top executives to handle the following problems and policies: operating problems and policies, appropriations and budgets, industrial and public relations, research, manufacturing facilities, purchase and sale of properties, patents, annuities and group insurance plans, and general and division expenses.

At the lower levels, committees may deal with such problems as accident prevention, employee recreation, reduction of waste and improvement in quality of the product, and other such matters that concern more than one department. Membership on a committee is usually limited in order that each member may feel personal responsibility for participation. On some committees, officers or representatives of labor unions may be included. Each committee should be organized for a definite purpose, and a committee dealing with a current problem should be discontinued when its purpose has been accomplished.

Multiple Management. A well-known adaptation of the committee plan in a line and staff type of organization has been developed by the McCormick Company, manufacturers of condiments, flavoring

extracts, spices, and related products, with main offices at Baltimore, Maryland. The plan of the McCormick Company, which is known as "multiple management," has been adopted by more than five hundred companies.[4]. The company has organized a junior board of twelve members which includes the most promising executives. The purpose of the junior board is to discuss any problem pertaining to the business and to make recommendations to the board of directors. After a proposal has been unanimously approved by the junior board, it is referred to the board of directors, called the "senior board," for further action. Any proposal adopted by the junior board must be approved by the board of directors before it is made effective. The two boards meet together once a month. Any executive may ask the junior board to investigate any problem which he thinks merits consideration.

Membership on the junior board is rotated by dropping the least effective members. Every six months the members of the junior board rate each other. The six members with the lowest ratings are dropped, while the six members with the highest ratings remain on the board to become a nominating committee for filling vacancies. In this manner the board perpetuates itself.

The advantages which have been found to result from the activities of the junior board are as follows:

1. The plan encourages management thinking among the junior executives.
2. The junior board serves as a school for the training of executives.
3. The junior board encourages co-operation between management and workers because the members are close to the workers. The board serves as a medium for the transmission of ideas, information, and suggestions.

The McCormick Company has also organized a factory board with membership drawn from the foremen. The factory board operates in the same manner as the junior board. It makes suggestions on such problems as inspection, complaints and grievances of workers, packaging, storeroom arrangements, improved machinery, layout, dust control, air conditioning, and training of factory workers. The company reports the advantages of the factory board as follows:

1. The board has been responsible for better and cheaper methods of production.

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[4] The plan is described in Charles P. McCormick, *The Power of People* (New York: Harper & Bros., 1949). See also "Multiple Management," *Factory Management and Maintenance,* Vol. CIV, No. 10 (1946), pp. 145–52.

2. The board has developed the prestige of foremen in the minds of both workers and management.

3. The board has raised human relations to a new level. Absenteeism has decreased, and turnover of labor has been lowered.

The plan of multiple management is frequently accompanied by a profit-sharing plan. In companies using both management devices, members of the junior board and the factory board usually receive an extra share of the profits.

Functional Organization. The word "function" means an activity or a group of related activities. In the functional organization, each executive is made responsible for a function and is given authority to supervise and direct persons in the organization who perform the activity. Since a workman may at various times perform more than one activity, he would be subject to more than one supervisor or foreman. The functional organization represents an extension of the principle of providing the services of specialists on which the line and staff organization is based. In the functional organization, the specialists become executives in charge of functions with authority to see that their recommendations are put into effect.

Development of the Functional Organization. The functional plan of organization has been developed largely at the lower levels. It has been used principally in the shop, where it is known as "functional foremanship." It was popularized by Taylor and his associates, who contrived the system to correct the weaknesses of the line organization at the level of the foreman. Taylor began by providing the foreman with an assistant; then he added other assistants, each in charge of a certain phase of the work. Finally, the assistants were made foremen with the same rank as that of the original foreman but with a very different assignment of duties. The complete plan provided for eight foremen, four in the office and four in the shop. This did not mean that there were eight times as many foremen as before, for the organization of the entire plant was changed. The eight foremen were as follows:

Foremen in the shop:	*Foremen in the office:*
Gang boss	Route clerk
Speed boss	Instruction card clerk
Repair boss	Cost and time clerk
Inspector	Shop disciplinarian

The duties of the foremen are partly, though not fully, indicated by their names. The gang boss had charge of the work up to the time it was placed in the machine. He was responsible for seeing that the

workers were provided with the proper machine tools and that the machines were correctly adjusted. If necessary, he demonstrated the correct method of setting up and adjusting the machine. However, he had nothing to do with the processing of the materials. His work ended when the machine was ready to operate. The work of the gang boss at the present time is performed by the setup man and the move man.

The speed boss supervised the operation of the machine. He saw that the cuts in the metal were started in the right part of the piece, that the machine was run at the proper speed, and that the depth of the cut was correct. Like the gang boss, he might be required to dem-

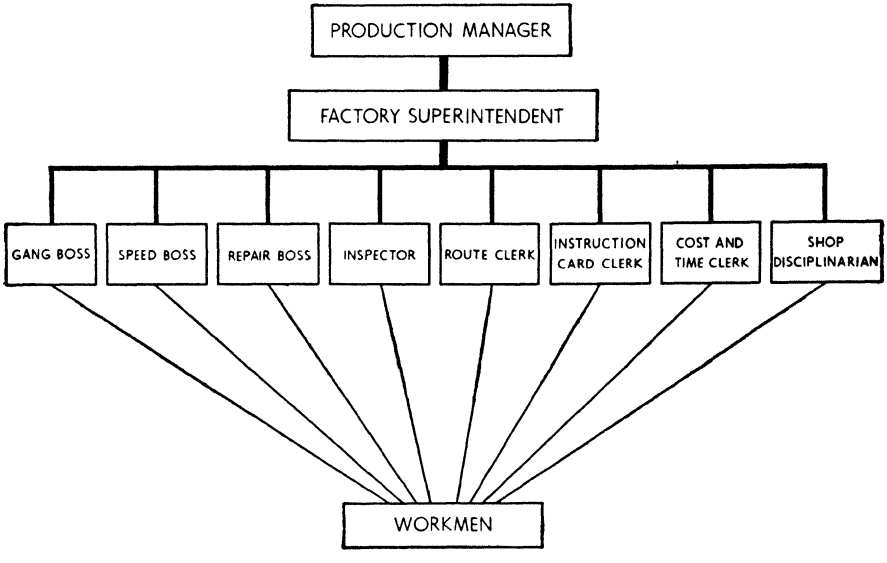

FIG. 6. Functional Foremanship Organization

onstrate how the work should be done. The name "speed boss" is not particularly appropriate and is often erroneously associated with the idea of speeding up the worker. The name merely refers to determining the correct speed of the machine and to supervising the flow of work through the various shops.

The repair boss was responsible for the repair and maintenance of equipment. His job was to see that equipment was kept in proper working condition and not merely to repair equipment after a breakdown. The inspector was responsible for the quality of the product. His job was similar to that of the inspector at the present time. The organization of a plant under the functional plan is shown in Figure 6.

Advantages of the Functional Plan. The advantages of the functional foremanship plan are as follows:

1. Each foreman can be a specialist in his field. The sphere of work for each foreman is so narrowed that properly qualified persons are easily found for each position. Special skill or knowledge is available at any point where it is needed.

2. Each foreman has sufficient time to attend to his duties because he is responsible for only one type of work.

3. The special abilities and aptitudes of the foremen are continuously utilized in work for which each is especially fitted. Each foreman always does that type of work for which he is best qualified.

4. Each person is required to co-operate with others and to look at problems from the point of view of the organization as a whole. One-man control of a department is impossible.

Disadvantages of the Functional Plan. The functional foremanship plan has not been generally successful and is not now widely used. The plan is impractical in most enterprises for the following reasons:

1. It is confusing to the employee. Theoretically, the division of authority between the eight foremen is clear-cut and distinct. However, it is in fact difficult for the worker to understand his responsibility to each of the foremen. In a stable working force the workmen might in time learn for what purposes and in what types of activities they are subject to each foreman. When labor turnover is high and many employees are new, workers are confused by this type of organization. The employee finds it much more satisfactory to work under the same boss all the time.

2. The workers feel less secure when they are subject to many foremen. They cannot be sure that their work is satisfactory when they have many persons to please. They may lose their jobs if any of the eight foremen disapproves of their work.

3. The narrow specialization does not train men to be well-rounded executives. Each foreman tends to become highly specialized.

4. Responsibility for failure cannot easily be fixed. Each foreman may blame the others for a lack of co-operation or for failure in any respect.

5. Discipline tends to be lax when the worker is responsible to several persons. Each foreman may leave to the others the correction of any difficulty, with the result that the worker may not be reprimanded for lapses and violations of rules. This tendency is emphasized by the designation of one of the foremen as shop disciplinarian.

Importance of the Functional Plan. The functional form of organization was never widely used in industry. Experience showed its weaknesses, and by 1920 it had been abandoned by the few plants which

used it. The significance of the functional plan is that it emphasized the idea of placing a specialist in charge of each function. While its strength lay in its provision for expert service, it violated the basic principle that each person should be made responsible to only one boss.

The functional plan hastened the development of the line and staff form of organization, which makes provision for specialists or staff departments to perform the work of Taylor's functional foremen. The work of the gang boss is now performed by the setup man, who may be in the engineering department. The work of the repair boss is now delegated to the maintenance department and that of the inspector to the inspection department. The work of Taylor's route clerk is performed by the planning or the production control department. The work of the instruction card clerk is performed by the standards and methods department, and the cost and time clerk has become the cost accounting and payroll department. The personnel department renders a wide range of services which replace but also go far beyond the work of the shop disciplinarian. The present-day foreman retains the authority of the speed boss and is in other respects the direct supervisor of the workers.

QUESTIONS

1. Is organization usually the result of planning at the time the enterprise is launched, or does the organization merely grow as the business increases in size?
2. Should the organization chart indicate the various positions, or should it indicate activities or functions associated with the positions?
3. One company lists its major divisions as follows: treasurer, controller, sales manager, manufacturing, and advertising manager. Criticize the organization.
4. A large company has organized its major activities into eighteen divisions. Each division is directed by an executive who is responsible to the president. Is this a desirable arrangement. Why?
5. In the line of organization, who performs the functions which are performed by the staff departments in the line and staff type of organization? Is it possible that the functions are neglected?
6. Why may problems be handled more quickly in the line organization than in the line and staff?
7. What is the principal weakness of the pure line organization?
8. The line and staff organization in the army was perfected by the Prussians and is often cited as an important reason for the success over France in the war of 1870. What are the staff divisions in the army? Why would this type of military organization be very effective?

9. What are the usual staff departments in a large manufacturing organization? In a large retail organization?
10. Why is co-operation between the line executives and the staff executives sometimes difficult to achieve?
11. An organization chart has been compared with a road map which shows the main highways but not all side roads. On many organization charts, clerical assistants are often omitted; and positions at the lower levels are shown as a group. Is this fact of any practical significance in the use of charts? Does it make any difference to an individual if his position is omitted from the chart?
12. How does the functional organization differ from the line and staff?
13. What weaknesses of the functional organization usually developed in practice?
14. Explain the principal respects in which you would expect the organization of the following enterprises to differ from each other:
    a) A manufacturing business which has one factory as compared with another manufacturing business which has six factories.
    b) A manufacturing enterprise in which all factories and branches are owned by one corporation as compared with another in which the factories and sales outlets are separately incorporated.
    c) A small retail store as compared with a department store.
15. Explain the advantage of handling the following problems through committees:
    a) Accident prevention.
    b) Budgeting for the various divisions and departments.
    c) Development of co-operation between foremen.
    d) Formulation of sales, financial, and manufacturing policies for the business.
    e) Reduction of the amount of scrap and defective products in the manufacturing departments.

CASES

1. CHANGE IN FORM OF ORGANIZATION

The Union Wire and Cable Company was incorporated in 1950 to acquire the stock of two other companies engaged in the manufacture of various kinds of wire and cable. It immediately issued all of its stock in exchange for 100 per cent of the stock of the two companies. During the remainder of the year, Union Wire and Cable functioned as a pure holding company. Its officers consisted of a president, a secretary, and a treasurer.

One of the subsidiaries owned two plants in Ohio. The main office of that company was in Cleveland. Top management of the company included the president, a market manager, a treasurer, a vice-president in charge of manufacturing, and a vice-president in charge of engineering. Plant superintendents

reported to the vice-president in charge of manufacturing. Under each plant superintendent were the following executives: works manager, personnel manager, service manager in charge of purchasing and stores, plant engineer, and the cost accountant.

The other subsidiary had only one plant. The top management of the company consisted of the president and nine vice-presidents in charge of sales, finance, controllership, public relations, manufacturing, personnel, engineering, purchasing, and traffic.

The president of Union Wire and Cable Company was convinced that the management of the company was top-heavy and that substantial savings could be effected by reorganization. He proposed to the board of directors that the corporate charters of the subsidiaries be surrendered to the state and that their assets and liabilities be taken over directly by the top company. Central offices would be maintained only for sales, manufacturing, finance and accounting, purchasing, personnel, and engineering. A plant manager under the supervision of the director of manufacturing would be placed in charge of each plant. Under each plant manager would be a works manager and local staff departments for personnel, plant services, maintenance, costs and payrolls, and production control. In the office of the president and acting as his staff assistants would be a public relations manager and the secretary of the corporation.

Required:

1. Draw up an organization chart of the company immediately after the holding company was formed.
2. Draw up an organization chart of the proposed organization.
3. Explain what difficulties may be encountered in putting the reorganization into effect. What provisions should be made for persons holding office in the present subsidiary corporations?

2. DEVELOPMENT OF STAFF DEPARTMENTS

The Maryland Electric Products Company with its main plant at Baltimore, manufactures electrical household appliances. About 300 men are normally employed at the plant, which is organized on the principles of a pure line organization. The plant manager, a former officer in the United States Army, believes that all authority in each department should be placed directly on the foreman. The plant is organized into 21 departments. The foreman of each department reports to a general foreman, who in turn reports to the plant superintendent. Other divisions handle sales, finance, accounting, engineering, and purchasing.

Each foreman is expected to have a thorough knowledge of the operations he supervises. He is also expected to handle employment, placement, and training of new workers and to take care of difficulties in the department as they arise. If the worker has any difficulty with machine setup, repairs, or adjustments, he goes to the foreman, who is expected to help him. Foremen are expected to experiment on improvements in the product and to advise with the engineering division on the design of new products. Foremen assume

full responsibility for workplace layout, standards of work to be done at each machine, and supervision of the flow of work within the department.

Recently, the company has had difficulty in meeting competition, and the sales division believes that the product is priced too high because costs are excessive. At a conference of top executives, the proposal was made that foremen should be relieved of some of their responsibilities. It was suggested that the engineering division should assume full responsibility for product design, machine setup, maintenance, machine tools, workplace layout, work methods and motion study, and standards of work. It was also suggested that a personnel department should be established to interview applicants, see that new employees are properly inducted, and handle other personnel problems. These proposals are now being considered.

Required:

1. Draw up an organization chart of the present organization.
2. Indicate how the organization chart would be changed by the proposed revision.
3. Explain what the company should do about the proposals.

3. PROGRAM OF ORGANIZATION PLANNING

The International Oil Corporation is one of the largest oil refining companies in the world. It produces gasoline and a variety of other products of crude oil, which it sells in half of the states of the Union. Its operations extend throughout the Caribbean area and many countries of Central and South America.

During the period following World War II, the president of the company, J. B. Mullins, appointed W. C. Rice to make a study of company organization with a view to the discovery of overlapping functions and responsibilities, the duplication of activity, and the lack of balance between departments. After a study of the organization, Mr. Rice reported to Mr. Mullins that the organization of the far-flung activities of the company contained many serious defects which were costly in time and effort. Many detailed facts were reported concerning executives who were overworked while other executives had a minimum of duties. In some departments, too many persons reported to one supervisor. Some functions which could properly be centralized were being conducted simultaneously in various departments, with the resulting duplication of effort. In some parts of the organization, an unnecessary number of supervisory levels had been created. This situation resulted in needless expense and also made it difficult for executives to maintain contact with operations.

After examining the report, Mr. Mullins decided to create a separate unit for the study of organization problems. The new unit might be designated an "organization department," or it might be made a part of his own staff under the direction of a staff assistant to the president for organization planning. The new unit would have no authority to make any changes in the organization but would be authorized to make recommendations to the president on such matters as the elimination of unnecessary positions, the creation of new positions, the consolidation of functions now divided between various departments, the

transfer of positions from one department to another, the revision of salary scales, the development of descriptions of various line and staff positions in the management, and the creation or elimination of certain horizontal levels in the organization.

Questions:

1. Is such a position as that contemplated by Mr. Mullins needed in a large company such as the International Oil Corporation?
2. What name should be given to the new unit?
3. What is the proper relationship of the new unit to the rest of the organization?
4. How should any changes recommended by the head of the new unit be put into effect?

CHAPTER IV

ATTRIBUTES OF ORGANIZATION

No ONE plan of organization is satisfactory for all enterprises, and a plan which is workable at one time may not be satisfactory in the same enterprise as activities increase. However, it is possible to indicate some of the attributes of a workable organization plan. Briefly, they are as follows:

Adaptation to the enterprise.
Responsibility definitely placed.
Channels of supervision and communication.
Lines of promotion indicated.
Logical assignment of responsibilities.
Regard for personal capacities.
Proper distribution of work.
Balance.
Centralized authority.
Co-ordination.

Adaptation to the Enterprise. The form of organization that is suitable for one enterprise cannot be used without adaptation by another. As explained in the preceding chapter, the organization will vary with the legal form, the number of employees, the variety of products manufactured and sold, the services rendered to customers, the number of factories, and other features of the business. In any enterprise the organization is necessarily changed from time to time as the business increases in size and as other changes in activities or in the personnel of the management group occur.

No unnecessary activities should be included in an organization. When the organization chart is reviewed, any unnecessary activities found to exist should be eliminated. In deciding what activities are necessary, however, the management should take a long-range viewpoint and perhaps should anticipate future requirements. For example,

a company cannot wait until an increased demand is reflected in current orders before provision is made for an expansion of plant capacity. It should not neglect commercial or industrial research or the designing of next year's product. On the other hand, a business may be wrecked by unduly emphasizing activities which do not increase the net income figure in the profit and loss statement of the current year.

Unprofitable activities may properly be continued temporarily in order to hold the working force intact. In time of depression or in periods of technological change, persons who might otherwise be dismissed are given make-work jobs until the slack can be taken up. Such activities may be discontinued as soon as the situation can be righted through the normal labor turnover or in some other manner.

Responsibility. The organization plan should place responsibility for all work which should be done. This means that every activity necessary to the efficient operation of an enterprise should be definitely assigned to someone. Moreover, the line of demarcation between the divisions and departments should be definite, in order that no person may evade responsibility and that each person may know who is expected to discharge each responsibility and who is to act in certain cases. A corollary to this proposition is that the duties should not overlap at any point.

Channels of Supervision and Communication. The organization plan should provide definite channels of supervision and communication. Supervision and communication are interrelated: supervision indicates direction, and direction requires communication. Since every person (except possibly the one at the top) is under the direction of another, and since the control of the whole organization is centered in top management, it is essential that the channels of communication permeate the entire organization. The lines of supervision and communication should always be kept open for the flow of information, instructions, directions, and orders from above and for the flow of reports, comments, and suggestions from below.

Communication begins at the top level as stockholders receive various financial and other reports from directors and officers and convey instructions to directors through resolutions adopted at stockholders' meetings. Directors receive reports, both written and oral, from officers at directors' meetings and by informal discussion outside the meetings. At the next level, the chief executive communicates with divisional executives through committee meetings, reports of committee meetings, written memoranda, informal conferences, and other means. The subjects of such communications include policy development, ex-

planations and applications of policies, expense and cost information, planning for physical facilities and executive personnel, and the coordination of various activities. The chief executive seeks not only to impart information concerning policies and plans but also to receive information on current developments and problems throughout the company.

Within each division, channels of communication are established for the transmission of information to and from the lower levels. Communication for any one person begins when he is appointed to a position and is informed of his duties and responsibilities. The newly appointed person is informed as to the duties of his position in order that he may know how to meet various recurring problems without the necessity of consulting with his superior each time. Media for such communications include a written description of the position, together with a personal conference. Subsequent information on changes in policies and new developments may be transmitted by personal interviews, monthly or weekly discussion meetings, executive orders, and written notices. Luncheon meetings of committees and other groups are frequently used for communications. These methods may be used to reach to the lowest levels of the organization. New employees may be informed of company programs and policies affecting them through their employment interview, talks as a part of the induction procedure, booklets on company personnel policies and employee services, and personal interviews with the foreman. In some companies, each new employee is placed under the sponsorship of a dependable employee who will assist him in using plant services such as the plant cafeteria and will answer his questions concerning routine procedures. After his induction the employee may be informed of later developments through such media as discussion meetings, announcements on bulletin boards, conferences, counseling interviews, and annual reports of the company to employees.

Many persons feel that the problem of communication from the upper levels to the lower is less difficult than that of communication from the lower levels to the upper. In upward communication the information may be incomplete or too condensed. Persons at the lower levels may hesitate to communicate unpleasant information, and they may omit details that might reflect discredit upon themselves or their subordinates. A foreman, for example, might prefer not to report that a machine needs repair if the difficulty is due to his own neglect. He might hesitate to report differences between himself and an employee if he thinks he might be held to be at fault. At times, his chief concern

is that his superior might learn of the difficulty in some way not under his control.

Lines of Promotion. The organization plan should indicate the lines of promotion. The usual line of promotion is to the next higher level in the same department as that in which a person's work lies. This should be clearly indicated, particularly in the upper levels, in order that each person may know how best to improve himself and to prepare for promotion. It is a mistake, however, for the management to hold out to every person the lure of promotion because some persons are not capable of development beyond a certain point and particularly are not capable of developing into first-rank executives. Many employees do not seek promotion to positions of increased responsibility.

In the well-known three-position plan of promotion advocated by Frank B. Gilbreth and Lillian M. Gilbreth, every person (except the one at the top and those at the bottom) was thought of as having a relationship to three positions in the organization—the position he now holds; the position below him, from which he was perhaps last promoted; and the position just ahead of him.[1] In his present position, he is a worker. He is also a teacher in that he is training the person in the job below him for advancement to his present job when an opportunity for promotion occurs. He is also a student in that he is himself training for the position ahead of him. In this manner the Gilbreths pictured the entire organization as laced together from top to bottom by a spirit of industry, study, training, and co-operation. This is a desirable situation to the extent that all persons are capable of advancement, are desirous of promotion, and can reasonably expect it.

The three-position plan would mean that every executive has an understudy who can substitute for him in case of temporary absence, as well as take his place when his position is permanently vacated. The result is that no person is indispensable. It also means that there should be no blind-alley jobs which offer no prospect of advancement. In many organizations, however, persons can be found who would like to appear indispensable and who would prefer not to have someone else learn all about their work. In most organizations, there are also jobs which lead nowhere. Persons holding such jobs can advance only by transfer, not by promotion.

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[1] F. B. and L. M. Gilbreth, "The Three Position Plan of Promotion," *Annals of the American Academy of Political and Social Science*, Vol. LXV (May, 1916), pp. 289–96. Reprinted in *Applied Motion Study* (New York: Sturgis & Walton Co., 1917), pp. 187–201.

Logical Assignment of Responsibilities. The work assigned to a division or a department should be logically related. Each division manager should be in charge of a major activity, such as production, sales, finance, or accounting. Each person reporting to an executive should be in charge of a logical subdivision of the major activity. The same principle should be followed at other levels in the organization. This means that there should be one person for each activity or subdivision of an activity. No person should be overloaded by having to manage functions requiring varied capacities; and all positions at the same level should require ability, training, and experience of comparable degree. Although this goal cannot always be achieved, it is a desirable objective.

Regard for Personal Capacities. The ideal situation exists when persons holding positions all along the line have the ability to do their jobs, have had sufficient training and experience to equip themselves for the work, and are interested in the things they are expected to do. However, if all people have just the ability necessary for their present jobs, promotion to positions carrying greater responsibility will be difficult. On the other hand, if their positions do not require their best efforts, they may become discouraged and seek employment elsewhere before they receive promotion to higher positions. It is the responsibility of executives to see that this does not occur, although no attempt should be made to hold a person within the organization when he can better himself by going elsewhere.

The principle of awarding promotions on the basis of ability, training, and interest is often violated in practice. Many positions are filled through nepotism, favoritism, or chance. The initial placement may be based on some principle other than merit, and methods of judging people for both employment and promotion are often faulty. Once a person is intrenched and particularly after a long period of service, it may be good policy to leave him where he is rather than to remove him to make way for a more capable person. Deserving employees may therefore be required to await the promotion or retirement of a superior before they are placed in the positions for which they are best fitted. A favorite device is promotion to a newly created position with a high-sounding title but with few responsibilities. This method is popularly known as "kicking a person upstairs."

The organization should provide for the utilization of the knowledge and ability of all persons associated with the enterprise. Top management cannot expect its grasp of the facts and details of the business to equal that of all other executives combined. The top executives can

receive valuable suggestions from persons at the lower levels. Valuable suggestions may come from clerical employees or workmen on the job. The view of a person who does a routine job is not broad, but he may see most clearly those things which lie within his field of vision. In the line and staff organization, there are numerous experts who know more about their special fields than the general manager can be expected to know. Some way must be found to bring their knowledge and training to bear in the formulation of the policies of the enterprise. The method of procuring from the experts their points of view and their counsel is partly a matter of procedure and partly a matter of organization.

A difficulty with altering the details of the organization and assigning duties on the basis of executive capacities is that illogical relationships might result. Activities that are unrelated may be assigned to some executives, and too many duties may be assigned to one person. However, a company may be required to do the best it can with the people who are available. Personal capacities cannot be entirely disregarded.

Distribution of Work. If possible, the work should be so divided that all persons at each level have approximately equal loads, with no person overloaded. This requirement is not easily met. If work is assigned by functions, the result is usually an uneven distribution. It can hardly be expected in a manufacturing enterprise, for example, that production, sales, and finance would make the same demands upon the executives in charge of each of these divisions. The same is true of the allocation of duties at other levels. The burden of the work would also be unequal because of differences in the ability, training, and experience of the executives and because of differences in their capacity to get things done. Nevertheless, equality of burden is a goal to be desired.

A common reason for inequality of burden within an organization is the difference in the temperament and disposition of executives. Some people get things done, while others may appear to be busy without actually accomplishing a great deal. When new functions are undertaken and new duties assigned, the additional work may be given to people who have succeeded in keeping their desks clear and their work up to date. In time, this policy results not only in the overloading of capable executives but also in an illogical assignment of tasks and functions.

Balance. In a properly balanced organization, the size of each division or department is adequate in relation to all others. The sales

division, for example, is just large enough to market the output of the manufacturing division. The accounting division is just large enough to provide the records and reports essential to management. Throughout the enterprise no important functions are neglected, no unimportant functions are stressed, and no department is overdeveloped in relation to the others. In a retail store the proprietor strives to keep the sales force and the inventory of the various departments properly balanced in relation to each other. In a university the teaching staff and the courses offered in one department cannot be correctly planned without reference to the extent to which other departments are being developed. The university service departments, such as admissions, records, finance, and buildings and grounds, should be planned with reference to each of the others and to the needs of the students. Many organizations are poorly balanced because the top executives are by training and experience more interested in some divisions than in others. In industry it is easy to expand such functions as advertising, market research, design of the product, customer service, and housekeeping to the point where the returns do not compensate for the expenditure.

Centralized Authority. Centralization of authority means that final responsibility for the success of the enterprise has been placed in one person and that he has been given the authority to see that the objectives are accomplished. It does not mean that the head of the organization attempts to make all decisions or to attend to details. According to legal theory, final authority in the corporation rests with the stockholders who establish the framework of the enterprise and delegate power to a board of directors elected by them and authorized to manage the business. In small corporations the theory is valid; but in large corporations the stockholders are unable to perform this function because of their large number, the expenses of holding meetings attended by them in person, and their willingness to trust others to act in their behalf. Occasionally, a few stockholders owning substantial blocks of stock take an active interest in corporate affairs. More often, the policy-making function and the final authority rest with the directors. However, the board of directors may leave many important decisions to the officers, for the board of directors meets infrequently and many members of the board may be less familiar with corporate problems than are the officers.[2] In any case, the essential requirement

[2] For a discussion of policy making in the large enterprise, see Robert A. Gordon, *Business Leadership in the Large Corporation* (Washington, D.C.: Brookings Institution, 1945).

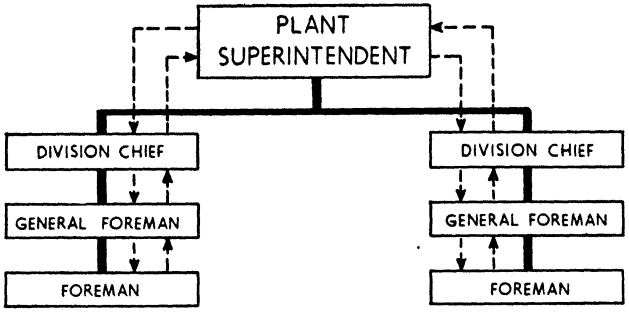
of a good organization is that final authority should be definitely placed, whether in the general manager, the president, the board of directors, or the stockholders.

The principle of centralization of authority implies that the number of persons reporting to any one executive should not be so large as to render accountability impractical. If the chief executive or the head of a department has too many persons reporting to him, he may be unable to supervise or direct them properly. Consequently, he may be compelled to let them act too much on their own initiative and judgment, without proper direction.

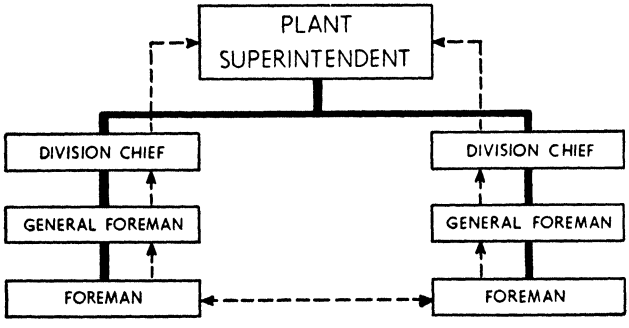
Co-ordination. To build the persons within the company into an organization working toward a common objective requires vertical and horizontal co-ordination. Vertical co-ordination means that the persons at the various levels work together with understanding and without friction. Each executive gives his subordinates the proper supervision, sees that all efforts are directed to the common goal of the enterprise, and knows what is being done by each subordinate. Vertical co-ordination also means that established lines of communication are always observed and that top executives never try to by-pass the heads of departments by communicating directly with persons far down in the organization. Likewise, junior executives are not permitted to by-pass their superiors to deal directly with executives at the higher levels. Problems requiring solution are handed down until they reach the proper executive, who proceeds to take the necessary action in accordance with established policies. In the same way, questions requiring a determination of policy are passed upward within the organization until they reach the executive in whose province the decision lies. This procedure cannot properly be called "passing the buck." It is merely the referring of a problem or question to the person who has been authorized to handle it. An executive may properly be said to "pass the buck" if he refers to another person a problem or a question which is within the range of his own authority.

Horizontal co-ordination means that work in the various departments at each level is co-ordinated effectively. For example, the enterprise is co-ordinated at the top level if the sales division directs its efforts to sell the type of goods made by the production division in the quantities it can economically produce and the finance division raises just the amount of funds necessary. This principle is closely related to that of balance in organization.

Horizontal co-ordination is achieved in part by communication. To avoid by-passing an executive and to assure that the organization is



Communication Through Official Channels



Direct Communication

FIG. 7. Methods of Communication

co-ordinated vertically, it is important that all such communications move upward to a common executive and then downward again to the proper level, as shown in Figure 7. However, this procedure is time-consuming, adds to the work of the executives, entails much writing and numerous reports, and is likely to result in a less satisfactory solution than would be achieved by direct communication. Frequent lateral communication also occurs between the foreman and the personnel department, between the production control department and the purchasing department, between the standards and methods department and the foremen of manufacturing departments, and between various other departments at the same level. Consequently, it is much better for executives to confer directly and to work out their problems by personal contact, provided the following requirements are met:

1. The executives agree as to what should be done.
2. The immediate supervisors know that personal conferences are being held.
3. The supervisors are kept informed as to what agreements are reached or policies initiated.

If any one of these requirements is not complied with, direct conferences should be discontinued; and the questions at issue should be taken up through the official channels of communication.

The problem of developing horizontal co-ordination exists at each level of the organization. Divisional and departmental rivalries often interfere with the development of co-ordination. Departmental or plant loyalties may result in a limited rather than a company-wide point of view. Methods of giving orders or otherwise dealing with other people may cause friction. Line departments may hesitate to utilize the services of such staff departments as personnel and engineering because of a fear that reliance upon others may be interpreted as a confession of weakness. Each executive may strive to handle his own problems as far as possible, without dependence upon others. Executives should strive to develop teamwork, suppress departmental rivalries, and cultivate an interest in the progress of the company as a whole.

Use of Charts in Organization Planning. Many companies make much use of organization charts, which show formal positions, titles, and perhaps the names of the persons occupying various positions. Such charts are useful in the development of the organization and also in instructing new members of the management group of their relationship to other persons in the company. The charts serve a useful purpose in disclosing defects in the assignment of duties and responsibilities. When an enterprise which has developed without reference to an organization chart draws up such a chart, one or more of the following undesirable features is usually found to exist:

1. Activities have been illogically arranged. The subfunctions are not related to the department to which they have been assigned.
2. Some activities have been assigned in part to one department and in part to another.
3. Some activities have been assigned to more than one department, with resulting duplication of effort.
4. Unrelated activities have been grouped together, with a resulting overload upon the head of the department.
5. Specialized departments have been assigned unrelated activities which the head of the department is not qualified to administer.
6. Departmental organization lacks balance. Some departments are overdeveloped and-others underdeveloped.
7. Too many persons have been placed under the supervision of the general manager. The same may be true of the persons responsible to the heads of certain of the departments.

The undesirable features in an organization may continue indefinitely unless a chart brings them into focus. However, all weaknesses should be corrected before the chart is set up in final form. It should be a cardinal principle that the chart is not rigid or fixed and that no one acquires a vested interest in his position.

Organization charts are subject to certain limitations. Although they show the vertical relationships of each position, they do not show all horizontal relationships. For example, they do not show the relationship of the purchasing agent to the cost accountant, the storekeeper, the standards and methods engineer, and other members of the organization. A further limitation of charts is that they do not show the authority associated with certain positions because of the personal influence or prestige of the persons holding the positions. An aggressive or competent person may exert much greater influence than his position seems to bestow upon him. He achieves his influence by his ability to help people and by the force of personality. Practical relationships in such cases do not conform to the chart or to organization theory.

Another difficulty with organization charts is that of keeping them up to date. This problem is particularly acute when the names of persons holding the various positions are shown on the chart. Organization charts may also tend to make the organization inflexible because management may strive to maintain the relationships that the charts portray. Because of theoretical objections, and also because of operating pressures, some companies have not prepared charts or have not kept them up to date.

QUESTIONS

1. A management consultant lists the following as basic weaknesses in organization. Indicate the circumstances which might cause each weakness and the consequences to management in each case.
   a) Inadequate organization planning.
   b) Failure to define organization lines.
   c) Improper allocation of responsibilities.
   d) Dual assignment of responsibility.
   e) Lack of balance in apportioning responsibility.
   f) Failure to allocate or to recognize certain functions.
   g) Disregard of organization lines by top executives.
2. An advertising manager was promoted to the position of chief executive of the company. Although a new advertising manager was appointed, the new chief executive continued to manage the advertising program. As a result of large and unprofitable expenditures for advertising, the business failed. What attributes of good organization were not observed?

3. Show how the attribute of balance applies to the handling of the following business problems:
   a) Expansion of line and staff departments.
   b) Expansion of sales, manufacturing, and finance divisions.
   c) Reinvestment of profits in the assets of the business.
   d) Borrowing from banks and financing through issues of capital stock.
4. Show the relation of authority and responsibility in the case of the following:
   a) An advertising manager.
   b) The public accountant who audits the books of the company.
   c) The board of directors.
   d) The credit manager.
   e) The supervisor of an office in a government agency.
5. What are the limitations of the Gilbreth three-position plan?
6. Under what circumstances is it advisable to bring in a person from outside the company for an important position instead of promoting from within?
7. Is authority centralized in a large corporation which has many thousands of stockholders?
8. Distinguish between vertical and horizontal co-ordination. Show why each is necessary to the success of an enterprise.
9. Show why it might be desirable for one foreman to communicate directly with another instead of through official channels. When would such communication be unwise?
10. Some executives object to the use of organization charts on the ground that they soon become out of date. Is this a valid objection?
11. A manufacturing enterprise which began with five employees many years ago has expanded into a large company with several thousand workers. No organization chart has ever been made, and the president has assigned or changed the duties of various executives as the situation seemed to require. What weaknesses would you expect an organization chart to show in this case? What difficulties would probably be encountered in perfecting a desirable organization? How might such difficulties be overcome?

CASES

4. FUNCTION OF AN ORGANIZATION DEPARTMENT

A large corporation with a number of subsidiaries has established an organization department under the direct supervision of the president. The function of the department is described in the company manual as follows:

"The Organization Department is responsible for developing organization plans and policies which will be given company-wide application. These plans and policies are designed to assist members of management at all levels in the discharge of their primary responsibilities for the maintenance of sound organization; the active and effective control of methods, payroll expense, and manpower utilization; the proper evaluation of daily rate jobs and salaried

positions; and the equitable administration of wages and salaries. The Organization Department furnishes assistance to the officers of the company and advice and assistance to departments and subsidiary management. The Department further provides functional guidance and assistance to executives who are responsible for organization and cost control in major departments. Periodically, the Organization Department appraises the effectiveness of the efforts of these divisions and positions, reviewing the results with the management concerned."

Questions:

1. Why should the Organization Department be placed directly under the president?
2. What duties should be given the department to enable it to perform its function?
3. What is the proper relation of the department to line executives?

5. ORGANIZATION OF WORK IN AN OFFICE

An office manager made an investigation of the work done by various employees in the office and found the following situations:

A register clerk attended to the checking of correspondence, and a file clerk arranged the correspondence in the files. The register clerk frequently was required to work overtime, while the file clerk was kept busy only half of the time.

The work of reviewing reports from salesmen was assigned to three reviewers, each of whom received the reports from one territory or section of the country. Reports varied greatly by days of the week because of differences in the time required for communications by mail to reach the home office. The result was that each of the reviewers had some very busy days and some slack days, but the busy days of different reviewers did not coincide. The supervisor estimated that on the average each reviewer was busy two-thirds of the time, with a tendency for each reviewer to have more work than he could do on certain days of the week.

In the mail section one unit handled incoming mail, and another handled outgoing mail. The unit handling incoming mail was very busy during the morning but had little to do in the afternoon. The unit handling outgoing mail was busy during the afternoon but had little to do in the morning.

The office received three types of applications, designated as "A," "B," and "C." A clerk was assigned to handle each type of application. The clerk handling "A" applications was overworked, while the clerks handling "B" and "C" applications had little to do.

Required:

1. Suggest a solution in each case.
2. Indicate the principle first applied in organizing the work and the principle that was found to have been violated.

CHAPTER V

LEADERSHIP [important tool]

THE organization chart is merely a drawing that shows the major departments and divisions of the enterprise, the rank and position of the persons in charge of each department or division, and the relationships of the various parts of the organization to each other. It is only the skeleton or framework of the enterprise. Before the organization can accomplish its purposes, it must have the services of persons who can provide leadership and management.

Nature of Leadership. Leadership is the activity of influencing people to co-operate toward a goal which the leader desires.[1] It is personality in action under group conditions. It includes the dominant personality traits of one person who is the leader and the personalities of the followers.[2] As a result of the influence of the leader upon the attitudes and interests of the followers, the course of action of the many is changed, unified, and directed toward the common objective.

The influence of the leader may be direct or indirect. Direct leadership is practiced through personal contact. It may be exercised by an executive at any level in the organization. Indirect leadership is exercised through other persons. An example of an indirect leader is a chief executive who influences foremen and workers at the lower levels in the organization by directing and inspiring intermediate executives or by transmitting information and directions through the medium of the intermediate executive. Indirect leadership is more difficult than direct leadership.

Leadership is also classified as autocratic, paternalistic, or democratic.

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[1] Ordway Tead, *The Art of Leadership* (New York: McGraw-Hill Book Co., 1935), p. 20.

[2] Emory S. Bogardus, *Leaders and Leadership* (New York: D. Appleton-Century Co., 1934), p. 3.

Autocratic leadership manifests itself in the assignment of tasks and quotas without consultation with the persons who are to execute the plans. It also manifests itself in the provision of physical facilities, clerical assistance, or other services without consultation with the persons for whom the services are provided. The autocratic leader assumes that he is best able to decide what should be done. He expects to achieve compliance with his orders through various types of rewards and penalties.

Autocratic leadership fails to utilize the capacities and training of other members of the organization. It does not build up their self-esteem, pride in accomplishment, and personal satisfaction. Even though the plans of the leader may be wise in their objectives, the group is likely to be antagonistic to changes which are made in an autocratic manner. If the subordinates have established group solidarity, they may become antagonistic and stand firmly together in opposition to an autocratic leader. By his example, the autocratic leader encourages foremen to deal in an autocratic manner with persons under their supervision. This type of leadership is likely to cause difficulties which will reveal themselves in various ways, such as insubordination and labor trouble.

The paternalistic leader is one who treats his followers as a father treats his children. He attempts to protect them by making decisions for them. Such leadership fosters dependency and fails to develop independence, initiative, and self-reliance. The success of the enterprise is made to depend upon the continuation of the services of the leader.

The democratic leader emphasizes the soundness of the opinion of the group. He suggests policies without dictating them and attempts to have group approval for his policies before they are carried out. Democratic leadership is likely to be slow, since the leader is required to wait until group opinion can be formulated. Democratic leadership may be successful, provided the leader is vigorous and can bring the group to agree upon a plan without undue delay. If the members are capable and co-operative, democratic leadership will result in sounder policies and fewer mistakes than either autocratic or paternalistic leadership.

Different types of problems require different types of conduct on the part of the leader. At times the leader may strive to arouse his followers to a high pitch of enthusiasm. A situation may require that he make a strong emotional appeal and present in strongest arguments the point of view which he wishes the group to adopt. Labor leaders use such tactics in the period prior to the unionization of a factory.

Frequently, labor troubles can be traced to the effort of the union leaders to make good on extravagant promises. Enthusiastic leadership is required of the executive who plans to build a new factory, to develop a new sales territory, or to add a new line of products.

The manager who faces the practical problems arising in the execution of his plans should demonstrate a different kind of leadership ability. He must maintain the loyalty of his followers and at the same time face the realities of the situation and perhaps effect compromises in his original plans and objectives. Many fail to make the transition required by the changed situation. For example, after the construction program has been completed, the enterprise must produce the goods and sell them in the market. The leader must then attempt to maintain the loyalty and efficiency of the group and to forestall a letdown of effort in any department.

The leader should at all times set the stage for success. Even a democratic leader cannot permit policies to be formulated by members of the group without participation and direction on his part. He should make the desires and opinions of the group harmonize with his own. He should know what policies will gain favor and what type of appeal will win the group to his cause. He must cause group attitudes to be altered. He inspires the group to greater effort and sets an example in vision, loyalty to the cause, and arduous application. He makes each member feel that he must merit the commendation of the leader and the other members of the group. The leader gains his objectives without dictating or threatening. He succeeds by utilizing the points of view and the capacities of his followers.

Qualities of Leadership. Several attempts have been made to enumerate the qualities of a good leader, but this is not easy to do because the types of leadership vary. Qualities of the successful leader of a large enterprise are not necessarily the same as those required of the leader of a small enterprise. Qualities of the top leaders are not the same as those of a personal leader at the lower levels. Some of the traits of top leaders, together with their opposites, are as follows:

Traits of the Leader	*Opposite Traits*
Positiveness or decision	Timidity, fear, caution
Vitality, initiative	Refusal to accept new ideas
Interest in people	Indifference to welfare of others
Reliability	Fickleness

Some commendable traits become objectionable if the leader is insincere or unsound in his judgment. To illustrate, perseverance or tenacity is a desirable trait, provided that the leader is correct in his judgment

of the factors in the situation. If he is in error, he may be regarded as stubborn. The relation of certain desirable traits to undesirable ones can be seen from the following tabulation:

Desirable Traits	*Undesirable Traits*
Perseverance	Stubbornness
Confidence	Arrogance
Enthusiasm	Egotism
Friendliness	Affectation
Sympathy	Indulgence

Desirable qualities of the foreman as listed by Frederick W. Taylor included technical knowledge, manual dexterity, tact, energy, grit, honesty, judgment or common sense, and good health. Although all of these traits are important, Taylor thought that the most imporant qualities were grit and "construcive imagination" or "the faculty which enables a man to use the few facts that are stored in his mind in getting around the obstacles that oppose him."[3] A very important quality of the supervisor at any level is the ability "to establish genuine, continuous two-way communication with each employee."[4] In the General Electric Company, supervisors are trained "to treat each employee as an individual—to respect his dignity, supply him with desired information, and give him a real sense of importance and participation." The successful supervisor develops in the worker a desire to do what is wanted and makes the driving of the worker unnecessary.

Leaders Concerned with General Policies. It is the function of the top executives to establish specific objectives for the enterprise. They should also determine the general methods of carrying out the policies. They should determine the duties and responsibilities of the various departments and define their relationship to each other. They should see that the necessary physical equipment and technical knowledge are provided. Finally, they should provide the stimulus for unified action.

If the top executives are to perform their work effectively, they will not have time to handle detailed questions and problems but should delegate to subordinates the authority to dispose of many such matters. The principle of delegation of authority with well-defined limits of the authority of each person is known as the "exception principle."

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[3] F. W. Taylor, *Shop Management* (New York: Harper & Bros., 1903), p. 140.

[4] R. L. Boulware, "The Business Leader's Larger Job," in Marvin Bower, *"The Development of Executive Leadership* (Cambridge, Mass.: Harvard University Press, 1949), . 54.

The executive establishes a general policy for the guidance of subordinates, who can then dispose of routine problems in accordance with that policy. When some question of unusual nature arises which is not covered by the established policy, the subordinate carries that question to the executive for decision. When the decision has been rendered, the new rule is used as a guide until another exception occurs. Routine affairs disposed of by subordinates or assistants are summarized in periodical reports which enable the superior to know what has been accomplished. The principle was stated by Frederick W. Taylor as follows:

> It is not an uncommon sight, though a sad one, to see the manager of a large business fairly swamped at his desk with an ocean of letters and reports, on each of which he thinks that he should put his initial or stamp. He feels that by having this mass of detail pass over his desk he is keeping in close touch with the entire business. The exception principle is directly the reverse of this. Under it the manager should receive only the condensed, summarized, and invariably comparative reports, covering, however, all of the elements entering into the management, and even these summaries should be carefully gone over by an assistant before they reach the manager, and have all of the exceptions to the past averages or to the standards pointed out, both the especially good and especially bad exceptions, thus giving him in a few minutes a full view of progress that is being made.[5]

The principle that the executive should concern himself only with general policies and with exceptional cases is of ancient origin. When Jethro, the father-in-law of Moses, joined the Israelites in the wilderness, he found Moses undertaking to sit as judge of all the people. Moses worked from morning until night and still did not get all the work done. Jethro saw that this procedure placed too severe a burden upon Moses, delayed decisions, and required too much waiting upon the part of the people. Following Jethro's advice, Moses set up what seems to have been a line organization with rulers of thousands, hundreds, fifties, and tens. The plan was based upon the exception principle, which Jethro explained in the following statement: "And let them judge the people at all seasons; and it shall be that every great matter they shall bring unto thee, but every small matter they shall judge; so that it be easier for thyself, and they shall bear the burden with thee."[6]

The extent of authority actually delegated to a subordinate varies with the company, the attitude of the superior, and the ability of the

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[5] Frederick W. Taylor, *op. cit.*, p. 126.

[6] Exodus 18:22.

subordinate to accept and meet responsibilities. In some cases the superior merely outlines the objectives of a department and exercises only that degree of supervision that may be necessary to assure that serious or costly mistakes are not made and that the work of the department is co-ordinated with that of other departments. The subordinate is made responsible for the accomplishment of certain objectives, and he is required to work out his own methods and techniques. In other cases the superior closely supervises the work of subordinates, limits the scope of their authority, and permits them to make decisions only on unimportant details. A third method of supervision provides for decisions to be made in conference between the superior and the subordinate in an effort to bring the experience and knowledge of both persons to bear upon the situation. This method attempts to reach a solution that is better than either person could achieve by acting alone.

In many companies, executives are overworked because they have failed to delegate authority or to train subordinates to accept responsibility; and they are required to attend to detailed problems to the neglect of larger issues. Even in a large company, for example, presidential approval may be required for purchases over a stated amount, salary changes above a stated minimum, public appearances of members of the management, and capital expenditures of more than a few hundred dollars. In smaller companies the president may approve grievance settlements that cost money, transfers of production workers, and awards made to workers for suggestions to management. In some small companies the chief executive opens all of the mail and signs all outgoing letters.[7]

There are several reasons for the failure of executives to delegate more authority. Perhaps the principal reason is that the executive believes that he can do the work better than any one else or that his judgment is better than that of subordinates. He may find it easier in any situation to do the work or make the decision than it would be to train someone. Another difficulty is that some executives enjoy handling detailed problems. A chief executive who has advanced by way of the sales division, for example, may feel that he knows more about sales problems than the present head of the division knows; and he may also derive a personal satisfaction from the handling of sales problems and the making of sales contracts.

Another reason for failure to delegate authority may be the unwillingness of the leader to assume responsibility for handling major

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[7] *Management News*, Vol. XXIV, No. 10 (October 31, 1951), p. 5.

problems. He may evade issues by becoming submerged in details. In this manner, he may explain to himself or to others his delay of decisions on important problems. However, in trying to evade his difficulties, he usually multiplies them. His fear of making the wrong decision increases the chances of failure.

An executive may hesitate to delegate authority because he is afraid that he may not receive credit for the results achieved unless he personally attends to numerous details. This fear is usually baseless. The head of any organization is credited with the success achieved because he selected capable persons for their positions, eliminated conflicts and difficulties, and directed the activities of the group toward the common goal.

In some cases the executive may have difficulty in delegating authority because the subordinate may prefer not to assume responsibility. A junior executive may insist upon taking his problems to the superior, with the excuse that he thought the chief executive would like to make the decision. If he does do so, the superior should decline to assume the responsibility. He may properly assist the junior officer by suggesting possible lines of action, or he may inquire whether the subordinate has considered certain difficulties. However, he should leave the decision to the subordinate if it properly falls within the scope of his authority.

The Development of Subordinates. The leader should train his subordinates to assume greater responsibilities. If a substitute is available for each position, the confusion occasioned by the death, resignation, or promotion of any executive is lessened. In some cases the leader may develop his subordinates by seeing that formal organized training courses are available and by encouraging them to enroll. However, the greatest development results from the assumption of responsibility and the experience of active participation.

When a project is to be initiated, the assignment to the subordinate should be in general terms rather than detailed instructions. The leader should be sure that the subordinate understands what is wanted and how much authority he has in the matter. As illustrations of precisely what is meant by the assignment of a problem by an executive, the following are typical: plans for the sale of stock of the corporation to employees, development of a new type of advertising appeal, the inauguration of a plant periodical, a change in the safety program, or a system of merit rating for employees.

When an assignment has been successfully completed, the subordinate should receive proper credit. Appreciation may be indicated

by praise of the accomplishment or by other award. If criticism is necessary, it should be given privately. The leader should avoid sarcasm and ridicule. If failure was due to circumstances which could not reasonably have been anticipated, the leader should show an understanding of the difficulties. If the original plan can be made workable by a revision of methods, the leader should aid by his suggestions and encouragement.

Praise for success provides the greatest stimulus when it is given after a task has been completed. The leader should therefore divide the major tasks of the organization into smaller parts which can be completed separately. This method is illustrated by the use of monthly or annual budgets and financial statements.

The training of subordinates should be designed to prepare them to advance to higher positions and to assume greater responsibility within the company. A basic requirement of such a program is the preparation of a detailed statement of the duties and responsibilities of each position in order that the training may be properly planned and directed. Another essential is the selection of some persons at the lower levels who possess the personal qualifications necessary to the executive. The program may include positive efforts at training through rotation in various positions, assignment of an understudy to an executive, formal courses of study, discussions with members of the management, and other such methods. The person being trained for greater responsibilities may be broadened by being permitted to observe how decisions are made and by being permitted to participate in decision making. Younger men may be invited to attend conferences at which decisions are reached concerning labor negotiations, advertising policies, the pricing of the product, and the contents of an annual report to employees or stockholders. The final step in the development of the subordinate may consist of placing greater responsibility upon him and permitting him to make decisions within a limited sphere.[8]

Promotion from Within. Most companies claim to follow the policy of promotion from within, although many do not consistently practice it. The advantage of this policy is that it encourages executives throughout the organization to strive to be worthy of promotion when the opportunity arises. It also requires leaders to anticipate changes and to see that someone is being properly trained as an understudy for each position. The success of the policy in stimulating both the execu-

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[8] See William B. Given, Jr., "Experience in the Development of Management People," in Marvin Bower, *op. cit.*, pp. 73–95.

tive and the understudy indicates that promotions should be made on the basis of merit rather than seniority.

Many leaders contend that if promotion from within is the established policy, no exceptions should be made. A feeling of injustice is engendered if a person who seemed to be in line for a higher position is passed over in favor of an outsider. Dissatisfaction thus created tends to spread and to undermine the loyalty and morale of the entire organization.

Several objections may be made to promotion from within as a consistent policy. First, there may be times when no person has the qualities necessary for the higher position. If this is the case, management may have failed in its responsibility for the development of leaders. However, the requirement that every person who is to be promoted to an executive position must start as an office boy or unskilled worker may result in a dearth of executive talent somewhere along the line.

A second objection to an unvarying rule of promotion from within is that the organization may become ingrown. This means that it may fail to keep abreast of developments. This danger can be avoided only by alert and progressive leadership. Some of the ways of avoiding it are the study of trade and technical magazines and books, attendance at conventions of trade associations and other organizations, discussions by executives within the plant, and visits to places of business of other enterprises.

A third objection to such a policy is that it may intensify rivalries within the organization. If a department is split into factions, the promotion of the leading person from either faction may serve only to intensify the cleavage and to destroy any possibility of harmony.

The policy of promotion from within causes difficulties if a subordinate is led to believe that careful application to his duties will assure him of promotion. At times the management may wish to promote some promising executive who is farther down the line. Equally significant are transfers from other departments. Persons may be transferred because they were originally misplaced, because they have developed new interests and capacities, and because the possibilities of promotion in their original department are limited. Management is handicapped in the development of its executives if every person transferred must start at the bottom in his new department.

An obvious limitation upon the policy of promotion from within is that it cannot be applied to many of the staff positions. For example, an administrative assistant cannot be promoted to the position of plant physician or engineer merely by a conscientious attention to duties.

Promotion should be made on the basis of ability, training, experience, and accomplishment. Ability to plan, to lead, and to carry a task through to completion is partly a matter of inherent capacity and partly the result of training and development. It is the responsibility of the leader to see that promotions are so made that the qualifications and talents of each person are in keeping with the requirements of his position.

Judgment by Standards. Subordinates should be judged by standards. The leader should have definite and reliable criteria by which to rate his subordinates and to determine which are the most valuable to the organization. The standards should be established in advance of performance, and they should be made known to the persons whose work is to be evaluated. If such qualities as punctuality, regularity of attendance, and personal appearance are important, the subordinate should know it in order that he may do what is expected of him. In making any judgment, the leader should make his ratings over a period of time which is long enough to permit a fair appraisal.

Three types of standards which may be employed in judging subordinates are standards of performance, financial standards, and standards of accuracy.

A standard of performance is a measure of the amount of output of an individual or a department. For example, the standard might indicate the number of units expected to be produced by the manufacturing division, the number of units to be sold by the sales division, the number of hours machinery is expected to be kept in operation, or the number and seriousness of accidents.

A financial standard is a measure of the success of an individual or a department stated in dollars and cents. The following are examples: sales made by each salesperson, sales returns in dollars and as a percentage of sales, markdowns in prices stated in dollars and as a percentage of sales, and bad debt losses in dollars and as a percentage of sales. The balance sheet and profit and loss ratios are financial standards. Comparison may be made with the performance of prior years, with averages for the industry, or with what is considered ideal performance.

A standard of accuracy is a measure of the quality of the work done. An example is the amount of defective or spoiled work in a department. A standard of accuracy is often combined with a standard of performance.

Both the leader and the subordinate gain when the judgments of the leader are based upon standards. The leader avoids partiality and

is consistent in his judgments from one month or year to another. He more easily gains and holds the good will and co-operation of his followers.

Reward should be related to accomplishment. Rewards may be financial or nonfinancial. Financial rewards are usually necessary, but nonfinancial rewards are also effective. Nonfinancial rewards include praise and commendation, increase in rank, additional authority and responsibility, and any recognition which increases the self-respect of the subordinate or the respect in which he is held by his associates. Recognition need not be given for each task successfully completed. It is sufficient if the subordinate knows that the leader is aware of meritorious service and ultimately rewards it. In the lower levels of the organization, however, rewards should be prompt if they are to be effective.

Action Based upon Information. The leader of a business enterprise should base his decisions on facts as far as possible. Even though policies are adopted and action is initiated only after a careful analysis of the situation, some mistakes are likely to be made. The mistakes of the informed leader will be fewer and less costly than the mistakes of a leader who is guided largely by intuition. Although the facts or circumstances relating to a proposed action are not the same as the circumstances of an earlier action, an analysis of causes and results should enable the leader to avoid a repetition of past errors and to control the factors which limited success in earlier undertakings. The ability to analyze a situation and to recognize the controlling or deciding factors in each case will enable him to handle new problems successfully.

In most cases the available facts indicate to the leader no more than that a proposed course of action probably would or would not be desirable. The executive must constantly face new situations in which experience does not prescribe a definite course of action. For example, he makes decisions concerning such problems as the appropriation of money for the study of new methods of production, the building of a new plant, the development of a new market, or the method of marketing a new product. In dealing with both physical facilities and human relationships, he uses available information to develop a program that seems to offer the greatest chance of success.

QUESTIONS

1. It has been said that three methods may be used to get people to work: hire, inspire, and require. Indicate situations where each method might be used.

2. Indicate which of the following steps show an exercise of leadership:
   a) The product design department proposes a new product to supplement the existing line of products.
   b) It presents the idea of the new product to the president and convinces him that it is practical.
   c) The president presents the idea to the policy committee, which recommends minor changes in the design to increase the attractiveness of the product to consumers.
   d) Plans are made to manufacture the product, to advertise it, and to market it.
   e) The plans are put into effect through the co-operation of all departments concerned.
3. Should the president of an enterprise submit plans such as those for plant expansion or for a change in the design of the product to a majority vote of the officers constituting the policy committee? Give reasons for your answer.
4. Show how the exception principle could be applied to the following procedures in a retail store:
   a) Granting credit to customers.
   b) Accepting returns of merchandise by customers.
   c) Making charges to the accounts of customers from sales tickets.
   d) Purchasing merchandise for sale in a department.
5. The following are possible reasons why a man might aspire to be the chief executive of a large enterprise:
   a) High salary and other monetary rewards.
   b) Security for himself and family.
   c) Social prestige associated with the position.
   d) Desire for power and influence.
   e) Gratification of ambition to succeed.
   f) Protection of his own investment in the enterprise.
   Rank the motives in the order of their probable importance. Might the importance vary with the individual?
6. It was recently reported that a man resigned his position as president of a large industrial enterprise to become president of a large railway system at a much lower salary. Suggest possible reasons for such action.
7. Compare the following methods by which a person might prepare for leadership:
   a) Work as junior executive or understudy under one or more successful executives.
   b) Study biographies of successful leaders in the army, government, industry, and the professions.
   c) Study the principles of leadership as found in books and periodicals.
   d) Take a general college course.
   e) Take a college course in business, psychology, and related subjects.

CASES

6. PROPOSED TRAINING PROGRAM FOR EXECUTIVES

The Glover Manufacturing Corporation employs 1,980 persons, of whom 480 are in the management group. The top management includes the president and eight divisional executives in charge of sales, manufacturing, advertising, personnel, engineering, product research, finance, and accounting and statistics. In February, 1951, the vice-president in charge of sales died suddenly; and the president found that no one had been trained to take his position. Inquiry among the top executives indicated that none of them had taken any steps to train a successor. Since a number of top executives were nearing the retirement age, the president concluded that a positive program of executive development should be undertaken.

When the president began to consider the details of a training program, he concluded that a prerequisite would be the formulation of a definite statement of the duties and responsibilities of each position as a guide to the program. While the descriptions of top positions would be in general terms rather than detailed statements of specific duties, the preparation of a manual describing all top positions, including that of the president, seemed desirable. A staff assistant was authorized to prepare the manual.

Several methods of developing subordinates were considered. The president believed that subordinates should be allowed to sit in at conferences where questions of policy were discussed and gradually to assist in the process of policy making. As subordinates proved themselves, special assignments of increasing difficulty would be given to them.

Rotation of positions was also considered as a method of executive development. Under this program, persons being trained would be transferred from one position to another according to a specific plan. This method was regarded as too costly as a method of training for top positions. Its value was considered to be limited to the lower levels within the organization, where the work has been simplified and is quickly learned.

As aids to executive development the president urged that executives at the divisional level encourage promising subordinates to take courses in business administration at night schools, to read current literature in management and administration, and to attend meetings of trade associations and other groups where management methods might be discussed.

Some of the divisional executives thought that a training program might do more harm than good. A person who began training for a position not yet available might be subjected to criticism from other persons in the company as "the crown prince" or "the fair-haired boy." He might not prove capable of developing sufficiently to take over the higher position, or he might become impatient if his superior did not retire as early as had been expected. Some executives appeared reluctant to train subordinates who might advance too rapidly and might encroach upon the prerogatives of the incumbents.

Questions:

1. Should the company adopt a program of executive development?
2. Was the manual describing top positions desirable?
3. What method of executive development would likely be most effective?

7. DIFFERENT TYPES OF LEADERSHIP

The plant superintendent of Company A called a meeting of foremen and told them that the percentage of rejects had to be reduced by 10 per cent during the next week as compared with the preceding week. Each foreman was to check on workmen, see who was responsible, and take such disciplinary action as the situation required.

The plant superintendent of Company B had a similar problem. He called the foremen together for a discussion of the problem of waste and seconds and asked for suggestions as to what could be done. One foreman suggested that tolerances might be unnecessarily close and that parts not meeting the required specifications might serve the customer satisfactorily. Another foreman suggested that workers with limited experience and skill might be classified as "rough finishers," with instructions to grind the part to a dimension somewhat larger than the specification. Exeprienced workers might be classified as "fine finishers." They would be assigned the work of finishing the part by grinding to exact specifications. Other suggestions related to quality of the raw material, machine adjustment, tool repair, wage rates, and other phases of the work. The plant superintendent agreed to investigate and to discuss the problem at the next meeting.

Questions:

1. What types of leadership are illustrated by the two cases?
2. Under which type of leadership does the leader assume greater responsibility for decisions?
3. Which type of leader is more likely to get the desired results in the cases cited?

CHAPTER VI

THE FOREMAN

THE FOREMAN holds a significant position in the organization of any company. He has the responsibility for directing an important unit of the productive activities of the company. He constitutes the last link in the chain of command because the line between management and workers is drawn just below the level of his position. Because the foreman is a part of management, he can speak and act in the name of the company. He is, in fact, "the front line of management."

The foreman is sometimes given the title of supervisor or department head. In a large company, his immediate superior may be the general foreman, who would in turn report to a division chief. In a small company, he might report directly to the plant manager or the works manager.

Work of the Foreman. The position of the foreman depends in part upon the type of organization adopted by the company. In many small businesses which provide few staff services by specailized departments, the company may be organized on the principle of the line. In such a company the foreman holds a position similar to that of the foreman in the Midvale Steel Company when Taylor began his studies about the year 1880. In the line and staff organization, the foreman retains the sole responsibility for the activities of his department but has the assistance and co-operation of departments performing staff functions. Staff services are commonly provided in the organization of large companies, and most of the discussion in this chapter relates to the position of the foreman in the line and staff organization. The work of the foreman in the line and staff organization will be considered under the following six heads:

Responsibility for directing the work.
Responsibility for employee relationships.

Responsibility for working conditions.
Co-operation with others.
Maintaining channels of communication.
Handling worker complaints.

Responsibility for Directing the Work. The foreman usually must assign men to their jobs; for although the planning department is responsible for the over-all scheduling of the work, the foreman may still be required to assign the tasks to the machines and the workers. If production is centrally controlled by a planning department, the foreman must see that production schedules are followed. He must see that machines and tools are properly used and that safety regulations are observed. He may be required to requisition the purchase of materials. He is responsible for good housekeeping, which means seeing that tools are returned to the toolroom when they are no longer needed and that materials and completed work are moved to the next workplace. The foreman arranges for the disposition of defective or spoiled materials. In case of emergency, such as fire, accident, or machine breakage, he must take the necessary action to protect the workers and the interests of the company. In short, the foreman is responsible for the smooth and orderly conduct of his department and for keeping down the costs of materials, labor, and expense.

Responsibility for Employee Relationships. The foreman requisitions help when it is needed. Although he is no longer required to interview and select workers, the newly employed worker must meet with his approval. When a worker is sent to his department for work, the foreman sees that he is properly instructed as to the requirements and conditions of the job and that he is otherwise properly inducted. This is an important responsibility. The foreman maintains discipline during work hours. He sees that workers fill out their time tickets, and he approves payment for work done by signing the payroll sheets. He makes sure that specifications are followed and informs workers of changes in specifications. As a leader, the foreman aids in the training and development of workers.

The foreman can meet his responsibility for handling employee problems only if he has the support and co-operation of persons higher up the line. He should have authority commensurate with his responsibility, and he should know just what his authority is in various situations. In certain cases, he might have authority to issue a warning or to give a reprimand. In handling minor problems, he might be given authority to act without making any report to his superior; and in other cases, he might be authorized to act but required to make a

report of the circumstances. In serious cases, he might have no authority to act but would be expected to refer the matter to his superior for instructions or recommendations.

Although the tact and judgment of the foreman are most essential in dealing with personnel problems, his task is made somewhat easier if he is given proper assistance and also recognition by others in the management. Relatively insignificant privileges granted to him may help by indicating to employees that he is a part of management. Special recognition may be given the foreman by provision of a desk or office, exemption from the requirement for punching a time clock, payment by check delivered by messenger, listing in the company telephone directory, a separate mailbox for communications, and various other privileges.

Responsibility for Working Conditions. The foreman should keep informed concerning developments relating to the workplace, the conditions of work, and the job. As for the workplace, he must know the layout and arrangement, the preparation time required for the job, and the time required to make necessary adjustments. He observes lighting, ventilation, and sanitary conditions. If a worker has inadequate light or is exposed to dangerous or obnoxious gases, intense heat, or moisture, the foreman should be the first to observe the fact and to improve conditions or to report the matter. The requirements of the various jobs should be analyzed and compared by the foreman. Jobs may make excessive physical demands upon the worker because of the necessity for lifting, stooping, standing, or making monotonous motions. Some jobs are dirty, hard on clothes, noisy, dangerous, irritating because of delays and uncertainties, or otherwise disagreeable. Some jobs offer little or no chance for the development of the worker. The foreman should co-operate with the personnel division in the evaluation of jobs, the rating of workers, and the placement of workers.

The foreman should be familiar with the qualifications of the workers and their fitness for the jobs to which they are assigned. He should know the extent of their training and experience, and he should see that workers are suited to the work they are doing. He may determine the adjustment of the worker to the job by observing the trend of his output, which may be declining, increasing, stable, or fluctuating in an erratic manner.

Co-operation with Others. The foreman, as a part of management, must carry out its policies, interpret them to the workers, and execute the orders received. Under democratic leadership, he is advised of impending changes and is permitted to express an opinion on a

proposal affecting his department before it is adopted. He should keep his superiors informed of developments in his department, such as shortages of materials, defects in materials or equipment, imperfect work received from other departments, personnel problems, and difficulties of workers in meeting standards. He makes recommendations for changes, such as improvements in layout, lighting, or air conditioning, and suggestions for the transfer of workers.

The foreman does not always find it easy to co-operate fully with other line officers. One difficulty is that since he is primarily concerned with getting the work done, he does not welcome changes which may interfere with the work immediately ahead. He is usually very close to the workers, for he has his desk on the floor of the shop. He spends part of his time at his desk, and much of the time he spends throughout the shop in actual supervision and in handling problems as they arise. Changes not only interfere with the work in hand but may also threaten the security of some of the workers in their jobs. Consequently, the foremen may be indifferent to orders received from above even though he may put them into effect.

In making his reports, the foreman usually would prefer not to inform his supervisors of difficulties which are due to his own mistakes and limitations. If he is having difficulty in meeting a schedule, he may not report the situation unless he thinks his superiors may find out from some other source. He is anxious to submit favorable reports of quantity production and unit costs. However, if the reports this month are very good, an equally good report may be expected next month. Consequently, the foreman may be as interested as the worker in seeing that current performance sets a standard that can be comfortably met in the future. A standard that is too tight will not allow for delays or mistakes.

Co-operation is made easier for the foreman if he is made to feel that he is really a part of management.[1] He should be notified in advance of all changes affecting his department, and he should never be permitted to hear of them by the "grapevine." He should receive proper credit for good performance in such matters as production, safety, and personnel relations. He should know company policies in order that he may know what position to take concerning problems which arise. All orders affecting his department should be transmitted through his office.

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[1] For an excellent discussion of the relationships of the foreman, see Burleigh B. Gardner and David G. Moore, *Human Relations in Industry* (Chicago: rev. ed.; Richard D. Irwin, Inc., 1950), chap. iv.

In order that foremen may be properly informed, some companies hold weekly or monthly meetings of all members of management. At such meetings, current developments relating to the company are considered, such as changes in production control, scheduling of work, maintenance, and expansion. The production records of various departments are graphically displayed on blackboards or bulletin boards, and the reasons for failure to meet schedules are considered. Mere mention of the cause may be sufficient to correct it. Members of management, from general manager to foreman, may be permitted to present a problem or discuss a policy in which others may be interested or to which they may contribute. Meetings of this kind serve not only to keep all members of management informed but also to build up the self-respect and morale of the foremen.[2]

The staff departments with which the foreman establishes regular contacts include maintenance, standards and methods, engineering, safety, employment, inspection, planning, cost accounting, and stores. Co-operation with some of these departments is easy for the foreman, but co-operation with others may occasionally be difficult. The foreman may request the services of the maintenance department when he believes a machine needs repairs or adjustment. The standards and methods department sets the standards of performance for each job. The foreman may call its representative to re-examine any standard which he believes to be too tight or too loose. If a worker has difficulty in meeting the quotas set, or if he can meet the quota too easily, the foreman may ask that another study of the job be made. However, the foreman may not report that a standard is loose; because of his nearness to the worker, he may prefer that all standards be such that they are easily met. If the workers meet the standards, they will not complain. If they cannot meet them, they may cause trouble for the foreman by making a complaint. Moreover, if the standards are loose, production may be maintained on days when things do not go just right. Loose standards may provide the slack to compensate for delays in production without the necessity for detailed reports of difficulties.

The engineering department investigates the possibilities of improvements in layout and rearrangement of equipment or in the design of the product. If a worker has difficulty in turning out a part according to specifications, or if he finds that a part does not function properly when the product is assembled, he notifies his foreman, who

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[2] W. E. Bahl, "Supervisors Kept in the Know by Weekly Get-Together," *Factory Management and Maintenance,* Vol. CIV, No. 8 (1946), p. 122.

in turn may notify the engineering department. However, the calling of the engineering department may be interpreted as a confession of incompetency on the part of the foreman who would ordinarily be expected to instruct and assist workers in meeting specifications. Usually, the engineering department must find out for itself the weak spots in the layout, the arrangement of machines, and the design of the product. An objective of top management in its contacts with foremen is to make them more cognizant of the services rendered by staff departments and more willing to make use of them.

The foreman has frequent contacts with many other departments. The success of the safety program requires his co-operation, and he should have a part of the credit for accident prevention. The foreman should uphold the inspector as a part of management, but he may at times feel that the inspection is unnecessarily close. He assists the personnel department in the induction of workers and in the training, rating, transferring, and promoting of workers. He sees that information required by the cost and payroll departments is supplied to them. Because of the important part played by the foreman in handling problems of production, he has been described as "the key man in production."

Maintaining Channels of Communication. The foreman is an important link in the channel of communication to and from employees. Most of the communications between foremen and workers are oral, and the writing of numerous memorandums indicates a lack of personal contacts and of personal understanding. For a new employee, communication from the foreman begins with an explanation of departmental regulations, introduction to fellow employees, assignment to a job, and explanation of what is expected. Later communications concern assignments to new work and the discussion of specific problems or developments, such as needed changes in working conditions, investigation of accidents, and assignment to new work. The worker is expected to communicate to the foreman a report of any difficulty he may have in maintaining quality standards, meeting production schedules, or understanding instructions of work to be done. He also reports to the foreman concerning any absences. The foreman keeps his own superior informed of developments within the department, and he also has frequent contacts with various staff departments. Communications with others in the management may be by telephone, personal discussion, and written reports.

If the foreman is properly to perform his function in communication, he must receive adequate communications from his own superior at

the next level in the chain of command. Information transmitted to him might include a foreman's manual on company policies, copies of the union contract, copies of the minutes of grievance committee meetings and decisions rendered, and executive orders. Information on current developments and proposed changes may be transmitted through daily contacts, interviews, and discussion meetings. Communications may consist of information, advice, or specific instructions.

The foreman is interested in having all communications to employees in his department transmitted by him. He is even more concerned with the reports to higher levels in the organization pertaining to his department. However, when a representative of a staff department comes into a line department, the foreman may not control the information which he sends to his superior. In such a case the line is short-circuited as far as the foreman is concerned.

For the line organization to be short-circuited by a staff department may have serious effects upon the foreman's attitude and his willingness to co-operate. The problem of the foreman is complicated by the fact that the reports may be conveyed verbally and in informal conversation between the staff member and his chief. To protect himself, the foreman may be careful to report to the general foreman all significant developments affecting his department. Because of his peculiar situation in matters of communication, the foreman has sometimes been described as "the man who is caught in the middle."

Handling Worker Complaints. A complaint is defined as "a spoken or written dissatisfaction brought to the attention of a management or union representative."[3] A grievance is a complaint which has not been properly handled by the management or possibly by the union officials. It may have been ignored or dismissed without due consideration. Complaints and grievances may concern wages, supervision, seniority rights, promotions, and general working conditions.[4]

The foreman should investigate the facts concerning all complaints which come to him. If he finds that the complaint is justified, he may be able to correct the difficulty. He may find it necessary to inquire what the policy of the company is concerning the question at issue. If he is not informed as to company policy, he may communicate with the general foreman, who may consult the division chief to determine

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[3] Paul Pigors and Charles A. Myers, *Personnel Administration* (New York: McGraw-Hill Book Co., 1947), p. 107.

[4] For illustrations and methods of handling, see U.S. Department of Labor, "Settling Plant Grievances," *U.S. Department of Labor Bulletin 60* (Washington, D.C.: U.S. Government Printing Office, 1943).

the policy; or he may have to ask for a ruling in case no policy has been established.

In some cases the employee may make the complaint to the union steward. The steward is an employee of the company who has a regular job but represents the union in dealing with the foreman. Cases which are referred to the steward are usually settled by a conference between the foreman and the steward. If an agreement cannot be reached, the foreman may refer the question to the general foreman. The case may be carried to the division chief and the works manager. The shop steward will also refer the question to his superior officer in the union organization, who may be the business agent or the chief steward. Above the chief steward are the executive committee and the president of the union.

If a grievance is to be carried to the higher levels in the organization, the foreman should ask that the worker prepare and sign a written statement. This plan has several advantages. If a worker must sign a written statement, he is likely to tone down the charges and to state the facts correctly. In many cases the result is that the employee looks at the matter in a somewhat different light, and he may decide to withdraw the complaint entirely. Many people hesitate to commit themselves to written statements which may later be shown to be incorrect. A second advantage is that both the foreman and his boss can see precisely the question at issue. The difference between the foreman and the worker can then be reduced to a question of fact or of principle. A third advantage is that the keeping of records by the foreman is facilitated. The next time the same issue is raised, he will know the policy of the company relating to the question. The decision may also be communicated to other foremen for their information.

If possible, the foreman should not permit a complaint to become a grievance. The fact that a worker thinks he has a grievance is in itself an undesirable condition. A grievance may indicate a lack of attention to the difficulties of the worker, or it may indicate an inability of the foreman to show the worker wherein his attitude is wrong. Because of his close contact with employees, the foreman has been called "the front-line personnel man."

The Training of Foremen. In time of rapid business expansion, when new plants are being put into operation or new shifts are being added to the work force, new supervisors must be trained. The new foremen are usually recruited from the ranks by upgrading. The need for training programs at such times is especially great. However, foremen's training programs are desirable at all times for the purpose

of maintaining loyalty and enthusiasm and of keeping the foremen abreast of new developments in company policies, technology, and other problems.

A person has a difficult adjustment to make when he ceases to be a worker and becomes a part of management. He may be afraid of making mistakes and therefore may be hesitant to take action; or in his anxiety to prove himself worthy of his new position, he may act hastily. If he asks for assistance, he may be accused of incompetence. If he does not ask for assistance, he may be accused of overconfidence. At this time he is particularly in need of assistance and support from top management.

The problems of the foreman were increased by the change in the type of factory workers after World War I. Prior to 1914 the ranks of factory workers were swollen by newly arrived immigrants, many of them from southern and eastern Europe. Since immigration has been restricted first by war and then by the adoption of the quota system, and since high-school education has become quite general, a larger percentage of workers are native born, with some high-school or technical-school training. These workers require intelligent and capable leadership. The foreman may also fear the competition of the better workers in case he fails to make good.[5] The problems of the foreman are further increased by federal regulation of labor relations which makes the employer liable for such acts as the enforcement of arbitrary rules, discrimination, or the firing of workers without cause.

Some training courses are designed to facilitate the entry of foremen into the ranks of management. The course for new foremen is given after promotion rather than before. If the program were given before promotion, the man would have to return to his job to wait for an opening. In the meantime, he would be subject to the jealousy and suspicion of the other workers. The man would also lack motivation because he might never be made a foreman.

One type of training program for foremen is intended to give them an understanding of the entire organization of the company. It may begin with a series of meetings, lectures, and conferences with top management.[6] Each of the executives may discuss his work in relation to the work of the foremen. The foremen may be conducted through the various offices and departments of the plant where they are told

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[5] See John W. Riegel, *Selection and Training of Prospective Foremen* (Ann Arbor: University of Michigan Publications, 1940).

[6] R. R. Tryon, "Training Foremen to Play on the Management Team," *Factory Management and Maintenance*, Vol. CIV No. 2 (1946), pp. 100–105.

of the work of each one. In conferences with the president, the sales manager, the controller, and other officers and also with the heads of such departments as employment, engineering, purchases, stores, and maintenance, the foremen are made to see that the company is an assemblage not only of machines but also of persons. The relation of the foremen to each of the various executives of the company is indicated. The purpose is to show that top management and the staff departments perform necessary services.

The training program may be designed to foster loyalty to the company and to the system of private enterprise. One company lists the following objectives of its foremen's training. The objectives indicate something of the content of the course.

Give a better understanding of our business system.

Instill a greater appreciation of the importance of good management and a conception of the problems of management in maintaining a sound and solvent business with steady employment, good wages, and quality products at competitive prices.

Show why business must earn a profit and why this is important to the worker.

Show why increased wages cannot come from profits but only from increased production.

Point out that our economic system has resulted in a higher level of well-being and opportunity to more people than any other system.

Make supervisors better leaders by increasing their knowledge and understanding.[7]

The training program may be designed to increase the technical skill and methods of foremen. The program may assist foremen in meeting the problems of supervision. The course given by one company covers such problems as the following:

Planning	Reprimanding
Organizing	Developing initiative
Commanding	Handling grievances
Controlling	Getting co-operation
Co-ordinating	Women on the job
Budgeting time	Work simplification
Building confidence	Developing an understudy
Inducting new employees	Teacher training

The methods of training vary somewhat with the purposes. The program may include conferences and discussions with top management, conferences among the foremen for the discussion of their prob-

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[7] Charles W. Drew, "We Give Our Supervisors Economic and Company Facts," *Factory Management and Maintenance,* Vol. CIV, No. 9 (1946), pp. 120–24.

lems, and classes with a fixed program of study. A continuous program may consist of meetings for the presentation of news bulletins, policy announcements, and achievements or problems of various departments. Visual aids, such as charts, drawings, diagrams, and motion pictures or slides, have been found to be helpful. Demonstrations, such as new work methods or safety devices, are also effective. Lectures are the least effective. A practical man whose energies are directed primarily at meeting a production schedule is not at home in a lecture room listening to a formal discussion.

Foremen's Unions. During World War II the unionization of foremen became a pressing problem. Top management feels that a foremen's union is inconsistent with principles of the organization and management of private enterprise. A union of foremen means that management is unionized because the foremen are a part of management.

While practice varies between industries and unions, the general rule in the mass-production industries has been that foremen and supervisors have not been permitted to become members of labor unions. In a few industries, unions have permitted foremen to become members. Such an arrangement exists in the building trades, parts of the metal trades, and the teamsters' union. A few long-established unions confine their membership to foremen. Some of the foremen's unions are affiliated with the American Federation of Labor or the Congress of Industrial Organizations, and some are independent.

When foremen organize or join a union, the usual reason is that they feel that they must protect their interests against mismanagement at the top levels and against further encroachment upon their authority and prestige through the development of staff departments. Even though the need may be imaginary, the movement indicates a neglect by top management which has created a breech within the organization. Some of the specific causes of the unionization of foremen are as follows:

1. While some foremen are paid a monthly salary, many are paid an hourly wage. The foremen feel that as a part of management, they are entitled to be paid on a weekly or monthly basis. The question is partly one of prestige.

2. The spread between the pay of the foremen and that of the men is sometimes not as great as the difference in position and in responsibilities justifies. In some cases, a skilled worker with overtime payments has been able to earn more than the foreman.

3. Foremen have sometimes received increases in pay only after increased wages have been received by workers through a strike or a threat of strike. The foremen may therefore conclude that the union affords them their best protection.

4. The foremen have not had sufficient contact with top management through discussion meetings and in other ways.

5. The authority of the foremen has frequently been usurped by their superior officers. Foremen have also been by-passed at times by workers, union stewards, and staff departments who may carry their problems directly to the top levels of management.

6. The foremen lack security in their jobs. They may be fired for any reason or no reason. Cutbacks during a business slump may result in the loss of a job or in demotion to the ranks of shopworkers without the protection of seniority rights which they held prior to promotion.

7. Machinery is often lacking for the settlement of the complaints of foremen. All the machinery has been directed to the settlement of worker complaints.

In December, 1945, the National Labor Relations Board recognized a union of foremen in the automobile industry as a legal organization for bargaining purposes and directed the Packard Motor Company to bargain with the union as the exclusive representative of the foremen. The significance of this decision was not that the foremen were given the legal right to form a union, for they already had that right. The significance was that that union and its members had the rights guaranteed by the National Labor Relations Act. The effect of the decision was to prevent any interference by the management in the affairs of the formen's union and any discrimination against the members because of their membership. The company was also compelled by law to bargain with the foremen's union, whether it wished to do so or not.

The Labor Management Relations Act of 1947 withdrew the protection of foremen's unions which had been extended to them by the decision of the National Labor Relations Board. The act excluded supervisors from the definition of an employee. This provision conforms with the view that the foreman is a part of management and is responsible for much more than the execution of orders received from higher levels in the organization. Management believes that its effectiveness would be greatly decreased if the horizontal line separating management and men should be drawn above the foremen rather than below them.

QUESTIONS

1. To what extent has the work of the foreman been changed by the development of staff departments?
2. Why should all communications from management affecting the department first go to the foreman?
3. Should the foreman take the point of view of the workers, or should he always take the point of view of management at the risk of being regarded as an errand boy for top management?
4. Should the foreman smoke in the shop, report late to work, and join in a baseball betting pool in order that the workers may regard him as a regular fellow?
5. Before he was promoted, a foreman regularly played cards with some of the workers after work hours. Should he continue this practice after his promotion? Why?
6. Indicate which of the following practices relating to the foreman should be observed in a manufacturing enterprise:
   a) All applicants recommended for employment in a department are referred to the foreman for final approval.
   b) Planned layoffs and discharges are referred to the foreman before a final decision is made.
   c) Promotions and transfers are referred to the foreman.
   d) Wage and salary adjustments within a department are made only after recommendation by the foreman.
   e) All decisions affecting an employee in a department are transmitted by the foreman.
   f) Any worker having a complaint to make is required to take the matter up first with his foreman.
7. Should a procedure be established for the handling of complaints and grievances of foremen? What types of grievances might foremen have?
8. What reasons might a worker have for declining to accept promotion to a foreman's position? What should management do when it finds that many qualified workers decline such promotion?
9. Explain the use to the foreman of reports showing the following information:
   a) Names of employees in the department earning a bonus.
   b) Number of parts passed by the inspector and number rejected.
   c) Budget of expenses and expenses actually incurred in the department.
   d) Fall-down report, showing work in the department which is behind schedule.
   e) Production in the department this year and number of labor hours.
   f) Number of accidents in the department, their cause, nature of injury, and days lost on account of accidents.

CASES

8. SUPERVISION OF FOREMEN

The question arose in the Ramspeck Corporation concerning the continuance of the position of assistant plant superintendent. The company organization chart showed that under the president were five divisions, with a vice-president in charge of each. The major divisions were sales, manufacturing, finance, controllership, and engineering. Reporting to the vice-president in charge of manufacturing were the plant superintendent, the service manager, the chief purchasing agent, the chief inspector, and the manager of production control.

The assistant plant superintendent reported directly to the plant superintendent. His work was to supervise the activities of various foremen concerning their problems and to effect closer co-operation between the foremen and the staff departments. The plant was organized into ten manufacturing departments, with a foreman in charge of each department.

A reorganization has just been effected; and C. B. Case, the assistant plant superintendent, has been made plant superintendent. At present, the position of assistant plant superintendent is vacant. Mr. Case has recommended to the vice-president in charge of manufacturing that his former position be abolished and that he continue to deal directly with the foremen. He believes that in this way he can maintain closer personal contact with manufacturing operations and can personally motivate foremen to take greater interest in their work. He says that the position of assistant plant superintendent was originally created because of the need of foremen for guidance after rapid plant expansion. Under present conditions, he believes that the position is unnecessary.

Required:

1. Draw up an organization chart of the company to show the position of assistant plant superintendent and other positions.
2. Under what conditions is a position such as that of assistant desirable?
3. Would the abolishing of the position of assistant plant superintendent require that greater authority be given to foremen?

9. INFORMING FOREMEN OF RESPONSIBILITIES

The plant superintendent of the Hill Machine Works is concerned with the fact that foremen do not always understand the extent of their authority and the necessary limitations. He asked L. C. Kaplan, the personnel manager, what he thought would be a good method of communicating this information. Mr. Kaplan agreed to study the problem and submit a report.

Conferences with foremen on the problem of authority indicated to Mr. Kaplan that the difficulty arose from the fact that the foremen were expected to deal directly with some situations; whereas, in handling other situations, they could only make recommendations or ask for instructions. Three degrees of authority on matters affecting a department and its employees were defined. These were as follows:

In handling certain detailed matters, foremen had full authority to act without consultation with their own supervisors. In other cases, they could

act with the limitation that the foreman's supervisor should be notified of the problem and the action taken. In other cases the foreman had no authority to act; he could only make a recommendation to his supervisor.

One method of informing foremen of their authority, used by some companies, was to give each man several hours of instruction when he was promoted to the position of foreman. After his induction, he was given the opportunity to discuss new situations with his supervisor when occasion seemed to require it. Weekly meetings of foremen were held at which foremen were asked to present their problems for general discussion.

A second method was to prepare a company organization manual for the use of foremen. This manual would outline the duties and responsibilities of foremen in handling various problems and explain the policies of the company in meeting different situations.

A third method was to prepare a concise check list of all possible situations and designate by number the extent of the foreman's authority in each case. One company was known to be using a classification as follows: (1) full authority, no report required; (2) authority to act, report to the general foreman required; (3) authority limited to making a recommendation. The situations tabulated by this company are arranged under the headings of employee relations, maintenance of quality, costs and budget control, work and production schedules, and maintenance.

Mr. Kaplan recommended to the plant superintendent that he use a combination of the first and third methods. The check list would be developed by the personnel manager after full consultation with foremen, general foremen, and the plant superintendent.

Question:

What are the advantages and the limitations of each of the methods of keeping foremen informed of their responsibilities?

10. GIVING FOREMEN A COMPANY-WIDE VIEWPOINT

The American Steel Company is a large corporation with four plants located in the industrial area of Pennsylvania, Ohio, and West Virginia. The general offices of the company are located in Pittsburgh. Since the employee has little opportunity to understand the general organization of the company, he does not always appreciate the services rendered to the plant by the general offices. When an employee becomes a foreman, the company believes that special training is required to develop a management point of view.

To broaden the outlook of new foremen, the company arranges for each one to visit the Pittsburgh offices for a training program of one week. Foremen are introduced to all of the top executives. Each executive discusses with the group the duties and responsibilities of his position and his relationship to the making and selling of the product. Formal talks are followed by a question-and-answer period. The company hopes by this training program to impress upon the foremen that they have become a part of "the management team" and that they now will represent management in their dealings with workers. The plan is also intended to develop a company-wide rather than a departmental point of view.

No man is sent to Pittsburgh for the training until he has been made a foreman. The management believes that to give such training before induction would place the worker in an uncomfortable position while he works on a job awaiting an appointment.

Questions:

1. Why do foremen need the kind of training given by this company?
2. Why is the training best given at Pittsburgh rather than at the plant?

CHAPTER VII

MORALE AND THE WORKER

MORALE is the state of mind or the mental attitude of persons who are associated with some enterprise or activity. It is that "attitude which results from the mobilizing of energy, interest, and initiative in the enthusiastic pursuit of the purposes of a group."[1] The word implies a group of persons rather than a single individual. The group might include all or a part of the employees of a company.

Morale grows out of the conditions in which the members of a group live and work. It is affected by their associations with each other, by their physical surroundings, and by their relations with their supervisors. It is a condition which may be strengthened or destroyed by contacts, policies, and leadership at any level in the organization. A low morale at any level of the organization would inevitably be reflected in a low morale of the workers. Morale reaches the lower levels of the organization by seeping down from above; it does not rise from the ranks to influence the leadership.

Importance of Morale. Morale is an important force in any organization. If it is high, the members of the group will themselves desire to accomplish the group objectives. They may put group interests ahead of personal interests and may sacrifice individual desires for the sake of the common cause. In industry a low state of morale is reflected in complaints, insubordination, absenteeism, tardiness, an excessive amount of time spent in the washroom, disinterest in the job, lack of pride in workmanship, waste of materials, rejects by the inspection department, an early wash-up, horseplay, and loafing on the job. These things are not easy to combat if they are indulged in by many persons.

[1] Ordway Tead, *Human Nature and Management* (New York: McGraw-Hill Book Co., 1933), p. 173.

A person is well adjusted in his work if the satisfactions which he receives from a job are at least equal to what he expects.[2] If most of the people in an organization are well adjusted, they are contented; and their morale is likely to be high. They derive personal satisfaction from their work and have few complaints. Labor turnover is low, since separations are confined to such causes as illness, personal misfortunes, and marriages of women workers. In an organization with high morale, workers generally strive to achieve a high rate of output and to avoid interruptions in the work.

The development of morale is affected by many factors, but most of them can be grouped into five principal problems of the worker. They are pay, job security, participation in decisions affecting the work, social status, and treatment as an individual.

Pay of the Worker. Pay is one of the most important influences in the building of morale. Some executives seem to think that, if the pay is right, other things are unimportant. Other persons contend that the rate of pay is of secondary importance. Many lists of the desires of workers have been compiled; and in most such lists, pay ranks one fourth or more of the way from the top.[3] There are many difficulties in ranking the desires of workers, however, particularly if the ranking is based on the stated desires of persons questioned. If the pay is satisfactory, a person will be inclined to name other and possibly minor things first because they are uppermost in his mind at the time. Moreover, people are often irrational in their statements as to the reasons for their actions. It is also recognized that the attitude of men toward their jobs is not the same as that of women. Attitudes vary with age, color, race, marital status, and degree of skill.

Ability to earn an adequate income is necessary to good morale. Adequate income is a relative matter, and the absolute amount depends upon what the individual considers adequate. If a person prior to his employment lived in a good residential section, he is likely to be dissatisfied to work permanently on a wage which will not enable him to live in his accustomed environment. A person who comes from a family of low income might feel that the same wage is adequate. Rising living costs will cause dissatisfaction if workers are required to deny themselves the comforts which they formerly enjoyed. They

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[2] Burleigh B. Gardner and David G. Moore, *Human Relations in Industry* (Chicago: rev. ed.; Richard D. Irwin, Inc., 1950), p. 239.

[3] See, for example, list compiled by R. B. Hershey in J. Stanley Gray, *Psychology in Use* (New York: American Book Co., 1941), p. 371. Also list in Herbert Moore, *Psychology for Business and Industry* (New York: McGraw-Hill Book Co., 1939), p. 297.

are likely to complain that they are not paid enough, regardless of the wage level. A reduction in pay will cause a similar complaint.

If workers are paid on a piece-rate or bonus system, they will complain about any conditions which interfere with their ability to make their usual earnings or bonuses. Their earnings could be effected by poor planning, necessity for waiting for job assignments, inadequate or confusing instructions, intermittent employment, the use of tools or equipment which are not kept in good condition, and poor housekeeping. If the organization chart provides for too many supervisors or staff assistants, employees will complain that too much is being spent for overhead.

If the rate of pay is considered inadequate, the reason may be that some jobs are thought to be paid more than others in relation to the skill, experience, physical effort, working conditions, or other factors. Differentials in pay for similar kinds of work in different plants are likely to cause dissatisfaction, and it will usually be assumed that the higher rate is the proper one. The level of pay is usually less disturbing than that which is believed to be a discrimination.

The payment of salaries which are considered excessive has an effect upon morale similar to the effect of wage differentials. The pay of executives may be thought to be out of proportion to the pay of employees, even after allowance has been made for differences in responsibilities and other requirements of the work. The pay of various persons in the organization cannot be determined by any measure of the worth of the services rendered. The differentials result from numerous factors, including bargaining power and influence with persons higher up in the organization. The demand of labor unions that they be permitted to "look at the books" arises in part from the belief that some payments are excessive and in part from the effort to convince workers that management has been concealing something from them.

A misunderstanding of the items appearing on the financial statements may create the feeling that the product of industry is being divided in an inequitable manner. An incorrect interpretation may be made of the profit of the company, unless allowance is made for income taxes and the amount of the net worth on which the profit is earned. Employees may readily misinterpret the meaning of a large surplus, reserves of various kinds as shown on the statements, a stock split-up, a large cash balance, or the nature of the depreciation charge. A misunderstanding of such items may easily create the feeling that the earnings and the amounts paid to stockholders as dividends are excessive

While the management cannot expect to remove all of the dissatisfaction over rates of pay and earnings, it can do much to correct inequities and injustice by paying wage rates that are fair in comparison with wages paid by other companies in the area and by adjusting wage rates to the requirements of each job. It may also be able to provide steady work and income by eliminating or reducing fluctuations in employment. Worker morale may also be improved by planning the flow of work to eliminate delays in production and to permit workers to earn bonuses. Annual reports, together with explanations of the items appearing on financial statements, may help to improve morale if workers can be convinced that payments to executives and stockholders are not excessive.

Security. Much of the dissatisfaction in modern industry is due to a feeling of insecurity. The majority of executives as well as workers live in urban or suburban areas where their living expenses cannot easily be reduced during periods of decreased earnings or unemployment. Their outlays for food, medical expenses, and rent cannot be cut sharply without undue hardship; and most persons outside the higher income groups do not have substantial reserves of cash or other savings. Provision for unemployment benefits under the Social Security Act and for severance pay by the employer has lessened but not eliminated the feeling of insecurity. It remains a problem requiring the attention of management.

A question which has long been uppermost in the minds of workers is how long the job will last.[4] The older person wants protection against the younger ones, and he finds a plausible reason in the argument that his experience makes him more valuable to the employer. A desire for security of employment and of wage rates is one reason for opposition to the employment of Negroes, women, and other groups. Many workers believe in a limited membership in their trades. The usual reason is that, if the trade becomes "crowded," there will not be enough work for all. The desire for security is a reason for artificial restrictions on admission to unions and for high admission fees.[5] In some cases, unions have been virtually closed to new members. Security is also a reason for placing restrictions on the kinds of work a member of the union may do.

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[4] See Whiting Williams, *What's on the Worker's Mind* (New York: Charles Scribner's Sons, 1920).

[5] For discussion, see S. T. Williamson and Herbert Harris, *Trends in Collective Bargaining* (New York: Twentieth Century Fund, 1945), p. 95.

The policy of dropping workers in slack times in reverse order of seniority, that is, of dropping first the workers with shortest periods of service, gives the older workers some assurance of steady employment. A measure of security for other workers may be achieved by the policy of spreading the work among all employees regardless of the length of service or of giving preference to persons with dependents. Frequently, the employer would prefer to base layoffs on merit in order that he might keep the most efficient workers or those who show promise of developing into executives. In any event, employees should know what the policy is. The union contract usually makes provision for layoffs and also for rehiring when more workers are needed.

Management can relieve fears for security by informing workers of proposed changes. Rumors of changes in the design of the product, in the layout of the workplace, or in methods of setting standards will generate fear and destroy morale. Such changes are often less serious than they are reported to be by way of the grapevine and rumor factory. When a major change is contemplated, employees should be given the facts in discussion meetings and by public announcements in order that all questions may be answered and all uncertainties dispelled. For example, if the report is circulated that a new conveyor system or an assembly line is to be installed, every person immediately thinks of the way it will affect him and his job. A wise policy in such a case is to put a complete statement of the facts before foremen and workers. Each should be told just how his job will be affected. If a person is not to lose his job or to suffer a reduction in pay, he should be so informed. A diagram of the new system together with an explanation posted on the bulletin board or published in the plant magazine may assure workers that their jobs are secure and perhaps that their work will be made more pleasant.[6]

Management has many reasons for its accident prevention programs, and an important reason is their effect upon worker morale. If a person has a safe place to work, he is a better worker because he is relieved of one cause for worry and fear. The same is true of measures which are designed to provide proper work conditions, such as the elimination of dust and dirt in the air, excessive heat, excessive humidity, and contamination by chemicals or fumes. Medical and dental care and the reduction of fatigue by the installation of machines to do heavy lifting or trucking have a similar effect upon morale. Such policies

[6] See George DeVries, "Selling the New Layout," *Factory Management and Maintenance,* Vol. CIII, No. 11 (1945), pp. 116–17.

are important for their effect upon both the mental attitude and the physical comfort of the worker.

In addition to the possibilities of unemployment, accident, and illness, the worker may face the prospect of old age without adequate financial support. Old-age benefits under the Social Security Act are now compulsory, with contributions by both the employer and the employee. However, the benefits under the act are not large; and the employee faces the serious risk that the purchasing power of money may decline to such an extent that he cannot maintain himself on the payments. To be sure, large numbers of persons now employed will not live to advanced age and will therefore not be confronted with the situation which they may fear. The effect upon morale arises from the uncertainty.

Managements have been well aware of the problem of worker fear and uncertainty. They have provided many plans to aid in the development of security. Financial plans include provision for the employees to purchase stock in their company, the organization of credit unions, group insurance for death benefits, and group health and hospitalizations plans. Any plan which relieves the employee of worry and fear will make him a better and more loyal worker.

A Feeling of Belonging. Every person who is employed by an enterprise would like to feel that he is recognized as a member. He would like to believe that he has a voice in decisions as to policies which affect him. Failure of management to allow worker participation in decisions on matters clearly affecting them is usually one reason for unionization. Union members can participate in union meetings and elections; and, indirectly through the union, they can participate in the formulation of company policies at the lower levels. Individual worker participation in decisions as to policy is not easy, and it can never be active and continuous.

The willingness of management to inform workers in advance of proposed changes gives employees a feeling that they are a part of the company. They feel that management considers their wishes important and has taken their needs into consideration in the formulation of plans. If the workers can be given an opportunity to indicate their attitude toward a proposal, their feeling of participation is greatly strengthened. This procedure might be feasible in the formulation of a plan to spread the work, to change the hours for beginning and ending work for each shift, to introduce a rest period, or to serve certain kinds of food in the plant cafeteria. When time studies are being made as a preliminary to the introduction of an incentive wage system,

workers may be given an opportunity to decide where the first studies shall be made and which jobs shall be first placed on an incentive system. Volunteers are often asked to make the first studies after the plan has been explained.

Many companies follow the practice of regularly conveying information to their employees. For this purpose they use the plant magazine, letters, newspapers, public address systems, bulletin boards, discussion meetings, induction booklets, radio, motion pictures and slides and press releases.[7] The following list indicates the types of information which may be given:

- Hours
- Vacations
- Layoffs
- Seniority
- Discipline
- Suggestion systems
- History of the company
- Grievance procedures
- Job-classification methods
- Shop regulations
- Changes in union contracts
- Training opportunities
- Efforts to stabilize employment
- Chances for promotion
- Personnel records
- Company benefits to community and nation
- Activities of top management as individuals
- Economics of the industry and the company

During the decade of the 1930's, many companies began the practice of making annual reports to employees. The typical report summarizes the financial results for the year in an informal and conversational manner. It tells something about the stockholders, how many there are, how many shares each owns on the average, where the stockholders live, and how much was paid to them in dividends. In a similar vein, it tells of the directors, officers, distributors of the product, and consumers. The purpose is to show the employee that he is one of a group and that all persons in the organization make certain contributions. It is intended to convey to the employee the idea that he is participating in an important project.

Workers are inclined to be suspicious of annual reports to employees, particularly if publication is begun during a period of labor strife. If management does not become concerned about informing workers on company affairs until it is confronted with the demand of the union for higher wages, the workers are likely to conclude that the annual reports are antiwage propaganda. Many reports are ineffective because the disclosures are believed to be incomplete or inade-

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[7] "How Management in 100 Plants Gets Information to Workers," *Factory Management and Maintenance*, Vol. CIV, No. 7 (1946), pp. 114–17.

quate. The information may be discounted in advance if workers are dissatisfied with working conditions, supervision, pay, or other work factors.[8]

The proper person for the employee to approach for assistance or information is his immediate superior or boss. Therefore, much depends upon the foreman. If the foreman is inconsiderate, obstinate, or unreasonable, the approach of the worker to management is ineffective. Since top management cannot easily be made accessible to persons at the lower levels in the organization, some other channel may be necessary for airing complaints and making adjustments. Management has provided such a channel through the industrial relations department. Workers often make their own provision through a union.

Social Status. During colonial and frontier days, every member of a community had reason to feel that he was recognized as a member with a social standing. He participated in house-raising, husking bees, pea shellings, corn plantings, harvestings, wolf hunts, and other community activities. He helped others and was in turn helped by them. He was accepted as a member in town meetings or at church, and he might serve as an officer in local organizations. His status in the community was generally known and recognized. No special effort to achieve status was required. In an urban factory community, the worker must adapt himself to a new type of environment, where a different social system exists. Social status is more difficult to achieve because the group is larger and lacks the cohesiveness and the stability of the earlier rural and frontier society.

The social groups within any plant bear many resemblances to social groupings in any other society. The most marked distinction is between the workers in the shop and those in the office.[9] Workers in the office often have a feeling that their social status is superior to that of workers in the shop. This feeling is sensed by shopworkers, who may argue against it but nevertheless recognize it. Because such a difference exists, shopworkers would usually consider a transfer to the general offices to be a promotion. This is one reason why the foreman, who has come up through the shop, may be inclined to take the point of view of the

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[8] See Clinton S. Golden and Harold J. Ruttenberg, *The Dynamics of Industrial Democracy* (New York: Harper & Bros., 1942), p. 159.

[9] For discussions of social groups within the factory, see F. J. Roethlisberger, *Management and Morale* (Cambridge, Mass.: Harvard University Press, 1941); F. J. Roethlisberger and W. J. Dickson, *Management and the Worker* (Cambridge, Mass.: Harvard University Press, 1939); Gardner and Moore, *op. cit.;* Wilbert E. Moore, *Industrial Relations and the Social Order* (New York: Macmillan Co., 1946).

worker in any controversy with members of the staff departments, such as the time-study man, the inspector, or the engineer.

Minor cleavages and status levels exist within the major groups. Often, the groupings of workers have no relation to their jobs or positions with the company. Many groups are informal, without definite organization. Group solidarity may be based upon church, lodge, racial, or other relationships; and it may be the result of friendships or associations outside the plant. Informal groups of workers eat their lunches together, play games, swap jokes, and at times help each other on their jobs. They may try practical jokes on a newcomer to the department. An organization of this kind plays an important part in the functioning of plant life, even though it is not shown on the organization chart.[10] It cannot be disregarded in the building of morale and loyalty to the enterprise.

Most people desire the satisfaction of knowing that their boss and their fellow workers think well of them. Some people feel such a desire more strongly than others, and not all of them strive for the same kind of recognition. To persons outside the plant, the title of an executive may indicate his standing within the organization. Persons not having an impressive title may rely upon salary or their manner of spending money to prove to others that they have social status. Inside the plant, however, wages or salary is only one of many criteria by which the status of the individual is indicated. Acceptance by the group and the approval of the employer may be indicated in many ways.

A desire for group approval may assist or defeat the purposes of management. Frederick W. Taylor found when he became foreman at the Midvale Steel Company that the informal organization of the workers was opposed to any increase in output. Since each person desired group approval, Taylor had great difficulty in securing the co-operation of the men and in getting them to accept his idea of what constituted a fair day's work. In the studies at the Hawthorne plant of the Western Electric Company, it was found that the workers had developed standards of conduct which each person was required to observe if he was to be accepted. According to the code a worker should not do too much work, or he would be regarded as a "rate buster." If he did too little work, he was a "chiseler." If he said anything to a supervisor which might get one of his associates into

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[10] For an interesting discussion of the social nature of the industrial problem, see "The Fruitful Errors of Elton Mayo," *Fortune,* Vol. XXXIV, No. 5 (1946), pp. 181 ff.

trouble, he was an "informer." Straw bosses who acted officiously also lost favor with the group.[11]

The fact that most persons desire the esteem of their fellow workers can be used by management to strengthen the spirit of the organization. There are many symbols which are generally interpreted as an indication of the success of the recipient. Some symbols are regarded as indications that the person has been promoted to a higher level of social status or of rank within the organization. A promotion of this kind does not necessarily mean an increase in pay or a raise to a higher level in the organization chart, even though a promotion might mean both of these things. The important fact is that the symbol of rank, authority, or position in itself may be highly regarded.

The symbols of rank and authority include exemption from the requirement of punching the time clock, payment by the week rather than by the hour, receiving pay by special messenger instead of having to stand in line, possession of a special type of pass or identification, the use of a certain washroom, the inclusion of one's name in the house telephone book, the size of the desk, possession of a name plate for display on the desk, and perhaps the location of the desk or workplace in a favored position in relation to the door or windows. Any change in such symbols may be looked upon as an indication of increasing or decreasing favors by the management. The employee may consider as significant the manner in which he is greeted by the foreman, failure of the foreman to call him by name, a request by the foreman to assist in making a new employee acquainted in the shop, or an assignment to a job requiring special skill. Both the worker and his associates seek to find in the little things some clue to the way things are going.

Some companies have found that loyalty may be fostered by the use of badges, buttons, pennants, and other such symbols. For example, a worker might be given one blue chevron for perfect attendance for three months, another for perfect attendance for an additional three months, and a third for a third such period. At the end of the year, if his attendance has been perfect, a worker might be given a red chevron to replace the blue ones in addition to more substantial rewards. Shields for display in the department may be awarded for good housekeeping, the best safety record, or other accomplishments. Formal recognition may be given for a certain number of years' service. Recognition of this kind is probably significant to the worker, provided it is

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[11] Roethlisberger, *op. cit.*, p. 22.

not relied upon as the only incentive. The military and naval services have used rewards of this kind very effectively, but much depends upon the manner in which the award is made.

Treatment as an Individual. The worker has a right to expect treatment as a human being. This statement implies not only that certain things be done but also that they be done in a way that indicates recognition of the dignity and worth of the individual. Some of the standards of conduct which demonstrate a proper attitude toward subordinates are as follows:

1. The worker should be properly inducted into his job in order that he may know precisely what is expected of him.
2. The employee should have an opportunity to learn in order that he may do his best on the job.
3. Machinery for the adjustment of grievances should be provided. Legitimate grievances should be corrected.
4. Credit for good performance should be given to the person who does satisfactory work or makes constructive suggestions.
5. Each person should be informed of his progress on the job and should be commended if his record merits it.
6. A person who is discouraged or is having difficulties should be shown how to improve.
7. All displays of official authority for the sake of proving that such authority exists should be avoided.
8. Workers who are leaving should be treated as courteously as those who are being employed.

These and similar principles should be observed not only by top management but also by its representatives all along the line. To a worker, management may include a driving foreman, a grouchy gate policeman, a meticulous inspector, or a pompous clerk.

Surveys of Employee Opinion. Some companies have undertaken to make periodical surveys of employee opinion by using questionnaires. Such surveys may accomplish a great deal if they are properly conducted. The greatest difficulty lies in getting employees to express themselves and to say what they think. If they fear that their replies may be identified and that the foreman will know who criticized him, they will hesitate to speak freely. On the other hand, they may say nice things about the boss in the hope that he will hear of it.

A survey of employee opinion cannot be made if many persons are known to be dissatisfied. All known causes of dissatisfaction should be corrected, or the reasons why they cannot be corrected should be

explained. Otherwise, management will be swamped with criticisms when the reports are returned.

The questions asked in making the survey usually are concerned with those things which are closest to the worker. They have to do with supervision, attitude of the foreman, induction and training program, policy of promotions, service in the plant cafeteria, recreation and sanitary facilities, hours of work, time studies and standards, safety, and other conditions of work. An attempt should be made in formulating the questions to find out what the worker really thinks about the company and its policies. An example of an employee questionnaire is shown in Figure 8.

The questions may be prepared by a committee which includes the foreman and one or more representatives of the personnel division. The questions should be short and easily understood. Each question should deal with only one subject. The number of questions should be large enough to cover a wide variety of problems. Space should be provided after each question to permit comments, discussion, or suggestions in addition to a "yes" or "no" answer.

The employees should be prepared for the survey by a preliminary discussion of the plan at a general meeting or in some other manner. The form may be accompanied by a letter stating the purpose of the survey and giving instructions as to the method of completing and returning the form. No signatures are required, and all answers are confidential except for summaries. Guarantees should be given that no employee will find his position jeopardized by his answer.[12]

The best method of distributing the questionnaire seems to be to send them to the home, with the request that the form be filled out and returned by a certain date. Mailing to the home probably results in more complete and more worth-while answers than the plan of having them filled out at the plant on company time. Returns may be mailed in by the employee or may be dropped in a box at the entrance to the plant.

What is done with the return is just as important as the preliminary work of preparation and distribution. If many workers sign the returns, the results may be tabulated to show the attitude of men and women, young workers and old workers, workers in various depart-

[12] For discussion of the questionnaire method, see Tom N. Boggs and Louis L. Maness, "How to Conduct Employee Opinion Surveys," *Factory Management and Maintenance,* Vol. CIV, No. 3 (1946), pp. 90–94. Also "How to Find Out What Your Workers Think about You," *Factory Management and Maintenance,* Vol. CVI, No. 8 (1948), pp. 81–91.

INFORMATION PLEASE

Here's that man again! The results from our last inquiry were so successful from a standpoint of co-operativeness, sincerity, and straight-from-the-shoulder answers that we wish to come again.

1. Are you working in the department you prefer? Yes_____. No_____.
2. How do you feel about your job? Fine_____. Don't like it_____. Okay_____.
3. Are your working conditions satisfactory? Yes_____. No_____. If not, why?

_____

4. Do you feel that you are receiving a square deal? Yes_____. No_____.
5. As compared with what you might earn elsewhere doing the same kind of work, do you think your earnings are: Good_____. About average_____. Low_____.
6. Do you work on standards? Yes_____. No_____.
7. Do you think the principle of our standards system is fair? Yes_____. No_____.
8. Do you think our safety conditions on the whole are:
   Good_____. Not so good_____. Fair_____.
9. Do you think the spirit in your department is:
   Good_____. Better than average_____. Ordinary_____. Not so good_____.
10. Have you been properly instructed as to how to do your job? Yes_____. No_____.
11. Please check in each of the following groups which you think best describes your foreman: Fair at all times_____. Fair most of the time_____. Seldom fair_____.
    Knows his stuff_____. Gets by_____. Workers know more than he does_____.
    Sets a good example_____. Is a poor example_____.
12. Do you receive personal benefit from the shop meetings? Yes_____. No._____.
13. Do you know how you stand with your foreman? Yes_____. No_____.
14. Do you think top management backs your foreman? Yes_____. No._____.
    Do you think your foreman backs top management? Yes_____. No_____.
15. Do you take all your grievances to your foreman?
    Yes_____. No_____. If not, why?_____.
16. Have your grievances been taken care of to your satisfaction?
    Yes_____. No_____. If not, explain if you desire:_____.
17. What do you think of management, in general, as compared with other companies with which you are familiar?
    Above average_____. Average_____. Below average_____.
18. Have you taken any classes sponsored by the company? Yes_____. No_____.
    Have you found them: To your advantage_____. Not helpful_____.
    A waste of time_____.
19. Did you read the handbook, YOU AND YOUR COMPANY, when you started to work? Yes_____. No_____.
20. Are you getting the kind of information you want about raises, pay rates, job classes, and other company policies? Yes_____. No_____.
21. Do you eat lunch in the cafeteria? Yes_____. No_____.
    Do you regard the food as: Always good_____. Good most the time_____.
    Satisfactory_____. Unsatisfactory_____.
22. Would you like the music in the cafeteria continued during the meal hours?
    Yes_____. No_____.
23. Do you favor Sunday afternoon sports? Yes_____. No_____.
24. Do you feel that this company offers you a dependable future? Yes_____. No_____.
25. If you answered the last INFORMATION PLEASE, did you get the action you desired? Yes_____. No_____.
26. What do you think of this questionnaire?_____
27. If you were President or General Manager of this company, what changes or what new things would you do in an effort to make this plant more productive and a better place in which to work?_____

FIG. 8. An Employee Questionnaire

Used by courtesy of LeTourneau Company of Georgia. Space for comment by the employee has been reduced.

ments, or other groupings. If the attitude of a group can be established concerning any one problem, such as the piece-rate or the bonus plan, standards set by time study, or safety conditions, the management may determine that certain conditions should be corrected. If the workers do not sign the returns but indicate their departments, such classification as is possible should be made. The results of each survey should be compared with the results of earlier surveys on comparable questions. The report of each questionnaire may be summarized and made available to workers as well as to members of the management.

The principal advantage of the employee questionnaire is that it reaches all workers and gives each one an opportunity to express an opinion. It may serve to indicate whether complaints are coming from a minority or whether workers as a whole object to certain conditions. It provides an additional channel for the communication of information to the management. Its principal disadvantage is that it can be used only at infrequent intervals, such as a year or half-year. For this reason, other machinery should be provided for finding and settling worker complaints as they arise.

QUESTIONS

1. A businessman says that he does not need to be concerned about the morale of his employees because he pays wages equal to or in excess of prevailing wages in the community. If his position logical? Discuss.
2. What acts of employees may reflect a low morale?
3. What is the significance of a statement by a worker that, if the company is going to kick him around, it should pay him more money?
4. What can management do to give workers a sense of security? Does management usually attempt to offer security to all employees or to a limited number, such as those having seniority?
5. Should a worker be made to feel that he is a part of the company? If he is not afraid of losing his job, will be continue to do good work?
6. Are reports to employees which are issued only once a year of much value in maintaining employee morale?
7. The president of a large company says that his door is open at any time to any worker, however humble. Can he expect by this policy to develop an understanding of employee problems and attitudes?
8. The factory superintendent frequently makes trips through the plant. He is accompanied by the division chief and the foreman. What can he expect to learn about employee attitudes in this way?
9. What is meant by the statement that the factory is a kind of community? What is the significance of this fact?
10. How can a factory worker be made to feel that he is important? Why

should management undertake to build up a feeling of self-respect among the workers?

11. A company organizes an "Old Timers' Club" for employees with twenty or more years of service with the company. What is the value of such a club?
12. Explain the value of the following methods of determining the state of employee morale:
    a) Complaints made to the foreman.
    b) Listening to remarks made by employees concerning the company and its officers.
    c) The employee questionnaire.
    d) Interviews with employees.

CASES

11. COMPARISON OF WORKER AND COMPANY WANTS

A manufacturer recently advertised that worker and company wants are exactly the same. His argument was as follows:

The worker wants a steady job. The company wants stabilized production and steadily increasing demand for the product.

The worker wants high wages. The company also wants high wages as long as they are earned because they are proof that the company is competitive with other companies.

The worker wants an opportunity for a better job. The company needs skilled workers and trained management people who have been promoted on merit. It seeks to find men who are capable of greater and greater responsibilities.

The worker wants comfortable, safe working conditions. The company also wants comfortable, safe working conditions in order that it may get good workmen and because it wants decent things for decent people.

The worker wants lower prices for what he buys. The company wants lower prices because a company can hope to stay in business and to grow only by providing better and better products at lower and lower prices.

Questions:

1. To what extent are worker and company wants the same?
2. To what extent are worker and company wants in conflict?

12. OBSERVANCE OF BIRTHDAY ANNIVERSARIES

At the Reed Corporation the established practice of the personnel department has been to send a birthday card to each of its four hundred employees on the date of his birthday anniversary. The assistant personnel manager believes that this method of recognizing the employee is ineffective and is largely a waste of money. He proposes to the personnel manager that on one day each week, all employees whose birthday anniversaries occur during the week be invited to lunch together in the plant cafeteria at company expense. A special table would

be provided, and a representative of the personnel department would meet with them at the luncheon. This plan, he believes, would afford recognition to the employee without too much fanfare.

Required:

Criticize the proposal favorably or unfavorably.

PART III

Equipment and Working Conditions

CHAPTER VIII

PLANT LOCATION

QUESTIONS of physical facilities should be considered by management along with the problems of organization, leadership, and morale. Management works with both people and properties. Questions of physical facilities pertain to the location of the plant, provisions for the building, layout of workplaces, planning for machines and equipment, and improvements in working conditions, such as air conditioning, lighting, and noise abatement. The first such problem to be considered is that of plant location.

The decision to establish a new enterprise or a new industry usually follows the development of a new idea for a product or a service to consumers. The inventor designs the product and estimates the volume he can make and sell at a profit. He selects equipment necessary for its production and plans the layout for a plant. He then leases, buys, or constructs a building suitable for housing the equipment.

In the execution of the plans, the finding of a suitable location is one of the first things to be done. Formerly, the plant was often located in the area in which the inventor or promoter lived. This fact may indicate that the promoter found it convenient to locate near his own home. It might also indicate that he did not thoroughly survey the possibilities elsewhere. In many cases, no doubt, the enterprise was originally thought of as serving a local rather than a regional or national market. The plants of large corporations are now located only after all possibilities have been carefully studied.

The first phase of the problem of plant location is the selection of the general area, such as the Great Lakes region, New England, or the Atlantic coastal strip. The second phase is the selection of the particular city or suburban area. The third phase is the choice of the exact plant site within the area. These three phases are not independent but

are indicated merely for clarity in discussion. A somewhat different problem is the choice of a location in a large city, a small town, a suburb, a community in which a single industry predominates, or a town built by the company.

Factors Influencing Location. In some industries the plant should be near markets, while in other industries it should be near the source of raw material. It is therefore not possible to list the factors in their relative importance except with reference to some one industry. Even a classification of factors as major or minor may depend in part upon the industry in question. The factors in plant location are as follows:

Nearness to market.
Nearness to raw materials.
Transportation facilities and costs, including private trackage.
Labor supply.
Power and fuel.
Vulnerability to air attack in wartime.
Cost of land and availability of good sites.
Water supply.
Waste disposal.
Building costs.
Service industries.
Industries which complement others by using their scrap or by-products.
Climate.
Financial aids.
Recreational, religious, educational, and other civic values.
Momentum of an early start.

Each of these factors is considered in the following pages.

Nearness to Market. Markets may be nationwide or local. If markets are nationwide, production may be centralized in one or several plants; or production may be decentralized in many plants near the consumer. Industries in which production may be centralized, even though distribution is national, are watches, clocks, jewelry, fountain pens, books, magazines, and radios. In all these industries the product is relatively light in weight, and labor is an important percentage of the cost. Goods produced locally include cement, brick, cheap furniture, bakery products, and some metal products.

Some processing plants increase the bulk of products or make a fragile or perishable product. Such industries profit by being near the consumer. Examples are cheap furniture, bakery products, barrels, tin cans, coffins and caskets, stoves and ranges, and cheap pottery. Industries in which the fashion element is important find it necessary to locate near the centers where fashions originate, even though the product is sold nationally. An example is the clothing industry, which

is centered around New York City. In recent years, Hollywood has become important as both a creator of fashions and a center for the manufacture of women's apparel.

Industries which produce goods in accordance with the specifications of consumers may profit by locating near the market. Examples are custom-made clothing, draperies, and tombstones. However, it may be more profitable to concentrate production in a large, centrally located plant and forward to it the specifications of the customer. This method is followed by some manufacturers of ventian blinds and men's suits.

Location in relation to the market is sometimes interpreted to mean that the plant should be near the center of population of the United States, as established by the Bureau of the Census. This is not necessarily the case, however, for the market may not be nationwide. It may be local, or the customers may constitute a relatively small part of the population. Nearness does not necessarily mean distance in miles. Cost and the time required to get the product to customers are more important than distance. A manufacturer who ships by parcel post or truck would have a different problem from one who ships by freight, since costs of shipping by truck or parcel post increase more in proportion to distance than do freight rates. Some companies have found it profitable to locate plants in the Far West to take advantage of the increased buying power of that area. A substantial part of the sportswear is now made in California. The production of work clothes and shoes has been shifted in part to Missouri in order to be nearer the market area, although other factors have influenced the trend.

Nearness to Raw Materials. Nearness to the place where materials are produced is a controlling factor where the materials are perishable, bulky, or low in value and are changed by the manufacturing process to a less perishable or less bulky product. Examples of industries that make the product less perishable are fish and oyster processing, fish canning, fruit and vegetable canning, and plants for the quick freezing of food. Industries that make the product less bulky are meat packing, lumbering, and ore refining. In these industries, nearness to raw materials is the most important factor. The materials may be carried through the first manufacturing process near the source and transshipped for further processing near the consumer. Lumber and metals are examples.

For some companies, nearness to the source of raw materials means nearness to the fabricating plant which supplies finished parts. Although the parts may not be perishable and are easily shipped, near-

ness to the source of supplies is an advantage in reducing the time required in shipping the parts, in permitting the purchaser to confer with the vendor as to prices and specifications, and possibly in permitting deliveries to be made by truck.

Transportation Facilities and Costs. Transportation in terms of costs and time is very important. This factor is closely related to both nearness to market and nearness to raw materials. One reason for the location of steelworks at Sparrows Point (Baltimore), Gary, and Birmingham is that heavy materials can be delivered to the plant at low cost. Another consideration is that large consuming areas are near the plant. The privilege of milling in transit, extended by the railway companies, has been an important reason for the location of flour mills at Minneapolis and some other cities in the Middle West. Grain is unloaded, milled, and shipped as flour to points farther east. The freight rate charged is the through rate for flour plus a charge for setting off cars loaded with grain and picking up cars loaded with flour. No back hauls are permitted when the grain is milled in transit. To a limited extent, fabrication in transit is used in the processing of steel and lumber.

The place where material is transferred from one method of transportation to another is frequently a good place for the location of a processing plant. For example, sugar refineries are located at San Francisco, New Orleans, Philadelphia, Baltimore, New York, and Boston. Raw sugar and fuel may be brought in by water at a low cost. For the same reason, oil refineries are located in New Jersey and other coastal areas. Crude oil is transported to the Texas seaboard in pipe lines and transshipped to the refinery by tanker. The point where a railroad crosses a river or connects with lake or ocean transportation is frequently a good location. Although modern highways and truck transportation have altered the advantages of many locations, water and rail transportation retain substantial advantages for moving heavy, bulky products.

Transportation costs are less important in the location of factories for the manufacture of such commodities as silver, jewelry, clocks, watches, locks, and cutlery because the cost of transporting the material is a small percentage of the total cost. Moreover, freight charges do not increase in proportion to distance shipped. The railroads have built up a complicated freight-rate structure with many broad zones in which rates do not increase.

Local transportation facilities are important for securing workers and executives. The value of a suburban or small-town location is

increased by the existence of adequate interurban and highway connections with nearby residential areas and with cities that afford shopping, theater, and other attractions. Local transportation conditions, however, may change within a relatively short period of time.

Labor Conditions. The number of workers and the particular crafts or skills needed should be considered in relation to the labor available in an area. Some factories employ young people or unskilled labor, while others use highly skilled or semiskilled workers. A factory which uses low-paid labor should be located near the workers. Highly paid workers, on the other hand, can be induced to travel a greater distance. This factor affects the choice of a city or suburban location.

Labor cost is affected by the efficiency of labor, the number of unemployed workers in an area, the extent of unionization, the level of wages, the cost of living, and the housing conditions. A larger percentage of native-born labor is available in some sections of the country than in others. Some sections of the country have a record of harmonious relations with labor, and others have a record of industrial strife. In some areas, manufacturers have trained a supply of local labor in the skills required in a number of industries, such as metalworking or woodworking.

Whether other industries in an area have seasonal demands for labor which coincide or dovetail with the labor requirements of the projected plant is another important question. Management will have lower labor costs and less labor strife if it can complement other industries in the area rather than compete with them. For example, a shirt manufacturer located three plants in northern Minnesota, where the wives and daughters from the families of miners may be employed. Labor supply was an important factor in determining the location, although other factors, such as the availability of buildings for lease at low rental, were also considered.

Power and Fuel. Although fuel and power are important costs to factories requiring a great deal of power, this factor is of decreasing importance. Electrical power costs have been decreasing because of the development of more economical methods of generation and transmission. The development of cheap electric power has been a significant cause of the decentralization of industry throughout the United States instead of the former centralization in relatively limited areas. The dependability of the power supply is exceedingly important for some industries, particularly those which process perishable materials. Such companies find an alternative source of power a decided advantage.

Vulnerability to Air Attack. Since the beginning of World War II,

many companies have located new plants with reference to possible bombing by the enemy. In making loans for the financing of new construction, the government has specified that, so far as possible, new plants should be built west of the Allegheny Mountains. Another consideration has been a desire to avoid overtaxing the transportation facilities in eastern states and to avoid making new demands upon the labor markets in those areas. With the increase in the range of bombing planes during and since the war, it may be impossible to get beyond range; but as long as war looms as a possibility, this will be a major consideration. The solution may be a wide dispersion of facilities, with many factories located in small cities or towns. Underground factories, as the Germans proved, are another possibility.

The Cost of Land and Availability of Good Sites. Cost of land is not usually important unless a city location is contemplated. The cost of land is an important factor in choosing between a city location and one in a town or suburb. Suitable land is limited along some water or lake fronts, and a lack of adequate space may force the company to choose a multistory building when other considerations indicate that a single-story building would be more desirable. Many companies require space for parking facilities, adequate light and air, and protection against undesirable neighbors. A location should not be selected merely because land or a building is for sale at what appears to be an attractive price. Location is not easily changed, and a poor location may burden a company permanently with heavy fixed charges.

Water Supply. Many modern industries generate large amounts of heat and use water for cooling as well as for other purposes. In some sections of the country, a shortage of water threatens to limit industrial development. Possible impurities in the water should also be considered, although this factor has decreased in importance because of improved methods of softening and purifying water in large quantities. Most states have passed laws to prevent the pollution of their streams; but the possibility of pollution by steel mills, soap factories, and other plants should not be overlooked. Chemical tests of water may not be dependable unless several tests are made at different times, for the composition of water in streams varies with flood or low-water condition and high or low tide. Some companies purify the water when it is removed from a river for use and purify it again before it is emptied back into the river.

Waste Disposal. Ore-processing plants, steel mills, and chemical plants must dispose of large quantities of waste. They may be prevented by state law from dumping waste into streams and by local

ordinances from piling it on land within the city. Some cities have provided public facilities for the disposal of waste from factory processes.

Building Costs. The costs of building construction do not vary sufficiently from one area to another to require much consideration. Costs are affected by local building codes regulating the width of streets, the height of buildings, the building line, and various features of construction. Such regulations are usually advantageous because they reduce the hazard of a conflagration and thereby affect fire insurance rates. Usually, a company is not fully protected against the losses incident to a fire even though it has adequate property insurance.

Service Industries. Industries which serve others tend to locate near the plants which they serve. Some companies purchase gas, repair services, repair parts, legal advice, income and accounting services, engineering services, statistical services, advertising, and management services such as might be rendered by consultants in management. A new company usually purchases many services which it provides for itself after it has become established. A newly organized company could profit by a location which is accessible to service industries.

Industries Which Use the By-products of Others. Steel companies in Detroit use scrap metal from automobile and other metalworking plants in the area. Toy manufacturers use scrap metal in the manufacture of toy airplanes and automobiles. Many articles are made as by-products of meat packing. Gas is a by-product of coke. The manufacturer of the main product may himself utilize the scrap in making a by-product, and in that case he must consider the question of the most profitable location of the by-product processing plant. This is a special phase of the problem of nearness to the source of materials.

Climate. Climate is usually not a deciding factor, although workers are presumed to do better work in some climates than in others. Extremely cold, hot, rainy, or dry climates are not desirable. The most important question is whether workers, foremen, and executives and their families would object to living in an area. Air conditioning within the plant may make it possible to provide good working conditions even in a location with poor climate, but complete air conditioning is expensive. However, industries which require controlled air conditions for manufacture of the product, such as humidity in textile mills, temperature in candy factories, or dust removal in fine manufacturing, cannot usually rely upon natural air conditions in any area.

Financial Aids. Some cities grant tax exemption for a number of years or donate land in return for an obligation to maintain a minimum

labor payroll for a stated number of years, or civic groups may sell stock if a plant is located in the city. A corporation should look at the "gift horse" before accepting it. The aid rendered may be more than offset by disadvantages in other respects.

Civic Values. Numerous features of community and civic life contribute to the desirability of the city or town as a place for employees to live. If the city provides many services for its residents, the worker and his family may receive benefits which are properly a part of his real wage. These include public health services; public playgrounds; public schools, including night schools for adult education; museums; band concerts; sewage and garbage disposal; hospitals; police and fire protection; and charitable organizations. Facilities for paid amusement, transportation services, shopping centers of various kinds, and the character of residential districts are other community factors. As the population of an area increases, many such services may later be provided by the city, by civic organizations, or by the company itself. In the meantime, some difficulty must be expected in maintaining a satisfactory labor force if the services are inadequate.

The company that moves into an area with a new plant should consider not only the facilities available but also the demands that the company and its employees will make upon such community services as schools, libraries, hospitals, housing, parking, traffic control, parks, and other facilities for recreation. The company may be required to assist in the development of such services either because of business necessities or because of a sense of obligation to the community. The maintenance of good employee and community relations requires attention to these problems.

Momentum of an Early Start. As an explanation of the present location of manufacturing plants within the United States, the establishment of an industry in an area should be listed as a major factor. Many industrial areas owe their prominence to chance development or to a source of raw materials, power, or labor supply at an earlier period. Once a city or area becomes established, it may acquire good will or market advantages. The losses which established firms would sustain in moving to a new and better location act as a strong deterrent to relocation.

The railroads have helped to maintain existing plant locations because they would lose by any changes. Much merchandise is shipped on commodity rates which aid industries located adjacent to the railroad. Such rates are subject to control by the Interstate Commerce

Commission, but the Commission is unwilling to order changes in rates which would force the relocation of industry.

Suburban Location. The tendency in recent years toward suburban locations has been hastened by improved transportation, particularly the private automobile and the bus, which have made it possible for workers to reach their work easily and quickly. Workers who live in the suburb in order to be close to their jobs have the advantages which result from being near a city. The lower price of land in the suburbs makes possible the one-story industrial plant with its many economies. Space may be provided for parking facilities and also for possible future expansion. Workers who live near the plant may have more living space. The suburb, in fact, combines many of the advantages of the city with those of the small town. However, the advantages may prove to be temporary. The suburb may in time become a part of the urban area with its congestion and other problems.

Decentralization. The plan of operating several plants in different locations instead of operating a single large plant is called *decentralization.* This plan assumes several forms. In some cases, certain parts and subassemblies may be manufactured in feeder plants located a short distance away from the assembly plant. The parts can be shipped to the assembly plant by truck within a few hours or possibly by an overnight trip. Instead of requiring workers to travel considerable distances to the plant, a part of the plant is moved to the workers. This plan is followed by the Sylvania Electric Products Company. In the case of bulky products such as automobiles and electrical appliances, the assembly plants may be located at considerable distances from plants making parts or accessories. Another form of decentralization is the setting-up of a complete production line in each of the plants located in different areas. This plan is feasible for a bakery, a shoe company, a textile mill, or a fruit-canning company. With this form of decentralization, the plants may be located in distant sections of the country.

Another form of decentralization provides for specialization between plants, with certain products being manufactured in each plant. Examples are food-processing companies and companies manufacturing a variety of products, such as chemicals, paints, and salad dressing.

Decentralization is designed to improve labor relations. There are many advantages to workers in living in a small city or town. Some costs of living, such as rent and transportation, are less; the same money wages mean higher real wages; and younger members of the

family may live at home while they work. In small cities, workers may own their homes and also have an opportunity to do gardening, fishing, and other odd jobs in their spare time. The workers are more likely to know each other personally, and their relations with their foreman are often personal and informal. A community atmosphere is established inside as well as outside the plant. From the point of view of the company, the people in small cities and towns who apply for work are usually very good workers. The high-school graduate in small communities is usually anxious to do a good job. He is more inclined to stay with the company, provided that he is given an opportunity to advance. Absenteeism is also less in small towns.[1]

Another advantage of decentralization is that it permits the placing of greater responsibility upon local management. In a single large plant, one manager undertakes to direct the entire operation through a line organization of division chiefs, general foremen, and foremen, together with staff assistants. When production is carried on through several small plants, local managers are given authority to manage a smaller part of the production facilities and personnel. Responsibility for local plant management provides for the training of men who may later be advanced to higher positions within the company.

The small-town location has limitations as well as advantages. Workers are not skilled in factory work and may be inefficient until they have been trained. Many of the people object to working in factories because it is confining indoor work. The community is often lacking in fire and police protection, which the company may be required to supply for itself. Whether these limitations are offset by the advantages will depend upon the nature and size of the factory and the individual city.

From the managerial point of view, decentralization presents a number of problems. Since local plant managers are given greater responsibility, much depends upon the ability of top management to select and develop good local managers. More attention must be devoted to problems of planning and scheduling production. Such problems are particularly difficult when parts are manufactured in a number of local plants and assembled in another plant. Communication between local plants and the central office becomes more difficult because greater reliance must be placed upon such methods as telephone, teletype, and the mails, with less opportunity for personal

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[1] Lewis K. Urghart, "Sylvania—A Case Study in Decentralization," *Factory Management and Maintenance*, Vol. CIII, No. 10 (1945), pp. 104–10.

consultation on day-to-day problems. Officials from the central office are required to spend time and money visiting local plants and advising with local managements. Decentralization also gives rise to greater complexity in the managerial organization because such functions as personnel, engineering, cost control, and production planning must be centralized in the main office, while the functions are managed locally at each plant by persons under the line control of the plant superintendent. This arrangement not only increases the difficulties of management but also adds to the cost.

The Company Town. In the chocolate, mining, textile, and some other manufacturing industries, corporations have found it desirable to build towns as well as plants. Such towns provide homes, stores, recreation facilities, and power and water services for the employees.

The company town has several advantages. It can be built in accordance with a plan for the entire community, including the residential areas, stores, places for recreation and amusement, and other services. The plant can be built in any location without regard to the willingness of real estate developers to provide housing facilities or the ability of employees to finance them. If the company provides the only available employment in the community, the risk involved in private construction of homes might be prohibitive. The company town can be established near the source of mineral deposits or with due regard to water supply, power, or other services. The company town also enables the company to profit by any increase in land values which may result from the growth of a city on undeveloped or partially developed land sites.

Most corporate managements seem to believe that company towns are not desirable for ordinary manufacturing enterprises. The company-owned town increases the capital required for the enterprise, and it requires that a larger percentage of the capital be invested in fixed assets. New problems of organization and management are created by the entrance of the company into real estate and town management. The development of a competent, dependable, and loyal labor force becomes more difficult when employees live constantly under the shadow of the company whether they are at work, at home, or in places of recreation. Both the living and the working environment are subject to a measure of control by the employer. The situation is particularly objectionable if poor living conditions are provided or if the houses all follow the same pattern. The company is also placed in a disadvantageous position when labor troubles arise. If the company requires striking employees who are unable to pay their rent to vacate

company houses, public opinion and employee attitudes are adversely affected. If it permits striking employees to live in the houses without paying rent and to buy at company stores on credit, it is financing the strike against itself.

Choosing a Location. Because of the large number of factors influencing the location of a plant, a person who is assigned the problem of finding the most desirable location might have considerable difficulty in making a choice of the available sites; and a possible procedure will be suggested. In the following discussion, it is assumed that the company already has one or more plants in operation.

Before any sites are surveyed, it would usually be desirable to collect certain basic data concerning the company and its production program. To aid in the selection of the general area, the engineer would need to know if market areas can be economically served by the present plants, whether transportation costs to some areas are preventing the realization of full sales potentials, and whether delays in deliveries are interfering with prompt and satisfactory services to customers. Data on sales in certain areas in comparison with possible sales might suggest that a branch plant can profitably be located in a certain territory. The decision might depend upon the extent of competition in the area as indicated by the location of plants of competitors.

The engineer would also need to collect certain data concerning types of manufacturing operations to be performed. For example, if the new plant is to make certain parts for final assembly in another plant, the new location should be chosen with reference to the location of the assembly plant. If the company makes more than one product, the engineer would need to know which varieties will be made at the new plant. He would also need to know the size of the plant necessary to the production of a sufficient volume to meet the contemplated sales quota, the space necessary for storage of materials and finished product, and possible plans for future expansion. This information would be necessary to determine the size of the new site, the desirable contour of the land, and the transportation facilities required.

Another factor in the initial planning is the intention of the company to rent an existing building or to construct a new plant. Greater freedom of choice is permitted if the company plans to build. However, management may delay the decision to buy, rent, or build until the survey of possible sites has been completed.

The study of plant sites in an area may begin with correspondence or personal interviews with officials of local chambers of commerce, or

the first approach may be made to an Area Development Division of the Office of Domestic Commerce of the United States Department of Commerce. Either source can supply a substantial amount of basic information concerning the available public services, labor supply, and other factors in the location. Either agency can assist the engineer in meeting public utility executives, real estate companies specializing in industrial sites, bank executives, officials of railway and trucking companies, and other persons who can provide information. Most state governments maintain research agencies that collect information pertaining to such factors as natural resources, transportation, labor supply, and public utility services in various parts of the state.

The information collected by the person who makes the survey may include a questionnaire filled out by himself in personal conferences with various persons who are in a position to supply information. He could get additional information from road maps showing street and highway connections, maps of railway and steamship connections, aerial photographs, contour maps, and reports of personal inspection of properties. The questionnaire consists of detailed questions covering all of the points on which information is desired. The questions should be carefully prepared in advance of each interview in order that no pertinent data will be omitted. The answers to the questions concerning any one site may be obtained from several persons and miscellaneous sources. If there is any problem of waste disposal, fumes, contamination of streams, or other menace or nuisance, the company should first plan to control them and then confer with local or state officials concerning its program.

After the information has been collected, it may be summarized to show the required capital outlay for each of a few selected sites. This summary would show the costs of land, improvements to the land for grading and landscaping, building, equipment, and other facilities. These outlays are initial costs and are largely nonrecurring. Another statement may be prepared to show the estimated cost of producing a given number of units of product at each location. The statement would indicate the costs of materials and labor and expenses for fuel, power, indirect labor, property taxes, corporate expenses, and various other manufacturing and general expenses. These costs are recurring in nature.

The estimate of costs is not entirely satisfactory because unit costs vary with the volume of production. This form of statement could not be used satisfactorily by a company producing a variety of products. In many cases an estimated statement of profit and loss is preferable.

This statement shows for each contemplated location the estimated sales, the estimated costs of production, and the estimated selling and administrative expenses. State and federal income taxes are computed to determine the net balance available for stockholders and for reinvestment.

Several difficulties arise in the preparation of an estimated statement of profit and loss. First, many variables cannot be accurately evaluated. Although the statements are valuable estimates, they should not be regarded as conclusive. Second, the results of operations will not be uniform from one year to another. Extra expenses will be incurred during the first year in setting up the organization and building up the labor force. These problems will be much the same in any location. Third, results even after the business has been established will vary from one year to another with the varying phases of prosperity and depression. This problem can be met in part by assuming varying rates of output in each location.

Probably the most serious difficulty in connection with estimates of costs and expenses at various locations arises from the effects of changes that may not be foreseen. The location of a large new plant in an area will in itself affect labor, housing, and other conditions. In time the development of new transportation facilities may alter the relative advantages of different locations. During the last 150 years, for example, some locations have gained and others have declined in importance with the development, first, of canals and, later, of railroads and highways. Cheaper and more rapid means of transportation have been made available. The invention of steamboats was followed by steam locomotives, automobiles and trucks, airplanes, and Diesel locomotives. Industries locating in New England to take advantage of moist climate, water power, and an efficient labor supply have seen their advantages disappear with the invention of moisture-control systems of air conditioning, the building of flood-control and electric-power projects in the South and West, and the development of labor markets in other areas. Companies building or acquiring plants near the source of raw materials have later found their locations to be disadvantageous as mineral deposits and timber resources have neared exhaustion and new deposits of minerals were discovered and new timberlands were developed in other areas. Plants locating in the East to be near the market have lost their advantage in this respect as the center of population has moved westward. Such illustrations could be continued indefinitely. They indicate the necessity for supplementing

any cost studies with a general economic analysis in an effort to ascertain or forecast the trend.

QUESTIONS

1. Show how plant location is affected by each of the following related problems:
   a) Decision to build a single-story building rather than a multistory building.
   b) Decision to purchase many parts required for the assembly of the product rather than manufacture them.
   c) Decision to start production on a small scale until customer acceptance of the product can be determined. When a demand for the product has been developed, production facilities will be expanded.
   d) Decision to organize the business as a partnership with three partners until the business has been established. Later a corporation may be organized, and stock in the company may be offered to the public.
2. What factors have influenced the location of the following industries in the United States: steel, shipbuilding, publishing of books, sugar refining, fruit canning, meat packing, watch and clock manufacturing, dress designing and manufacturing, and automobile manufacturing?
3. Indicate a principal type of business or industry which you would expect to find in the following cities, giving your reasons in each case: Washington, D.C.; Reno, Nevada; Baltimore, Maryland; Los Angeles, California; Detroit, Michigan; a small city in northern Indiana; a small city in eastern Maryland; a small city in Georgia.
4. Can the effects of the destructiveness of modern weapons of war be avoided through a policy of plant location or the construction of underground factories?
5. Should civic values be considered in choosing the location for a plant? May such facilities be provided by the employer or by commercial enterprises when they are needed?
6. How does the momentum of an early start for an industry in a locality affect plant location in a later period? What are the advantages to a company in locating in a community where the industry is already established? Are there any disadvantages?
7. Under what circumstances would a company be justified in locating a plant in an undeveloped area and building a town about the plant for the accommodation of employees?
8. Why should cities and states seek to attract plants to the area? Who benefits when new plants are built in a city? Does anyone lose when a city grows in this way?
9. If a plant is located in a small town because of favorable labor conditions, should the plant manager work through his local chamber of commerce to persuade other corporations to locate plants in the same town?

CASES

13. LOCATION OF A CARPET MILL

When a large carpet manufacturing company sought a suitable site for a new mill, it established a set of basic requirements for the new location. The first requirement was that the mill be convenient to railway transportation because both the raw materials and the finished carpets are heavy and require transportation by rail. A second requirement was that the mill be near a river into which waste could be dumped. While the company intended to treat the waste and to render it innocuous, a river seemed to provide the cheapest and easiest means of waste disposal.

Another basic requirement was an efficient and dependable labor force. The management believed that a rural community or a small town afforded the best chance for development of good workers. Previous factory experience of applicants was not considered necessary because the company would transfer the managerial force and a few skilled workers from its existing plants. Workers should be willing to accept factory jobs and should not insist upon office work.

A highway system connecting with the plant was important in order that workers might not be required to live adjacent to the plant. The company was anxious to avoid any possible charge that it was fostering a slum area.

Nearness to market was not a primary requirement, although it was considered important that the plant be located in the eastern part of the United States where there would be easy access to the large cities of the northeast. Location in this area was also important because the carpets were made of imported wool.

The local area should be fairly level to permit the construction of a plant, railway sidings, loading platforms, and parking lots. The elevation should be sufficient to assure that the building site would not be subject to overflow in time of high water.

After the basic requirements were determined, the company began its study of possible locations by scrutinizing maps. It compiled a list of all the places in the eastern half of the country where railroads crossed rivers. It found about one hundred such places. By a process of eliminatoin, it found that only a few of the places met the other requirements. A few locations were then visited, and investigations were continued at possible plant sites. The company had no difficulty in finding one site that met all basic requirements.

Required:

Evaluate the procedure followed by the company in selecting a location for the new plant.

14. CHANGE IN PLANT LOCATION

In 1923 the Arabian Coffee Company established a plant in Los Angeles, California. In 1950 the company decided to move to the East San Francisco Bay area, and a site was selected at San Leandro. This location was chosen because of the facilities for ocean shipping at the nearby port of Oakland, the highway and railway facilities, the availability of an undeveloped plant site,

the central location in the market area, and the availability of housing facilities.

At the Los Angeles plant the company had four production lines for coffee. Because of the emphasis upon freshness as a quality of good coffee, the company was unable to build up an inventory to supply customers during the period when machines and equipment were down for moving. It was therefore decided to move one line at a time and to keep three lines continuously in production. With some overtime the company would be able to keep customers supplied and thus retain the market.

As the building in San Leandro neared completion, the chief engineer drew up a time schedule for moving. The location of each machine in the new building was planned, and the exact position was marked on the floor. Each machine was numbered, and the corresponding number was used to identify the location in the new building. As soon as one line was set up and placed in production, the next line was moved according to schedule.

Employees and members of the management at Los Angeles were given the opportunity of moving and retaining their positions. The company agreed to pay each employee $300 to meet moving expenses, and it also agreed to pay the additional living costs while the employee was finding a place to live. Wherever possible, the company granted leave with pay for two days to those employees who wished to visit San Leandro prior to moving to look for a place to live. Sixty-five per cent of the employees accepted the offer to move with the plant. The high percentage was due in large part to the fact that the production lines were largely automatic and that most of the people held specialized positions at good salaries.

Each employee was told when his line would be moved. As soon as a line was taken out of production, employees on that line who were not making the change were shifted to other lines; and enough employees from other lines who wanted to move were transferred to the new plant to fill the positions. With new recruits at San Leandro, three lines were kept fully manned. To prevent premature quitting of employees not making the change, a bonus was paid each person for continuing work as long as his services were required.

Questions:

1. What costs are involved in moving a plant?
2. Under what circumstances is a company justified in making such a change?
3. What steps did the company take to reduce the costs?

CHAPTER IX

BUILDING

THE building is an expensive and important part of the equipment of an enterprise. Its significance to management results from both its long life and its large cost. The annual depreciation charge is a fixed expense for the life of the building. Other building expenses are taxes, insurance, repairs and maintenance, heating, lighting, and possibly ventilation. If the annual returns or benefits to the enterprise throughout its life are not commensurate with the fixed charges to which it gives rise, the company may be unable to realize a satisfactory return from its investment. The building should be regarded as a part of the equipment for production, and its cost should be considered in relation to its adaptation to the operations housed within it. By a pleasing external and internal appearance, the building may make a significant contribution to good employee and public relations.

Some companies continue to use buildings that are inefficient and unattractive. In some cases the buildings were originally designed for other purposes and are not suited for present operations because of size, number of stories, poor facilities for employees, obsolete heating and lighting systems, or other reasons. Some enterprises use poorly adapted buildings because the plants were offered for sale or lease at low prices by other companies that had been liquidated or had found the building unsuited for their purposes. If a location within a certain urban area appears desirable, a company may be required to choose between a few buildings, none of which are especially suited to its needs. If a building is available at low initial cost, it may be chosen despite certain disadvantages in operations.

The Decision to Rent or to Build. Many enterprises begin operations in rented properties. This arrangement may be necessary because of the uncertainties of the life of the enterprise. Until the owners can

be sure that the product can be marketed at a price which will yield a profit, they would usually face too great a risk in immediately acquiring a building. If the future of the business appears to be uncertain, management might rent or lease a building or a part of a building for a limited time until the enterprise has passed through the experimental stage and a market for the product has been developed. Another possibility would be to contract for the manufacture of the product by an established company, or to contract for the manufacture of all or almost all of the parts. If this plan is followed, the cost of the product may be reduced by the use of standard parts that are generally available. If all of the parts are purchased, the company promoting the sale would require only a limited space because it would perform only the final assembly operations.

The chief risk arising from the ownership of a building is that it results in the freezing of a substantial part of the assets of the enterprise. Money put into a building can be recovered only through the annual depreciation charge over a period of years or through the sale of the property itself. For this reason a company should not build unless the greater part of the necessary cash is available. If more than half of the cost of the new building and the new plant site must be borrowed, it is probably better to continue to rent. Borrowing creates a charge for interest in addition to the expenses of maintaining the building.

The proposal for building construction usually arises because the existing facilities appear to be inadequate. When the management is confronted with this situation, it should first inquire into the possibilities of improving the layout, eliminating delays in production, and utilizing available space more effectively. Sometimes, discontinuing the manufacture of some types of products which do not pay their way may result in savings which make large facilities unnecessary. A reduction in the amount of space devoted to storage facilities may also release the additional room required in manufacture. If these rearrangements and economies are inadequate, it may be advisable to consult the owner of the leased properties concerning possible additions and expansion. The possibility of leasing additional space should also be considered before a decision to build is finally reached.

The management should next inquire into the sales possibilities for the products of the company, including any new products which are contemplated, during the period immediately ahead and also for the next five or ten years. Present increased demand may prove to be temporary, or competitors may be preparing to increase their output

to supply the market. During periods of business prosperity, demand is often illusory because of overordering and the placing of duplicate orders by customers. The effect of a decreased demand during periods of depression or business recession should also be considered. Some authorities contend that expansion of plant facilities should not be made unless the enterprise can break even on the production and sale of 50 per cent of the normal output.[1] Before any commitments are made, it would be well for management to know where the break-even point is, that is, at what volume of production the company neither loses nor makes money. This point will vary with changes in the selling price of the product and changes in the cost of labor, materials, and supplies; but losses due to gross miscalculations may be avoided by attention to this phase of the problem.

The decision to build may depend upon the availability of steel, plumbing, and other materials and the allotment of such materials that may be obtained from vendors and agencies of the government. Restrictions were placed upon the use of many materials during World War II, and they were again imposed during the period of increased production for defense following the outbreak of hostilities in Korea in 1950. The trend toward increased governmental restrictions cannot be ignored in formulating building plans.

If the demand for the product appears permanent and fairly stable, and if the new building can be safely financed, plant ownership will relieve the company of the fixed rental charge, which may result in a net saving. The plant increases the assets of the company; and after it has been paid for, the financial ratios as indicated by the figures on the balance sheet are improved, and the financial standing is bettered. The company may also have greater freedom to make alterations and improvements in a plant that it owns, and the initial construction may provide a more modern plant that is adapted to the particular requirements of the enterprise. A further advantage is that the employees may feel more secure in their jobs if they know that the company owns its building instead of leasing it. Plant ownership creates a feeling of security and permanence and thus improves morale.

The Time to Build. Most building construction is carried on in times of industrial prosperity. During boom times, when existing plant facilities are being used to capacity, the need for additional space seems very pressing. However, since building costs are high and labor

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[1] See H. K. Ferguson, "To Build or Not to Build," *Factory Management and Maintenance*, Vol. XCV, No. 4, Part 2 (1937), pp. 42–45.

is inefficient, much of the expansion that is made near the peak of prosperity is later found to have been unwise. Much depends upon the avoidance of excessive commitments at such a time. On the other hand, if management fails to make expansion when the market permits, profits and opportunities may be forever lost. The companies which properly time their expansion increase their sales and their profits. The financial affairs of companies which make unwise expansion are reorganized or liquidated through receiverships and bankruptcies during periods of depression.

The Building Plan. Having decided to build, management should put down on paper the plans for an ideal arrangement of its buildings. This can be done without regard to cost, contour of land, streets and highways, existing railroad facilities, or any other local conditions. If three or four good arrangements are planned, it may then be possible to choose the one which offers the greatest advantages in low costs of production, maintenance costs, employee comfort, depreciation, taxes, appearance, and other features. In making such a plan, an analysis should be made of the product and the parts which go into it and the processes required for the production of each part. The workplaces necessary for each step in the manufacture of each part can then be planned, with due allowance for space required for workers, machines, and materials. Plans should also be made for aisle space and for equipment used in the transportation of the product. Space may also be provided for numerous other requirements, such as storerooms, locker rooms, washrooms, cafeteria and other employee facilities, dispatching desks, toolrooms, and shipping room. Outside the plant the area desired for landscaping, yards, sidewalks, driveways, and parking facilities should be indicated. It may be necessary to modify the plan when costs are considered; but planning in this manner emphasizes the fact that the plant, like a machine, should be designed to fit production requirements.[2]

The plan of the building may greatly affect operating costs. A multistory building makes possible the use of gravity chutes or other conveyors. It may be necessary to locate heavy machinery on the first floor in a multistory building, whereas any location is possible in a one-story building. Floor supports are more likely to interfere with the arrangement of workplaces and equipment for moving materials in a multistory building. The ease of supervision, the cost of transportation within the

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[2] W. G. Sanders, "Single or Multistory Plant Is Dictated by Process," *Factory Management and Maintenance,* Vol. CIV, No. 4, Part 2 (1946), p. 52.

plant, possible rearrangement of workplaces when the design of the product changes, and the location of offices and employee services depend upon the design of the building. The possible enclosure of railroad tracks is also a problem of building design. In very cold weather and particularly in seasons of snow and ice, it is advantageous to have the railroad tracks and the loading area enclosed.

Some companies have found that a standardized design of building is feasible for all of their buildings in different locations. The architect's plans for a building in one location can be used for a building in another location with only slight modifications for size or changes because of differences in the contour of the land. Standardized buildings have been found to be suitable for manufacturing enterprises as well as chain stores, hotels, garages, and chain restaurants.

Single-Story Buildings. One-story buildings have been increasing in number for two reasons. First, improved methods of transportation have caused many new plants to locate in small cities or towns where adequate space is available and land is low in cost. Second, the one-story building is less expensive to build and, in some industries, results in substantial operating economies. Industries which use heavy machines or make a product which is very heavy must have the manufacturing operations on one floor. This is true of foundries, forge shops, locomotive and car builders, steel rolling mills, and press and stamping shops. Many automobile manufacturers have also found one-story buildings to be more economical than multistory structures. In initial cost the single-story building is usually considered less expensive to build. One engineer estimates that the cost of space increases 5 per cent if a second story is added and 10 per cent if a third story is added.[3]

The single-story building requires fewer columns throughout the central area than does the multistory structure because only the weight of the roof has to be supported. The spacing of the columns depends somewhat on the type of trusses in the roof.[4] A wide spacing of the columns is possible, though at a cost which increases rapidly because the roof trusses must carry longer roof beams. In a multistory building the spacing of columns depends upon the floor loads and arrangement of the steel used in the structure. Wide spacing is advantageous because it affords unobstructed work areas, permits greater flexibility in the layout and arrangement of the workplaces, lowers the cost of transportation, and permits better supervision.

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[3] *Ibid.*

[4] Moritz Kahn, "What Type of Plant to Build," *Factory Management and Maintenance*, Vol. XCV, No. 4, Part 2 (1937), p. 52.

Provision for expansion is easily made if a building is one story, provided the land is available. The location of the plant in an area of low-cost land is a factor in long-range plans for expansion.

Multistory Buildings. Enterprises which are engaged in light manufacturing frequently find a multistory building to be more economical than a one-story plant. If both the materials and the machines used are lightweight, a multistory structure may meet all requirements. This is true of such industries as food processing, shoes, clothing, printing and publishing, drugs, chemicals, beverages, and light hardware. When the materials can be moved by gravity chutes or other gravity conveyors, the multistory building makes possible low-cost operation. Examples are bread baking, sugar refining, glass-bottle manufacturing, and soapmaking. In some industries, height of buildings is desirable for storing or processing the product, even though a floor is not required at each level. This situation exists in plants making granulated soap and in certain food-processing plants. In a multistory building, much space on the upper floors may be used for storage. A second story may be desirable for office space in order that the offices may be isolated from the noise of the shop.

The most important saving in the multistory structure is in the cost of the plant site. In locations where land cost is high, multistory buildings are necessary. Industries which find an urban location desirable in order that they may be near markets or for other reasons will usually be located in multistory buildings.

The conventional shape of multistory factory buildings is rectangular. If additional space is required, one or more wings may be added. Thus, a building which originally had the shape of an I may be expanded to take the form of an L, U, F, E, H, or possibly a square or a solid block. The expansion is usually made at right angles to the flow of work. If this plan is followed, expansion may be made with a minimum of interruption of the normal operations. In any case, it is important that the new space be integrated with the old. If the extension is merely added, the plant will in time become an inefficient aggregation of rooms with heavy operating costs. Failure to provide for expansion is now recognized as one of the most common errors in the design of factory buildings.

One method of plant expansion is illustrated by the Appleton Electric Company, whose plant is shown in Figure 9 (p. 144). The company was started in 1903 with two employees. The units of plant in the background and to the right were first constructed. Next, the units in the background and to the left were added in 1920. Units

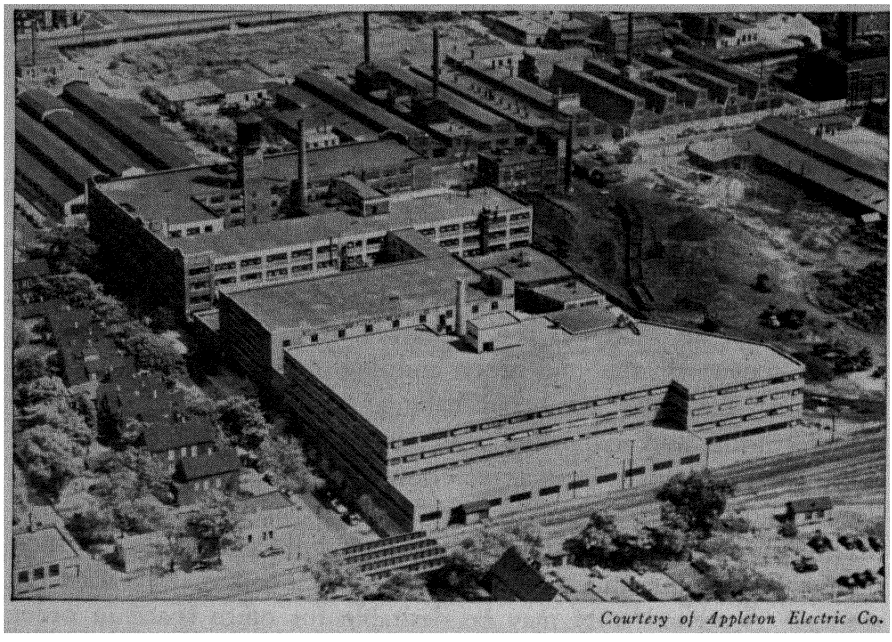


FIG. 9. Illustration of Plant Expansion

nearer the foreground were added in 1926, 1937, 1940, and 1947. This company planned the direction of its expansion and prepared for it by acquiring the land which would be necessary.

Number of Buildings. Sometimes the plant consists of two or more buildings adjacent to each other. Separate buildings are more costly to construct and waste ground space. An added item of construction cost is the requirement for pavements between the buildings. Maintenance costs are increased, particularly the cost of heating and air conditioning; in the winter the courts between the buildings must be kept free of snow. Operating costs are increased because the flow of work from one workplace to another is interrupted and because employees must spend more time going to and from various service facilities unless duplicate facilities are provided. As the plant grows, the operations are likely to become disorganized because of the difficulties of keeping an effective, orderly arrangement of workplaces. These weaknesses may be minimized by constructing passageways between the floors above ground and by providing roofing over the ground area between the buildings. Where several buildings are constructed instead of a single building, the reason may be that different processes require different types of construction. Fire and explosion hazards may be decreased by the segregation of certain departments.

Separate buildings may also be used to house the administration offices, research laboratories, and the power plant. Any auxiliary buildings should be so located that they will not impede future expansion of the main building and its operations.

Types of Construction. Regardless of whether the building has one story or several stories, it may be any one of five types of construction. These types are not always clear-cut and distinct, since they have many adaptations. The choice of a type of construction, like many other management problems, should be made by balancing various phases of cost, including original cost, maintenance, depreciation, and fire protection.

Light Wood-Frame Construction. Light frame buildings are constructed of thin wooden joists and rafters with light studs inside the partition walls. The frame is sheathed with relatively thin wooden boards. Since the edges of the wood are exposed, fire could spread rapidly along the length of the boards. The fire hazard is increased in factories because of the possible saturation of the floors and walls with oil or grease. Wooden stairways increase the risk to life and property because they aid in the spread of the fire to the upper floors.

Frame buildings are little used for factory construction, although their initial cost is low. They are unsuited for permanent structures because of their rapid depreciation, the great danger of fire, and high insurance costs. Some enterprises which are definitely temporary use frame buildings because they are quickly constructed at low cost and are easily altered to meet changed conditions.

Brick Wall-Bearing Construction. In brick or stone wall-bearing construction, the weight of the upper floors and the roof is transmitted to the walls by steel or wooden beams. The side walls are of brick with heavy pilasters or brick columns to carry most of the weight. The pilasters may project from the wall by as much as one third of their thickness. Brick construction also requires heavy center columns. Since much of the weight rests upon the walls, the size of the windows is limited. This type of construction is better than light wood-frame construction in that it is more permanent, depreciates more slowly, and is low in cost. It can be used for operations which do not require heavy floor loads.

Standard Mill Construction. This type of construction is usually associated with the mills of New England — particularly the textile mills. It is also called "slow-burning construction" because it is especially designed to reduce the hazard of fire. The walls are built of brick; the floors and roof are made of heavy timbers or thick planks

which burn slowly and which will continue to support the weight of the building after they are partly burned. In the frame of the building, no timbers are used with any dimensions less than six inches. The roof planks are two or three inches in thickness, and the floor planks three or four inches. Timbers and planks of these dimensions will prevent the collapse of the building even though fire may have penetrated half an inch or more into the wood. With reasonably good fire protection, the flames will be extinguished before they have burned through the supports to walls, floors, and roof.

Mill construction is also designed to prevent the spread of a fire from one floor to another. No openings or chutes in the floors are permitted. Elevator shafts and stairways are fully enclosed by walls of heavy wood or other noncombustile construction. Doors which open to stairways or elevator shafts are self-closing and fireproof. In parts of the building where the fire hazard is increased by manufacturing processes, the ceilings are made of plaster or other noncombustible material such as sheet metal or asbestos. They are also equipped with automatic sprinklers. The beams and columns are chamfered in order that they may not catch fire easily or assist the spread of fire.

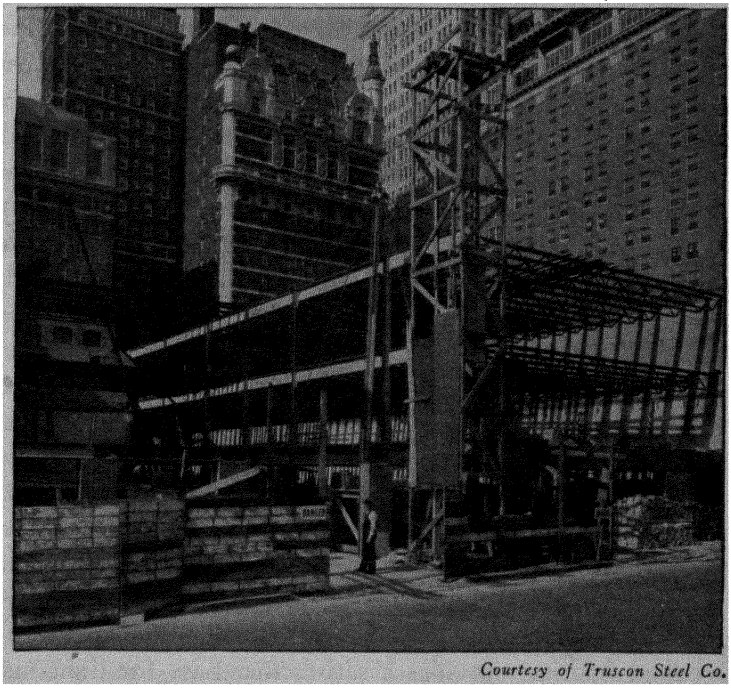
Mill construction has other advantages in addition to reducing the fire hazard. The building will safely support heavier floor loads than buildings of either light wood-frame or brick construction. Vibrations of machinery are not easily transmitted because of the firm and heavy construction. Alterations in the floor arrangements may be made, or openings in wall or floors for piping and power lines may be cut with relative ease.

The principal disadvantage of the mill type of construction is the cost of the heavy timbers. The columns necessary for the support of floors and roof are also a disadvantage in many types of manufacturing which require large unobstructed space and good natural lighting. Since the weight of the structure is carried in large part by the walls, the amount of window space is definitely limited. This factor in turn limits the possible width of the building. Mill construction has now been largely supplanted by other types.

Steel-Frame Construction. This type of building is supported by a series of steel columns which are braced together by horizontal girts. The walls that do not carry the weight of floors or roof are usually of brick or hollow tile. Corrugated sheet metal may be used for the partitions or even for outside walls, but it is not entirely satisfactory because it deteriorates rapidly when exposed to dampness. Rooms

with sheet metal walls are also hard to heat because of excessive radiation. An advantage of steel-frame construction is that alterations and reinforcements are easily made.

Unless the entire building is fire-resistant, steel-frame construction carries a decided fire hazard because the steel columns will soften and become weakened when heated. The buckling of the steel will cause the entire building to be wrecked. For this reason, floors should be of concrete or other fireproof material. The roofing material should also be fireproof. Since the contents of the building may burn and cause



Courtesy of Truscon Steel Co.

FIG. 10. Steel-Frame Building under Construction

intense heat, the steel frame should be fireproofed with concrete. A building which is fully protected in this manner is expensive to build. A steel-frame building under construction is shown in Figure 10.

Reinforced-Concrete Construction. In reinforced-concrete buildings the weight of the building is supported by a frame of concrete in which steel reinforcing bars are imbedded. The floors are also made of reinforced concrete, although they may be surfaced with wood, linoleum, or other material. Columns along the outside wall and also within the building space support the floors and roof. The side walls may be of brick, stone, or hollow tile. Much of the wall may be of

glass, since the walls do not carry the weight of the building. The roofs are usually of reinforced concrete, although they are surfaced with other waterproofing material.

Reinforced concrete is a favorite type of construction for multistory buildings. The cost is somewhat less than it is for steel construction; yet the building carries very little fire hazard, is cheaply insured, and depreciates slowly. Maintenance and housekeeping costs are low. The floors are rigid and free from vibration and can be constructed to carry heavy loads.

The objections to reinforced concrete are that the plan of the building is not easily changed as manufacturing processes change, and that new openings for power lines, heating and ventilating equipment, or for other purposes are not easily made. Machines cannot be readily attached to concrete unless their location is anticipated and provided for during construction by imbedding anchor bolts in the concrete.

A reinforced-concrete building must be correctly proportioned to prevent deterioration due to stresses which result from expansion and contraction with changes in temperature and from uneven settlement of the foundation.

Floors. The floor should be adapted to the use to be made of it. In a steel-frame or reinforced-concrete structure, the building may be made to support any type of floor which is required. It is not necessary that the same type of floor be used in all areas or departments. Plain concrete floors may be used in toilets and dressing rooms, since this type of floor is durable and easy to clean. A concrete surface with an armored grid reinforcement is adapted to open passageways and elevator openings where the traffic is heavy. This type of floor is long wearing and affords a safe footing. Hardwood tongue-and-groove or smooth-edged flooring provides a satisfactory base for light machines and is not uncomfortable for employees. Unless the base is perfectly flat, however, the edging of the boards will break under heavy weight or in traffic. Brick floors are used in heat-treating departments. Wooden blocks, installed on end with the wear on the end of the grain, are sometimes used for the shipping room and certain other departments. If machinery is set upon wooden blocks, anchor bolts must reach through the blocks to the concrete floor to hold the machinery firmly. Asphalt tile is satisfactory for offices. Other types of floors are available for departments which have special requirements.[5]

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[5] George Money, "Selecting the Right Floor for Low Upkeep Cost," *Factory Management and Maintenance*, Vol. CIV, No. 8 (1946), pp. 140–41.

Roofs. The choice of roof depends upon such factors as cost of construction, appearance, ease of inspection and maintenance, air conditioning, and relation to materials handling. A common type for either single-story or multistory buildings is the flat roof. This type is easily inspected for leaks and is easily repaired when defects are discovered. In single-story buildings, flat roofs are sometimes used for parking, although such use requires sturdy construction of the roof and strong wall support. Easy access by means of a ramp or otherwise is also essential. Some companies are experimenting with the spraying of water on flat roofs in hot weather to lower the temperature inside of the building. Flat roofs may be observed in the buildings in the foreground of Figure 9 on page 144.

The saw-tooth roof, as the name suggests, gives the appearance of the upturned teeth of a saw when viewed from the side of the building. The short side of each "tooth" consists of windows which face, preferably, to the north. The windows are usually vertical to prevent the rapid accumulation of dirt, although they may be slanting. The principal advantage of saw-tooth roofs is that air and natural light may be admitted from the windows in the roof as well as from windows in the walls. A building with a saw-tooth roof is shown in Figure 28 on page 209.

The monitor roof has a raised central portion with windows along the sides of the monitor section similar to a railroad passenger car. The roof on either side of the monitor section may be either flat or sloping. Monitor roofs may be seen in the buildings in the background of Figure 9 on page 144. The principal advantages of the monitor-type roof are, first, the effective use of natural light and, second, the additional overhead space which may be used for cranes or other materials-handling equipment.

The pitched roof, commonly used for residences, consists of two sloping sections. This type of roof is best adapted to a one-story or two-story building, although it is sometimes used for taller buildings. It provides additional overhead space which assists in the movement of air if the ceiling is omitted. The small buildings in the left foreground of Figure 9 on page 144 have pitched roofs.

The bow-type roof has increased in popularity during recent years, particularly for warehouses and temporary structures. It provides a maximum of overhead space; and for this reason, the walls are sometimes not as tall as in buildings of more conventional types.

The V-shaped roof hastens the flow of rain water from the roof as compared with the flat roof. It reduces the need for gutters and down-

spouts and makes icicles less likely in winter. The various types of roofs are illustrated in Figure 11.[6]

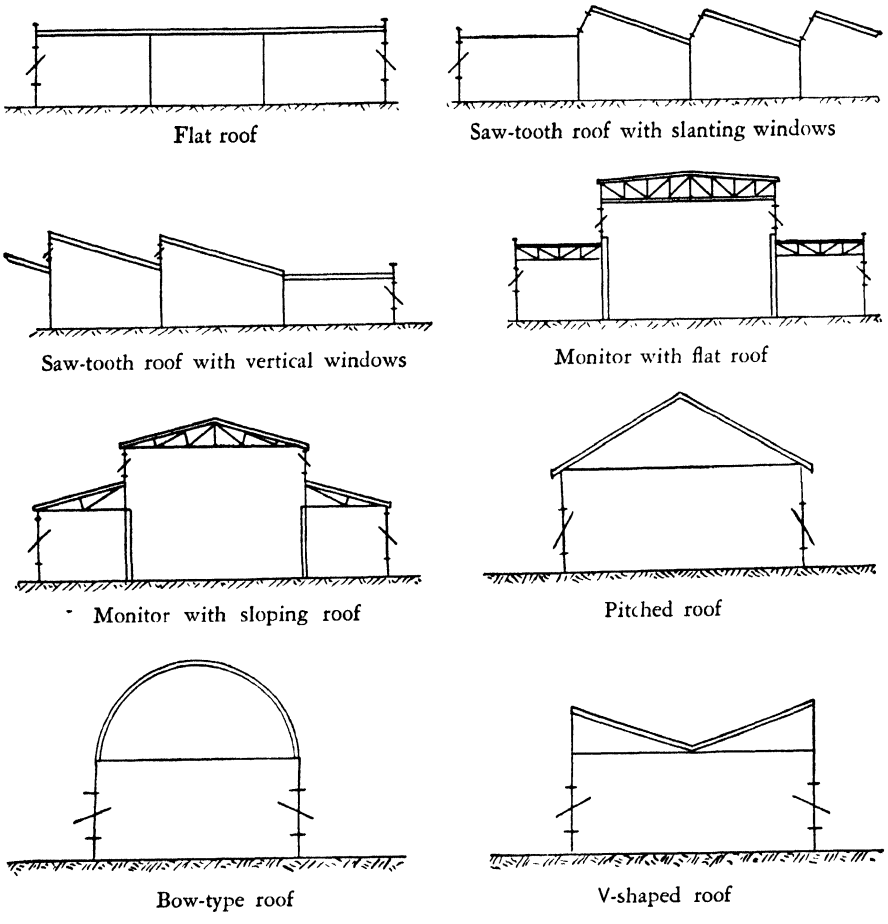

FIG. 11. Types of Roofs

Employee Comfort. The building should be designed not only to house the machinery, afford protection from the weather, and facilitate the flow of the work, but also to provide comfortable, healthful, and reasonably quiet working conditions for the employees. This problem must be considered in the initial plans; for in many respects, employee comfort is promoted by features which are embodied in the building structure and are not easily changed after the building has been completed.

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[6] Adapted from *Factory Planning and Layout* (New York: Metropolitan Life Insurance Co., 1947), p. 21.

Provision should be made in the original design for such employee services as toilet and washroom facilities, showers, first-aid rooms, canteens, a cafeteria and kitchen service, meeting rooms, and an auditorium for recreation and training. Before the original plan is completed, these services should be located; and the amount of space to be allotted to each should be fixed. Although these are problems of plant layout rather than building construction, the two problems are very closely related.

Built-In Safety. Safety is another problem which should be considered in the original plans. Building codes and fire regulations make many specific requirements for safety. Such regulations must be fully complied with; but in many cases, they are regarded only as the minimum requirements. Safety provisions not required by law are often incorporated in the building plan.

The fire hazard is exceedingly important and must be watched carefully. There are also many features of the building entrances, stairways, elevators, materials-handling equipment, lighting, and heating which affect safety. Concrete steps should be capped with a metal grill or other device to prevent slipping as well as to prevent wear. Rail supports should be provided for stairways inside and outside the building. The stairway should be wide enough for a double line of travel but not wide enough for three persons unless there is an intermediate handrail. The angle at which the steps rise to the next floor, the width of the tread, the height of the rise, and the uniformity of both the tread and the rise are important features. A door should not be placed to open immediately upon the stairs. Doors which lead to stairways should be self-closing and protected with wired glass. The lighting facilities and also the location of the electric switches are important in safety. Overhead cranes which are located in such a position that heavy materials are lifted over the heads of workers create an accident hazard. The dangers resulting from crossing highways, railroad tracks, and production lines are frequently eliminated by underground passageways leading from entrances or locker rooms to the main floor. Such features as these cannot be changed after the building has been completed except at substantial cost.

External Appearance. At little extra cost, the exterior of the building may be made pleasing and attractive. At least it need not be ugly and objectionable. It should not be decorative or ornamental, and no attempt need be made to conceal the fact that it is a factory building. Good design is achieved by proportion, balance, and strong, flowing lines. Landscaping is important, for no building makes a good

presentation in an ugly environment or in crowded quarters. This fact is an added advantage of a suburban location, although in urban industrial districts, manufacturing concerns could do much to improve the appearance of the city by giving proper attention to the building and grounds.

Building appearance is also an important factor in employee morale. People like good environment. Whether or not employees consciously analyze the causes of their attitudes, they respond to those acts of their

Courtesy of Truscon Steel Co.

FIG. 12. Interior of a Modern Building

employer which indicate that he is interested in their comfort and their welfare.

Trends in Building Construction. In buildings constructed since the close of World War II, several trends have been manifest.[7] The most significant developments are as follows:

Increased Use of One-Story Buildings. These structures are being built in small cities or suburban locations.

Plants Built around the Process. Buildings are regarded as a part of the productive equipment and are designed for specialized purposes. The plan of the building makes special provision for manufacturing operations, offices, and special services.

Increased Use of Metal. Steel and various alloys are replacing wood as roof supports and window sashes. For light roofs, slabs of gypsum and concrete are replacing wooden planks. Figure 12, which

[7] For discussion of building trends, see *Factory Management and Maintenance,* Vol. CX, No. 4, Part 2 (1952). The entire section is devoted to buildings.

shows the interior of a modern building, illustrates the use of steel for roof supports. The wide unobstructed area in such a building permits the easy movement of materials and equipment, makes changes in the layout relatively simple, and makes for better diffusion of light.

Better Appearance. Buildings are placed back from the street. Architectural designs harmonize with other buildings in residential areas.

Provision for Expansion. Space for expansion is often acquired when the plant is built.

Increased Storage Space. Shortages of materials due to labor troubles in the plants of vendors, interruptions in transportation services, and other causes have required that more space be provided for storage both in the usual storage areas and along the production lines.

Higher Ceilings and Fewer Columns. Higher ceiling clearances, often twenty feet or more, are the result, in part, of an increased use of lift trucks and other economical methods of handling materials which permit moving of tall loads and high stacking in storage areas.

Greater Attention to Employee Services. In-plant food facilities are now accepted practice. Other employee facilities are larger shower rooms, ventilated lockers, air-conditioned locker rooms, and conveniently located smoking rooms. The space devoted to recreation facilities is reduced in some plants because outside recreation facilities have made company-sponsored activities unnecessary.

Provision for Employee Traffic. Enclosed walkways and passages flanking the production floor have been provided in order that traffic will not interfere with production. In many multistory buildings, provision is made for escalators. In order that an incoming shift may not interfere with workers on the job, locker rooms are located between the entrances and the production floor. Adequate space is provided at entrances and in locker rooms where an incoming shift may wait until the previous shift vacates the production area.

Lower Maintenance Costs. Housekeeping and repair costs are reduced by the elimination of sharp corners, the use of glazed and ceramic tile walls and concrete or asphalt floors, and the increased use of metal.

Maintenance Program. The management cannot consider that its building program is at an end when the building is completed but must seek to protect its investment by keeping the property in a good state of repair. Preventive maintenance is designed to discover the need for minor repairs and to make them before extensive damage has been done. Some features of the building require more frequent attention than others, but the program should be organized on a five- to ten-

year basis. Attention should be given to floors where damage may be caused by moisture, oil, or heavy traffic loads. Cracked masonry joints in the walls should be repaired by replacing the mortar. Walls which permit water to penetrate should be calked, and cracked putty around the glass should be replaced. If glass in windows is broken, the cause should be found and corrected if possible. Broken window glass may indicate a settling of the building or excessive floor loads on the floor above the window. It may also indicate the need of protective wire guards inside or outside the building. The maintenance program should include roof inspection and repairs, painting, window washing, and ordinary housekeeping. It should preserve both the operating efficiency and the good appearance of the plant.

The maintenance program should be continued in good times and bad regardless of whether the company is making a profit. Spasmodic maintenance is more costly in the long run than a planned program which prevents damage by eliminating the causes of trouble.

QUESTIONS

1. What costs and risks are incurred in the purchase or construction of a factory building by a new enterprise?
2. In what order should the following decisions or plans be made: choice of plant location, plan for building, plan for machinery and equipment, financial plan for issuance of stocks and bonds?
3. The Apex Manufacturing Company is unable to supply the needs of its customers at the present rate of output. Operations are now limited to 8 hours per day for 5 days per week. What alternatives are open to the company?
4. What are the advantages to the employer in plant ownership as compared with a rental or lease arrangement?
5. At what phase of the business cycle should additions be made to plant and equipment? It may be assumed that reliable forecasts of cyclical changes can be made.
6. Why has failure to provide for future expansion been the mistake most commonly made in planning for factory buildings?
7. Compare the single-story and the multistory building in the following respects:
   a) Initial cost.
   b) Lighting.
   c) Heating.
   d) Maintenance.
   e) Possible materials-handling methods.
   f) Fire protection and fire insurance.
   g) Convenience of employees.

8. Under what circumstances would a company wish to build several buildings instead of one? What types of operations or departments might be located in separate buildings?
9. Why have buildings of standard mill construction seldom been erected during recent years?
10. What are the advantages of standard mill construction?
11. Compare the steel-frame and the reinforced-concrete types of building construction from the points of view of cost, fire hazard, ease of making alterations, and permanence or length of life.
12. Compare the types of building construction from the point of view of the means by which the weight of the roof and the upper floors is supported.

CASES

15. PLANNING FOR NEW FACILITIES

In March, 1951, United States Steel Corporation broke ground for a new steel mill at Morrisville, Pennsylvania, which is north of Philadelphia. Until the company began construction operations, Morrisville had been a small country town; and its businesses were limited to local merchandising and service establishments. The plant, which was expected to cost $400,000,000, would transform the community into a large industrial center.

The management of the corporation recognized from the beginning that local public agencies could not be expected to handle community problems created by the building of the new plant. Before ground was broken for the mill, the company began the study of the control of smoke and dirt, water pollution, schools, stores, hospitals, traffic, and other such problems. Representatives of the company discussed possible plans with local governmental agencies for the purpose of arriving at a joint solution of as many problems as possible.

The company made plans to install the most effective anti-smoke devices it could find. It expects to eliminate all smoke and to permit only steam to be released into the air. To provide the vast quantity of water required, the company built a new treatment plant that will clean the water as it comes from the river and treat it again before it is returned. The volume of water to be handled by the plant equals two thirds of the amount used by the city of Philadelphia. The safeguards against air and water pollution were expected to cost more than $8,000,000 to install.

To provide for the health of employees, the corporation helped to finance the building of a 150-bed institution in the neighboring town of Bristol. Until the new hospital could be completed, the corporation contributed to the support and improvement of facilities in Trenton, which is also nearby.

It was found that four of the houses on the plant site had been built during the colonial period and constituted landmarks in the area. Their removal could not be avoided, but the company dismantled the buildings and shipped the materials to Mount Vernon for use in construction on that historic estate.

Traffic problems were anticipated. During construction, as many as 10,000 men were employed, all of them on one shift. After completion of the plant the company expected to employ 2,000 to 2,500 workers on each shift. Arrange-

ments were made with bus companies for the establishment of new bus lines to the plant. Traffic problems were analyzed and discussed with state highway officials, who made plans to relocate and widen roads in the vicinity. Problems of parking space also received due consideration.

Housing constituted a major problem. To reduce the need for housing, the company planned to select workers from the Lower Bucks County–Philadelphia–Trenton area as far as possible. Since many workers could be expected to move into the area, a prominent real estate developer was interested in the construction of a low-cost housing project in the area. The plans for the residential area made provision for schools, churches, stores, medical facilities, parks, athletic fields, picnic areas, and other recreational facilities, including a lake.

Questions:

1. Why did the corporation assist in the provision of community facilities?
2. What problems were faced by this company that would not ordinarily be encountered in the building of a new plant?

16. RELATION OF BUILDING DESIGN, MATERIALS HANDLING, AND PLANT LOCATION

The National Container Corporation is one of the largest manufacturers of metal and fiber containers in the United States. Its products are used for packaging fruits, vegetables, coffee, meats, fish, olive oil, motor oil, milk, and numerous other products. The company has usually sought to locate its plants near the markets because the product is bulky and relatively expensive to ship. The usual method of shipment of tin cans is as follows: From the can-making machines, cans go by overhead conveyor to the shipping department and to the freight car in which the cans are shipped. Cans are stacked in tiers across the car, with the open ends of the cans toward the middle of the car. No shipping containers are used, but the sides of the car are lined with a fiber covering to prevent damage. A worker stands inside the car and lifts the cans from the conveyor by means of a forklike wooden tool which permits him to lift ten cans from the conveyor at a time.

At the canning plant the cans are not placed in a storeroom but are sent directly from the freight car to the preserving lines. Cans are picked up in the car and placed on a conveyor by means of a forklike tool similar to that used in loading the cans. Because of the economy in loading and unloading cans, freight cars are used for shipment even for short distances.

Since the business of the National Container Corporation is expanding, the management is contemplating the building of a new factory in California. The president has been approached by the executives of a soup company with the suggestion that the company locate its new plant on land adjacent to the soup plant in a small town in southern California. This arrangement would enable the cans to be sent directly from the can lines to the canning plant without the necessity of shipment by freight car. In this way, transportation costs would be reduced; and delays due to car shortages or failure of the railroad company to place or move cars would be eliminated. The saving in costs would be shared by the two companies.

The president of the container company inquired concerning the regularity

of demand for cans by the soup company and was told that demand was more constant than the demand for cans by most packing companies because some varieties of soup can be made during off-seasons. The attorney for the container company advises that long-term contracts with the soup company for containers would probably be illegal under the antitrust laws and that new contracts would have to be negotiated each year. There is also some question as to the legality of the arrangement under the Robinson-Patman Act, which prohibits discrimination between customers. While the United States Supreme Court has not passed upon the legality of pricing by a plant that is located adjacent to the plant of a customer, a federal court held in 1949 that the American Can Company was discriminating between its customers in granting lower prices to a customer who received his cans from the plant of the can company by means of a conveyor. In that case the court said:

"The defendant may in good faith construct its factories in certain localities and thereby incidentally create a locational advantage to those customers situated nearby. In such a case, defendant may sell f.o.b. the factory, provided it is the normal source of supply, and the nearer customers will receive their cans at a smaller delivered price than those less favorably situated. This, however, is not discriminatory for the difference is justified in delivery costs. When, however, additional facilities, the runway here, are furnished so that those near the factory receive their cans at a price lower than that normally incident to locational advantage, a discrimination does exist, and the seller, defendant here, must either furnish proportionally equal facilities to all customers purchasing that commodity, discontinue the furnishing of such facilities, or, in this case, discontinue the granting of a discount based upon the existence of the facilities." (*Russellville Canning Co.* v. *American Can Co.*, 87 Fed. Supp. 484, 498.)

The container company cannot provide the same service for all of its customers because it has 3,000 customers and only 58 plants.

The labor supply in the town in which the soup company is located appears to be fully employed, but the container company employs a relatively small number of unskilled workers since can making is largely mechanized. Most of the machines are fully automatic. The company would be required to move a substantial part of the management group from its present plants to the new location.

Materials would be available at plants of steel mills in the San Francisco Bay area. Although tin plate has at times been in short supply, both the steel manufacturers and the government have favored food container manufacturers in making allotments of material.

Land is available for the proposed location at prices that are low in comparison with land in industrial areas adjacent to large cities.

Questions:

1. What additional information would be required before a decision is made as to plant location?
2. What would be the advantage of the proposed location?
3. What would be the disadvantages?
4. How is building design affected by location and methods of handling materials?

CHAPTER X

MACHINERY AND EQUIPMENT

THE PROBLEM of the selection of machinery and equipment first arises when a new enterprise is to be established. The plans for a new business usually begin with machinery and equipment because the amount and types of equipment determine the need for the building to house and protect it. After the operations have been started, problems of machine selection arise from time to time as expansion programs are planned, layouts are changed, and old equipment is found to be inefficient because of depreciation or obsolescence.

Basically, machines and equipment consist of two types — machines for fabricating or fashioning materials and machinery and equipment for moving or storing materials.

EQUIPMENT FOR PRODUCTION

A machine is a device to transmit or modify a force or motion and to direct it for the purpose of performing work. It consists of three parts: (1) a rigid frame or base, (2) moving parts which transmit the force, and (3) one or more tools for performing work. The purpose of the frame is to hold the other parts in proper alignment. The moving parts which transmit force include belts, pulleys, gears, clutches, and shafting. The tools may be grinding wheels, rollers, needles, hammers, screw drivers, knives, brushes, or shaping devices.

A machine may perform three types of operations. The first operation is that of moving or transporting the material. The machine may move the material or container to the proper position for fabrication. After the operation has been completed, the machine may eject the material or move it to a storage place, bin, or conveyor. The second operation is holding. The material may be held in position and the tool moved to it, or the work may be advanced to the tool, or both

the work and the tool may be moved. The third operation is fabrication. In the canning of fruit, for example, fabricating includes grading for size, cutting in half, removing core or seed, peeling, bleaching or coloring, placing in containers, and cooking. In metalworking industries, operations consist of rolling, cutting or shearing, punching, forming, drilling, finishing, welding, assembling, polishing, and painting.[1]

From the point of view of the amount of attention required of the worker, machinery and equipment can be grouped into three classes, namely, manually operated, semiautomatic, and fully automatic.

Manually Operated Machines. Manually operated machinery or equipment requires the constant attention of the worker because the worker is required to place the material in position for fabrication, and he may also be required to remove the finished part. He may be required to guide the tool; and in the case of some machines, such as power saws, he may guide the material as the operation is performed. If the machine completes the fabrication without any worker attention other than placing the part in position and starting the machine, continuous attention may still be required because the cycle of work is very short. The power for the operation of a manually operated machine may be supplied by any source, such as electricity, gasoline, or steam. Examples of manually operated machines are typesetting machines, welding and riveting machines, gasoline and electric trucks, steam shovels, and various types of equipment which require that the material be fed into the machine by the worker. In the office, manually operated machines include typewriters, adding and computing machines, bookkeeping machines, and some types of duplicating equipment.

From the point of view of management, the significant factor concerning manually operated machines is the low initial cost and the relatively high operating expense. Adjustment of output to seasonal variations in demand is not easily accomplished because an increase in production during the busy season may require the hiring and training of large numbers of workers. The quality of work done on manually operated equipment depends upon the skill of the worker, but the quality may be better. Custom-made clothing, for example, is usually made on manually operated equipment.

Semiautomatic Machines. Machines which are semiautomatic

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[1] See discussion by E. W. Leaver and J. J. Brown, "Machines without Men," *Fortune*, Vol. XXXIV, No. 5 (1946), p. 165.

operate through a cycle of production without attention by the attendant. Semiautomatic equipment requires the attention of the worker only in loading the machine, starting it, and unloading it for each successive cycle of production. The machine may deposit the processed material in a pile which may be removed at the convenience of the worker. A common example is the machine for slicing meat, such as may be seen in many local meat markets, although some slicing machines are manually operated. Small bakeries may be equipped with a similar machine for slicing bread.

Another example is the hobbing machine, which is used for cutting the teeth of gears and similar parts. A hob is a grooved or fluted hardened steel tap which is firmly fastened to a shaft. The outer surface consists of a fluted steel worm or a series of teeth which will cut grooves of the proper dimensions for the gears. When the worker prepares to cut gears on the hobbing machine, he fastens one or more blanks on a shaft, places them in the machine, and starts it. The rotating hob approaches the blanks and begins the cut, moving across the piece until it finishes the cut, when it automatically stops. While the machine is making the cut, the worker prepares the next blanks for the machine. He usually runs a battery of machines.

Semiautomatic machines are more expensive than manually operated equipment, but the unit cost of the product may be less if the machines can be operated continuously. Investment in semiautomatic machines is profitable provided, first, that the volume of production is sufficiently large to keep them operating at a high percentage of capacity and, second, that the machines are adaptable to changes in product design or to the manufacture of new products.

Fully Automatic Machines. This type of machine operates continuously through successive cycles. Fully automatic machines do not stop when they have finished with one cycle of operations or one batch of material but continue with the processing of other units. This means that material is introduced continuously by the machine or that extra parts are available when required at any phase of the operation. In some machines the material, such as paper or cloth, is introduced as continuous stock. This is the case, for example, with the paper used by a machine for wrapping bread. In other machines the materials are placed in a magazine, from which they are automatically fed into the machine. The magazine may be refilled while the machine is in operation. Examples are automatic stokers, coffee grinders, and flour mills. The material may be fed into the machine by a conveyor system. For example, in a bakery, the mixture for doughnuts may be poured

into a magazine, from which it is drawn and shaped and dropped into hot fat for cooking. The machine turns the doughnut at the proper time and lifts it onto a conveyor, which moves it along as it cools and finally drops it into a machine for coating with powdered sugar. No attention is required of the worker during any of these operations.

When several fully automatic machines are organized into a production line and connected with conveyors which automatically transport the material from one place to another, the factory resembles a single huge machine with highly complicated and fully integrated parts. Worker attention may be limited to supervision, inspection, and possibly a few manual operations at certain stages. This condition is approached by many factories which refine crude oil, ore, or sugar; process milk or cereals; or can fruits and vegetables.

Fully automatic machines require fewer workers than do semiautomatic machines. In busy seasons, production can be increased without a large increase in the number of employees. However, automatic machines are more expensive to purchase and install and can be justified only when the output is large and designs of the product are fairly stable. If standards of product are exacting, fully automatic machines are not always satisfactory because of the frequent attention required by cutting tools or because of variations in quality. For example, in the manufacture of corrugated paper cartons, the material may be automatically fed into the machine for stapling; or in another type of machine the worker may place the material in position and start the machine by pressing a pedal with his foot. Quality is more uniform when the manually operated machine is used because the worker can place the sides in proper position. However, an unskilled or careless worker may produce a lower quality product with the manually operated machine.

When one machine performs more than one operation, or when several machines perform a sychronized series of operations, a delay at one machine or one part of a machine means a delay all along the line. For example, where one machine prints, cuts, folds, staples, and wraps a magazine and prints the mailing address on the wrapper, the stoppage of one part of the machine means the stoppage of all other parts. The difficulty can be minimized but not eliminated by the operation of the conveyor in such a manner that a few parts are banked while awaiting fabrication. In a rolling mill, for example, the slack between operations is taken care of by a pit into which the sheet may be permitted to dip. However, arrangements of this kind merely provide for slight differences in the rate of fabrication at differ-

ent stages. They do not eliminate the difficulties of long delay due to machine breakdown.[2]

General-Purpose Machines. From the point of view of the variety of uses, machines are classified as general-purpose and special-purpose. A machine is designated as general-purpose if it can be used to perform more than one type of work. This statement does not mean that the machine will perform all types of operations, for all machines have relatively small adaptability. An example of a machine which is used for many purposes is the lathe. This machine holds and rotates

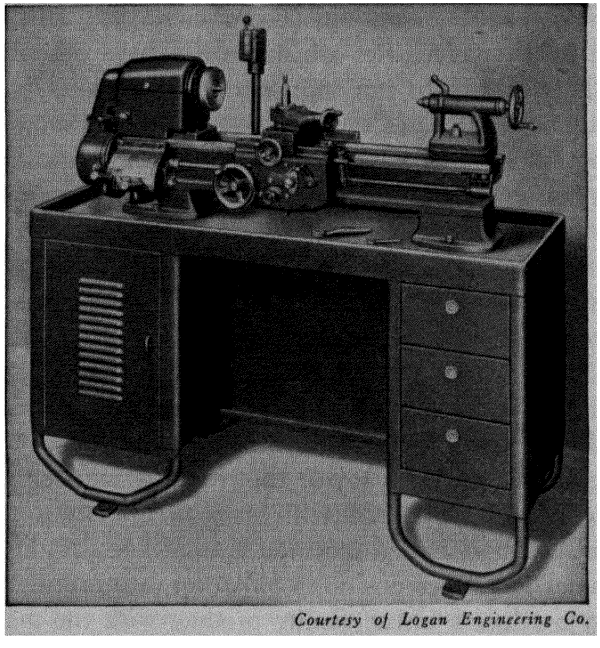

FIG. 13. A Modern Lathe

a piece of wood, metal, or other hard material to which a cutting tool is presented. The earliest form of lathe was the potter's wheel which was used in ancient times in the making of vases, bowls, and other pieces of pottery. It was a crude table which was rotated and on which a lump of clay was molded into symmetrical form by the hands of the worker. An improved type of potter's wheel is still used in making many types of china. A modern lathe is shown in Figure 13.

In a manually operated lathe the cutting or shaping tool is held or clamped against a rest. In a semiautomatic lathe the tool is held in a

[2] For further discussion of this point, see Earle Buckingham, *Production Engineering* (New York: Wiley & Sons, Inc., 1942), pp. 62–67.

slide which automatically moves across the part to make the desired cut. A number of cutting tools may be fixed in a turret or monitor which is pivoted in such a manner that any one or more of the tools may be presented to the work. The lathe is adapted to a wide variety of operations by a change in the cutting tools.

Another widely used general-purpose machine is the milling machine. This machine is equipped with fluted, sharp-edged rotary cutter surfaces for shaping and dressing metal. The hobbing machine which was mentioned earlier is an example of the milling machine. It may be adapted to various types of work by changing and adjusting the cutter. The milling machine is one of the most flexible machines found in industry, since it can be used for smoothing wood or metal surfaces as well as for cutting milled edges and grooves. Other general-purpose metalworking machines are drilling and planing machines.

General-purpose equipment in industry may be compared with similar equipment in everyday use. The carpenter may use his brace to bore holes of varying sizes by changing the bit. The housewife may use her sewing machine for sewing, hemstitching, pleating, shirring, or making buttonholes simply by changing the attachments. In the same way, she can use her vacuum cleaner to vacuum rugs, upholstery, walls, or draperies. With other attachments the vacuum cleaner can be used to polish floors, to spray insecticides on blankets and clothing, or to paint furniture and walls by the spray method.

General-purpose equipment affords many advantages. Plants which are equipped with general-purpose machines can produce a variety of products by a variety of operations. In fact, a company whose products are not standardized must use machines and machine tools of a wide range of usefulness, size, and type. A second advantage of general-purpose equipment is that a change in design of the product or the addition of a new product does not necessitate new equipment or a new layout, although such a change may require changes in tools or attachments. The total investment in machinery and equipment is at a minimum because machine capacity may be utilized on many types of work. Repair costs are kept low because parts are standardized and a part may be adapted to two or more machines. Repairmen and workers are also more likely to be familiar with the operation and functioning of general-purpose equipment.

Special-Purpose Equipment. This type of equipment cannot be used for any work other than that for which it was designed. For example, a machine may be made for blowing glass bottles of a certain

size and shape. Such a machine would ordinarily not be profitable to buy because a change of product might require that it be scrapped. Machine builders can make machines especially designed for any purpose, such as fashioning, machining, or finishing a part. Much special equipment has been used by manufacturers in the mass-production industries. The installation of special-purpose equipment depends upon such factors as initial cost, maintenance required, efficiency of operation, obsolescence of the machines, possible changes in the design of the product, the volume of output, and the amount of special work the plant is expected to produce. Machines of special design may be fully automatic and capable of producing a large quantity of work within a short time. A plant may be equipped with some general-purpose equipment and some single-purpose machines to take care of special operations.

Some plants use general-purpose machines for special purposes by means of especially designed fixtures or machine tools. The machine is used continuously on the same operation until a run is completed or perhaps until the design of the product is changed. This arrangement permits the company to realize some of the economies of special-purpose machines while minimizing the costs of changes in plant layout and in product design.

Factors in the Selection of Equipment. In addition to the amount of supervision or worker attention required by a machine and the operations which it is designed to perform, the following features are important in selecting equipment:

Variances in Dimensions of Parts Machined. A machine will process a part to certain dimensions, but the parts will not be exactly the same. The standards for the product permit some variations from the prescribed dimensions which are called "tolerances." If the parts as processed by a machine vary from the standard dimensions by more than the tolerances, further machining is necessary to remove the excess material, or the parts must be scrapped. One factor in the selection of machinery, therefore, is the required exactness in the processing or fabricating of the material.

The Maintenance Necessary to Keep the Machine in Good operating Condition. Maintenance includes lubrication and the replacement or adjustment of moving parts. The ease or difficulty in adjusting or lubricating the machine is sometimes important. Repair costs are affected by the cost of repair parts and their availability. If a new gear to replace a broken one can be obtained only from the manufacturer, the purchaser of the machine may be required to keep an ab-

normally large supply of repair parts or run the risk of delay as a result of machine breakdown.

The Output of the Machine in Relation to Fuel Costs. The output of a machine should be compared with the cost of electric power, gasoline, or other power required to operate it. Automobile owners are interested in knowing the number of miles an automobile will travel on a gallon of gasoline. The output per hour or day of a production machine is also important. This figure may be compared with the miles per hour for an automobile.

EQUIPMENT FOR HANDLING MATERIALS

Among the newer phases of industrial management are the development and widespread use of specialized equipment for the handling of materials. In the days of Frederick W. Taylor, much of the handling of materials was done by hand methods. Men with shovels loaded and unloaded cars of coal and gravel. Before World War I, improved methods were developed for the movement of various kinds of materials both inside and outside the plant; but in many cases the new methods were not immediately installed. Because interest was centered in the development of efficient machinery for processing the material, inefficient methods continued to be used for the transportation of the material from one workplace to another. Since 1920 and particularly during World War II, the adoption of improved materials-handling methods has been more rapid.

Costs Resulting from Poor Methods. An obvious cost of poor materials-handling methods is the wages paid to laborers. In factories which fabricate lightweight materials, such as clothing, radio instruments, watches, or telephone receiving sets, internal transportation is less costly than it is for a cement mill or a meat-packing plant; and in some departments, the materials may be merely pushed along the bench from one worker to another, or a worker may leave his workplace to get a batch from another machine. However, this method may result in damage to delicate parts if the materials are not carefully moved. In plants which move heavy, bulky material, the wages paid to workers employed in the work of moving materials have sometimes constituted as much as 80 per cent of the total labor cost. This is a significant part of the cost of manufacture, particularly since the moving of materials does not change their form.

Poor materials-handling methods are also costly because they increase the cost of plant space. When materials are handled by manpower or by other inefficient methods, wide aisles must be provided

for trucking, whereas it might be possible to utilize overhead space. Material must be stored at the workplace and at other places throughout the plant until it can be moved. In the storeroom, material cannot easily be stacked to the ceiling unless special equipment is used to lift it and to place it back on the floor when it is needed. Space is not properly utilized, with the result that the plant operates below its true capacity. The congestion of material between departments and around the workplaces may create a false appearance of activity and productivity. Improved materials-handling equipment causes the parts to be moved along rapidly to the assembly line, the storeroom, or the shipping room.

In estimating the possible savings from the installation of equipment for handling materials, the plant engineer would make a careful survey of present methods in comparison with the proposed methods.[3] This survey might be made with or without the assistance of equipment manufacturers. The report of the survey would show the number of men engaged in moving materials, the time spent, and the labor cost. It would also include an estimate of the time lost by workers in each department waiting for materials and the wages paid for idle time. The costs of interruptions to production and the annoyance to foremen and workers due to delays in the movement of materials should also be estimated, even though the costs cannot be accurately determined. In some companies that handle heavy materials like cement or make a bulky product like tin cans, the planned production from week to week may vary considerably unless efficient methods of handling materials can be used. The cost of storage space adjacent to the workplace and the loss of overhead space that cannot be utilized without the better methods of materials handling should be estimated. Estimates should also be made of accident costs, premiums on compensation insurance, and losses on spoiled work due to the poor methods. A survey of this kind is designed to determine whether any change should be made and what type of equipment should be installed.[4]

Factors in Installation of Materials-Handling Equipment. Some plants may effect greater savings from materials-handling equipment

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[3] For forms used in making such a survey and illustrations of methods of materials handling, see *The How Book of Cost-Cutting Materials Handling,* published by Yale and Towne Manufacturing Company, Philadelphia 15, Pennsylvania.

[4] A good discussion of the various phases of materials handling may be found in the *Material-Handling Handbook,* published by the Electric Industrial Truck Association, 208 South La Salle St., Chicago 4, Illinois.

than others. Some find a conveyor system or other automatic equipment to be a necessity, while others may consider it uneconomical. The differences lie in such factors as the following:

The Weight of the Materials. Heavy materials, such as guns for battleships, structural steel, rails, and stone, require cranes and large trucks or railroad cars which may be run into the shop. Lighter materials may be moved by hand truck or other method, while very light materials may be conveyed by moving belt, carried by messenger, or pushed along from one workplace to the next.

The Temperature of the Material. Very hot materials, such as molten metal in a foundry or hot metal in a blacksmith shop, require special types of equipment. Safety is as important as economy. The handling of many chemicals creates similar problems.

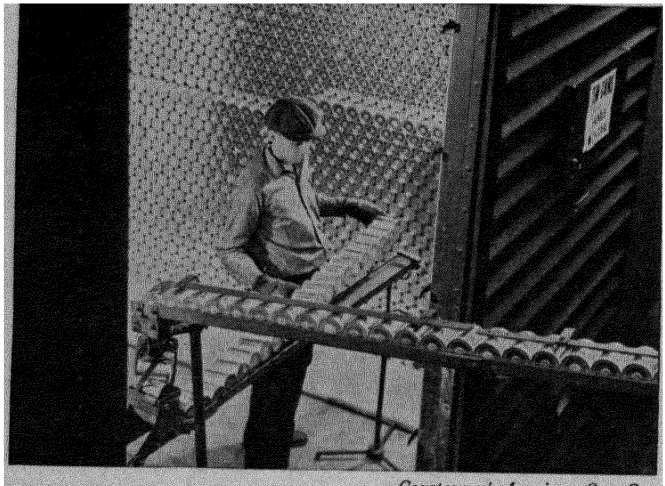
The Number of Units to Be Moved. In a bakery, the number of loaves of bread to be moved is so great and the value of each unit is so small that economy of transportation is essential. The same is true of bottles and jars in a glass factory, tin cans in a container factory, and pieces of fruit in a canning plant.

The Need for a Continuous and Uniform Rate of Movement. This problem may also be illustrated by the bakery where the loaves are carried from the oven to the slicing machine and thence to the wrapping machine, or by the operations of the wrapping and packaging department in a soap factory. A continuous and uniform rate of movement is necessary to keep machines constantly in operation. In other plants, some material may be conveniently stored at the department and then transferred to the next department in batches.

Possible Damage to Material in Handling. Before the installation of a conveyor system by a manufacturer of delicate instruments, damage from improper handling was a large item. In plants which make or assemble washing machines, furniture, or automobile bodies, the conveying equipment must be designed to prevent the product from becoming scratched or scuffed. If the materials-handling equipment does not function properly, bottles of materials may be broken, cans of fruit may be dented by dropping, and wrappings of containers may be soiled or torn. In each case the equipment must be designed to meet the requirements of the material or product to be handled.

The Distance to Be Moved. If light materials are being moved to the next bench, they may be pushed along by the worker or may be placed on a roller conveyor. Movement for a longer distance or to another floor requires a different type of system.

Flexibility Required of the System. A company which makes a number of products on general-purpose machines has a very different materials-handling problem from that of a company which makes a single product on special-purpose machines. The workplaces in a plant which makes only one product may be arranged in such a manner that the materials always follow the same course through the plant, or at least through certain departments. If a number of products are made



Courtesy of American Can Co.

FIG. 14. Movement of Tin Cans to Freight Car by Conveyor

on general-purpose equipment, a conveyor system usually cannot be installed because it would fail to provide adequate flexibility. However, some flexibility may be provided by a series of units which can be linked together like cars in a train. This method is used by a tin-can manufacturer, as shown in Figure 14.

The Fluidity of the Materials. Industries fabricating materials which can be pumped through pipe lines, or permitted to flow through gravity conveyors, or moved through the line by some mechanical means, have had the greatest development in this field. Such industries include synthetic rubber, dehydration of vegetables, tobacco, rayon, food canning, paper, and gasoline refining. The transportation of the materials is controlled automatically by instruments. During both transportation and processing, machines automatically control temperature, atmosphere, pressure, humidity, and the rate of flow similar to the way a thermostat controls temperature in an air-conditioned building. Some

instruments control a single operation; some control a batch of operations, and some the entire processing.[5]

Types of Materials-Handling Equipment. It is not possible to describe, or even to enumerate, all of the various types of equipment that are available. Hoisting machinery includes various types of cranes, derricks, cableways, bucket conveyors, power shovels, and dredges. The railway and motor-truck systems outside the plant are an important part of the system for handling materials. Elevators for moving materials from one floor to another may be automatic or may be operated by an attendant. One method of moving materials from an upper to a lower floor is by gravity chutes. To delay the descent, the chutes may be circular or spiral. The friction of the material against the outer circular wall of the chute slows its movement and prevents it from spilling out at the end of the chute.

Conveyors may be used for the horizontal movement of materials or finished products. Packages may be moved on flat-roll conveyors, gravity conveyors, or line conveyors. The use of a gravity conveyor for moving tin cans is shown in Figure 14, although some sections of the conveyor are powered. These conveyors extend from the can lines where the cans are made to the railway car in which they are shipped. As the illustration shows, cans are stacked in the car without being placed in bags or other containers. They are removed from the car in a similar manner at the canning plant and are placed on conveyors that lead directly to the production lines.

Overhead Conveyors. One type of overhead conveyor is a crane which moves on a runway. It may move the length of the shop. Overhead chain conveyors may be used to carry parts of any type from one workplace to another. The carrousel conveyor is an endless chain which moves from the storeroom to the assembly line and back again to the storeroom. It is often used to keep the assembly line continuously supplied with parts. The conveyor may be directed upward in some areas and may be dipped downward where the parts are needed. Such an overhead conveyor has also been used to store parts until they are required. A part somewhere on the conveyor line is always within reach of the worker, but it need not be removed from the line until it is needed.[6]

Trucks. Trucks may be used to pull one or more trailer loads. Some trucks are equipped with cranes for lifting heavy parts; others are

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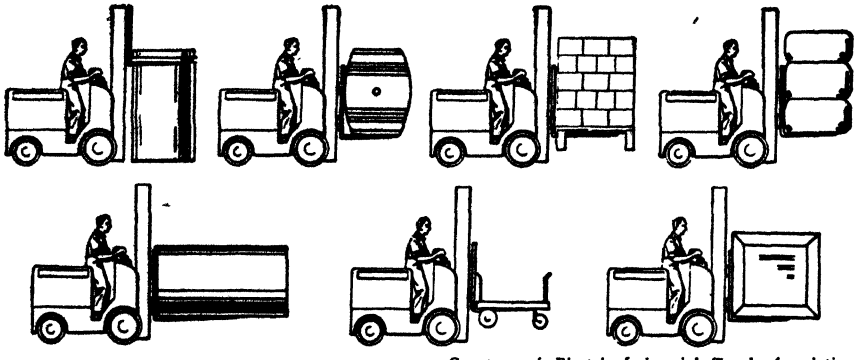
[5] "Taylor Instrument," *Fortune*, Vol. XXXIV, No. 2 (1946), pp. 89 ff.

[6] See Lewis K. Urghart, "How Traveling Stockrooms Solved a Layout Problem," *Factory Management and Maintenance*, Vol. CIII, No. 4 (1945), pp. 88–91.

equipped with forks which may be inserted beneath skids loaded with materials and which may thus lift the entire load without rearrangement. Trucks may also be equipped with devices to lift newsprint, oil drums, reels, sheet steel, concrete or steel pipe, and other materials. Some uses of lift trucks are illustrated in Figure 15.



Courtesy of Electric Industrial Truck Association

FIG. 15. Some Uses of Lift Trucks for Materials Handling

In many plants, materials-handling methods have been revolutionized by the use of pallets and lift trucks. The pallet is a platform or two-faced skid. It has a flat base that rests on the floor. Above the base are short legs or runners which support a second platform of the same dimensions as the one which rests on the floor. Material may be piled on the pallet with the cartons interlaced to prevent them from falling off when moved. When the loaded pallet is to be moved, the fork of a fork-lift truck is inserted between the two faces of the pallet, and the whole load is lifted off the floor; pallet and material are then moved to the new location. The truck can set the pallet on the floor or lift it to any desired height within a considerable range. Since the pallet has a flat base, one load of material can be piled upon another without damage to the material. With a fork-lift truck the top load of a tier of palletized material can be easily removed, or the entire stock of material can be rearranged if necessary. The method is illustrated in Figure 16.

Many special types of pallets have been designed and developed. Some are made of sheet metal; and others, boxed pallets, have boxed-in sides and a top to prevent materials from falling while they are being moved. Some boxed pallets have double-faced tops as well as double-faced bottoms. A fork-lift truck has been devised which will invert the pallet and place the opposite side up. This device is especially

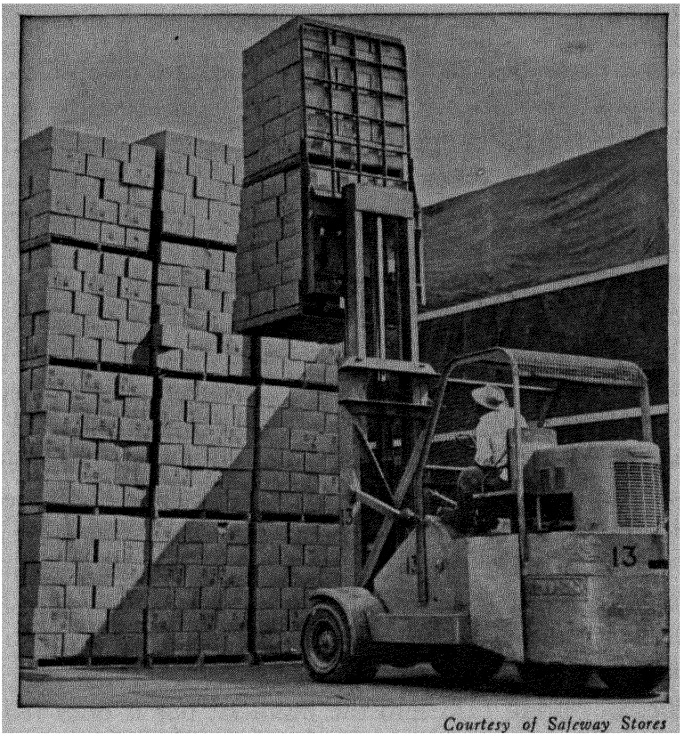


FIG. 16. Use of Lift Truck for Storing Materials on Pallets

Note manner of interlacing cartons to prevent falling. Driver is protected by grillwork above his head. Inventory taking would be facilitated if the same number of cartons were placed on each pallet. More even piling would reduce the danger of damage to cartons and contents.

adapted to up-ending condensed milk which must be turned about every thirty days to prevent spoiling. Special boxed pallets have been designed to store odd-shaped materials.

When the pallet system was first developed, it was used largely for intraplant transportation. The pallets were considered to be too expensive for interplant movement of materials unless the pallets could be returned. In recent years, many companies have begun the practice of packing finished merchandise on expendable pallets for shipment to customers. The pallets are made of cheap grades of wood or fiber and need not be returned. Each shipment of this kind constitutes a relatively large quantity. The amount stacked on one pallet should be planned in relation to the usual quantities purchased by customers and the width of the freight car or truck in which the shipment is made.

THE REPLACEMENT OF EQUIPMENT

Equipment must ultimately be scrapped because of obsolescence or decreased operating efficiency. Obsolescence means that the equipment ceases to be economical in operation because more efficient machines or processes have been developed to perform the same or similar work.

Decreased operating efficiency is reflected in lower output per hour, a larger amount of time when the machine is out of use for overhauling or repairs, and the increased cost of labor and parts for repairs. Ultimately, machinery will have to be junked regardless of the regularity and the thoroughness of the repairs and maintenance.

Policy of Continuous Replacement. Continuous replacement is effected by using the funds provided each year by sales or other income and retained in the business by the depreciation charge.[7] For example, if the equipment is estimated to have an average life of ten years, the annual depreciation charge would be 10 per cent. When an entry is made in the accounts charging depreciation of machinery, the effect is not only to decrease the profits by the amount of the entry but also to retain cash in the business by the same amount, provided that the business is not operating at a loss. The entry for the depreciation charge does not bring cash into the business; but it does reduce the amount available for dividends or required for the payment of income taxes. In the absence of a definite policy of machine replacements, the amount of cash retained in the business may be used for any purpose, such as the payment of liabilities or an increase in current assets. By action of the management, the funds withheld may be used to replace any equipment which has become so inefficient that it should no longer be kept in operation.

The policy of continuous replacement is effected through the cooperation of the plant superintendent, the foremen, and the plant engineer. Equipment which is known to be inefficient in use is listed by the shop superintendent and is then investigated by the management. Comparison is made with new equipment which is available for replacement, and replacements are made where the operating economies appear to be most promising. The total amount spent for new equipment in one year is limited by the amount of the funds provided by the depreciation charge.

The advantage of the policy of continuous replacement is that it usually results in the scrapping of machines at the end of their useful

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[7] Lewis H. Kimmel, *Depreciation Policy and Postwar Expansion* (Washington D.C.: Brookings Institution, 1946), p. 9.

life. No attempt is made to keep machines in operation indefinitely after the period of their useful life is passed. It is also argued that any other policy causes the funds provided by the depreciation charge to be invested elsewhere, even though the purchase of equipment would be better business policy. Continuous replacement also equips the shop with machines which embody the latest principles of machine design and construction.

The policy of purchasing new machines each year in an amount equal to the annual depreciation charge will result in a stable net dollar investment in machinery and equipment from year to year. If the price level remains stationary, the physical units of machinery in use will also remain fairly uniform. During periods of rising prices, however, the method is inadequate. The depreciation charge does not provide sufficient funds to replace the machines at the higher prices, and the physical equipment of the company will gradually deteriorate in terms of productive units. This difficulty can be met only by using as a basis of the depreciation charge some figure other than original cost, or by supplementing the funds retained by the depreciation charge with additional funds provided by profits or by borrowing.

Estimating Savings from Replacement. A second policy in the replacement of machines provides for their purchase only when the savings will pay for their cost within a few years. A new machine may operate more efficiently because of savings in labor, power, repairs, supplies, and space costs and because of greater output. However, the new machine may result in higher costs in some respects, such as depreciation, taxes, and insurance. To determine whether the purchase of a new machine to replace an old one is profitable, the total cost of operating each machine may be computed and the difference in costs determined.

The method of estimating the savings from the installation of a new machine raises many theoretical questions. Formulas have been developed by different companies for estimating the savings from scrapping an old machine to buy a new one, and some of them are quite complicated.[8] To illustrate the difficulty, assume that a company has a semiautomatic machine which it acquired five years ago at a cost of $30,000. Its capacity is 28,000 units per year. An automatic machine is now available at a cost of $40,000, but its capacity is said to be 40,000 units per year. The new machine will have lower costs for labor, maintenance and repairs, and power; but it will require greater

[8] See Charles A. Koepke, *Plant Production Control* (New York: Wiley & Sons, Inc., 1941), chap. xii, "Machine Replacement."

costs for floor space, taxes, and insurance. Interest is computed at 5 per cent on original cost. In each case, depreciation is 10 per cent. The cost accountant might make up a table similar to Table 1.

TABLE 1

COMPARISON OF COST OF OLD MACHINE AND NEW MACHINE

	Old Machine (5 Years Old)	New Machine
First Cost	$30,000	$40,000
Annual operating costs:		
Labor	$5,000	$1,000
Maintenance and repairs	300	200
Power	1,800	1,500
Depreciation, 10 per cent	3,000	4,000
Interest, 5 per cent	1,500	2,000
Floor-space cost	400	600
Taxes and insurance	2,000	4,000
Total cost per year	$14,000	$13,300
Number of units produced	28,000	40,000
Cost per unit	$0.50	$0.3325

This tabulation shows that the new machine would cost $700 less per annum and that the cost per unit with the new machine is only 33.25 cents, as compared with 50 cents per unit for the old machine. However, depreciation and interest on the investment in the old machine are figured on original cost, whereas the machine is now five years old. Both of these expenses should be computed on present value. If the old machine is assumed to have a trade-in value of $3,000, the expenses would be computed as in Table 2.

TABLE 2

COMPUTATION OF COSTS WITH OLD MACHINE ON THE BASIS OF PRESENT VALUE

Annual operating costs:	
Labor	$5,000
Maintenance and repairs	300
Power	1,800
Depreciation, 20 per cent of trade-in value of $3,000	600
Interest, 5 per cent of trade-in value	150
Floor-space cost	400
Taxes and insurance	2,000
Total cost per year	$10,250
Cost per unit	$0.3661

The total annual cost of the old machine is now shown to be only $10,250, and the cost per unit is only 36.61 cents. This computation indicates a slightly lower cost per unit with the new machine. How-

ever, a decision to purchase it should not be made until some other factors have been considered.

The new machine has a capacity of 40,000 units, whereas the old machine has a capacity of only 28,000. If the old machine is adequate to take care of existing demand, the purchase of the new machine might result only in unused capacity. On the other hand, if the old machine is inadequate, the new machine might lower costs on other machines by permitting them to operate at nearer capacity. A further consideration is whether changes in the design of the product are contemplated. A change in design might make the new machine obsolete before its cost could be recovered in production. These uncertainties suggest that formulas cannot be used as infallible guides to policy in such matters but that the final decision will depend upon the judgment of management.[9]

POWER

Although problems relating to power are important to management, a discussion of their technical phases is beyond the scope of this book. Engineering advice should be sought before any decision is made on any power problem. The principal problems relating to power would be as follows:

The Source of Power. Electrical power may be supplied by steam, hydroelectric, gas-engine, or internal-combustion-engine plants. A good source of power would be adequate for the work to be done. The flow should be even and dependable.

Alternating or Direct Current. Alternating current is commonly used because it can be transmitted more economically over long distances. Although direct current has some advantages in use, it must be transmitted and used at the voltage at which it is generated.

Purchased Power or Ownership of Power Plant. Any one of the following policies might be adopted:

Ownership of power plant capable of meeting maximum needs.

Ownership of power plant capable of meeting the normal load, purchase of additional power.

Purchase of normal power requirements, ownership of power plant to meet additional requirements.

Joint ownership of power plant by two or more companies with complimentary requirements as to peak loads.

Purchase of all power.

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[9] For further discussion of this point, see E. E. Lewis, "The Control of Capital Expenditures and the return on Capital Investment," *Bulletin of National Association of Cost Accountants,* Vol. XXII, No. 6 (1940).

The decision to purchase power or to own a power plant should be based upon such factors as total cost, possible increase in rates by the local utility company, dependability of service when needed, possible expansion of the business, extent to which the business has established itself in the industry, and available capital.

Type of Drive. There are four types of power drives, namely, single-motor drive, group-motor drive, unit-motor drive, and a combination of group-motor and unit-motor drive. In the single-motor drive, one motor supplies the power for all machines in the plant. Connections with the motor are made by means of shafting and belting. In the group-motor drive, one motor supplies the power for a group of machines. In the unit drive, each machine is equipped with its own motor. The single-motor drive is now seldom used, since it does not permit sufficient flexibility in plant layout. The shafting and belting interfere with lighting and the movement of materials and create an accident hazard. Its advantage is low initial cost. The unit drive has the highest initial cost, but it permits the maximum flexibility in plant layout.

LABOR AND MACHINE PRODUCTION

When the introduction of a new machine results in net economies in production costs, the usual reason is that labor costs are decreased. To the worker, the increased use of machinery may mean temporary unemployment. Older workers may suffer a permanent reduction in pay, rank, and social status, since the machine may reduce the amount of skill required by the worker. At best, the introduction of the machine means uncertainty, worry, change, and readjustment, which the worker seeks to avoid.

The cost of unemployment caused by new machines may be borne in several ways, such as the following:

1. The worker may be thrown out of work and required to find a new job for himself. This policy places the cost on the worker and his family and is particularly costly to older workers. The cost is greatest when improvements in machines are made during periods of depression.
2. The worker and his family may be compelled to seek gratuities from local charitable organizations. This policy places the cost upon the people who live in the neighborhood of the plant.
3. The federal government may provide public works or make-work projects to support workers who are otherwise unemployed. This policy places the cost upon the taxpayers.

4. The employer may keep the displaced worker on the payroll until he finds work elsewhere. This policy places the cost upon the employer. If all employers follow such a policy, they may be able to raise prices and to shift a part of the cost to the consumers of the product.

5. All employers may jointly bear the cost through unemployment insurance as provided by social security legislation. The government may bear a part of the cost through its payment of the expenses of the administration of the plan. The incidence of the cost is uncertain. The cost may eventually be borne by consumers as a result of higher prices, by workers as a result of lower wages, or by stockholders as a result of decreased profits.

The introduction of machinery is frequently regulated by contract between the company and the union. The contract may contain such provisions as the following:

When a reduction of employees is contemplated because of mechanization, the company shall endeavor to agree with the union upon an equitable solution before it dismisses any employee.

The union and the employees affected shall be notified six months in advance of the proposed changes. The employees shall be given an opportunity to learn new skills or acquire additional knowledge.

Dismissals, when necessary, shall be made in the reverse order of seniority.

An employee who is dismissed shall be given preference over a period of one year for re-employment for any vacancy for which he is qualified.

Severance pay for an agreed number of weeks shall be paid to any employee who is dismissed because of mechanization.

Even though management is not required by union contract to respect worker attitudes and interests in introducing laborsaving devices, it should not fail to do so in every case. Some of the desirable management policies concerning mechanization are as follows:

Workers and foremen should be trained in the new methods of production. This policy will lessen the problems of readjustment.

The earning power of workers whose jobs are affected should be protected. Workers will naturally oppose machines if their pay is to be reduced.

Major technological changes should be introduced during periods of increasing production, when displaced workers can be employed in new jobs.

Normal labor turnover should be permitted to take up the slack caused by technological change. This policy does not completely solve the problem of community technological unemployment, but it will greatly lessen the shock.

Increasing mechanization of industry must be expected because the introduction of machines is both economically and socially advantageous. If the cost is borne by industry or by all the people, the results

will be beneficial to everyone concerned. Workers cannot be expected to bear the total cost of mechanization. The growing power of organized labor gives assurance that they will not be required to do so.

QUESTIONS

1. A manufacturer of alarm clocks provided for the transportation of the product in process of manufacture by having men pick up the clocks and carry them from one workplace to the next. What economies might be realized by providing a belt conveyor adjacent to the workplaces on which each worker could place the clock when he had finished work on it?
2. Indicate the types of materials-handling equipment which would be suited to each of the following operations:
   (*a*) Movement of loaves of bread in a bakery from the oven to the slicing machine.
   (*b*) Movement of wheat from railway car to elevator.
   (*c*) Assembly of candy in a box in a candy factory.
   (*d*) Movement of cases of canned food from storage in a warehouse to the shipping room.
   (*e*) Movement of dresses in process of manufacture from one machine to another.
   (*f*) Excavation of dirt and movement to a vacant lot for a fill.
   (*g*) Movement of molten metal in a foundry for pouring.
3. What factors influence the type of materials-handling equipment which is suited to any operation?
4. What are the advantages of the pallet system? For what types of materials is it suited?
5. How does the depreciation charge provide funds for the replacement of machinery and equipment?
6. What argument may be made for the policy of purchasing machinery and equipment each year in an amount equal to the depreciation charge? What is the objection to this policy?
7. Can the introduction of a laborsaving machine be justified even though a worker loses his job?
8. Is a labor union wise in opposing the use of laborsaving machinery? What is the best policy for the union?
9. Who should bear the cost of technological unemployment? In what ways may the cost be shifted by the employer? Why is the government concerned with the answer to this question?
10. What can management do to reduce technological unemployment?

CASES

17. SAVINGS FROM MACHINE REPLACEMENT

The following information is available concerning a machine now in operation and a new one that is available for the same work:

	Old Machine	New Machine
Cost new	$60,000	$100,000
Power costs per year	5,000	3,000
Labor and supervision	8,000	2,000
Space cost	500	800
Repairs and maintenance	800	200
Taxes and insurance	3,000	10,000

Depreciation is computed at 10 per cent per annum for both machines. Interest is computed at 5 per cent. The old machine is six years old, and a reserve for depreciation has been set up in the books in the amount of $36,000. Trade-in allowance for the old machine is $10,000. Unit capacity of the old machine is 10,000 per year, of the new machine 30,000 per year.

Required:

Prepare a report to show the cost per unit with the present machine and with a new one now being offered for sale in the market. Point out any additional factors which should be considered before a decision is made as to the purchase of the new machine.

18. METHODS OF MATERIALS HANDLING

The Moore Spring and Wire Company, located in Oakland, California, manufactures automobile seats, bedsprings, wire fencing, and miscellaneous wire products. The raw materials consist of wire, rods, and certain textiles used in covering automobile seats. Most of the products are made on order according to specifications of the customer. The plant is a one-story building in the industrial area.

The manager of production planning has had some difficulty in having deliveries of materials made to various work stations on schedule. The parts are small, and many of them are required for a single product. The present plan of materials handling provides for loading the parts on hand trucks or platform trucks. In accordance with instructions from the planning department, the trucks are loaded in the receiving room or the stockroom; and the truck is pulled by a worker to the first station. Work in process of production is moved in a similar manner. Work is unloaded on the floor adjacent to the machine where the next operation is to be made. This method slows deliveries and is expensive in labor cost.

The manager of production planning has proposed to the plant superintendent that the company install a trackless train for moving materials. He knows that this method has been successfully used for many years by some of the automobile companies. A train would consist of a gasoline-powered or electric truck which would pull a number of trailers resembling the flatcars of a train. Materials would be loaded on the trailers in the receiving room. Materials regularly carried in stock would be loaded in the stockroom. Bulky materials would be placed directly on the trailers. Small parts would be placed in boxes or pans, which would then be lifted to the trailers. Trains would be assembled

in the receiving room and also in the stockroom. In each department the trailer carrying materials or parts for processing at each machine would be detached from the train and placed in a side aisle until needed. Loaded trailers would be attached to the train for movement to the next department or to the shipping room. The trains would run on schedule, although the schedule might be altered in emergencies. At the end of a run, the driver of the truck would telephone the dispatcher concerning his next assignment. Aisles are believed to be sufficiently wide to permit the maneuvering of the trains. Space for parking trailers in the departments is considered sufficient. The chief engineer has said that the floors can safely support the trucks and loaded trailers.

An alternative method suggested by the plant service manager is the use of lift trucks and pallets. Materials would be loaded on pallets to be picked up by lift trucks and moved to the departments. Empty pallets would be returned to the receiving room or the stockroom. Less space would be required for the storing of empty pallets than would be required for trailers.

Questions:

1. What are the advantages of the proposed methods?
2. What additional information might be required before a decision is made to adopt either of the proposed methods?

19. USE OF DISPOSABLE PALLETS

The American Chemical Company produces a varied line of chemical products which are sold to other manufacturers. The chemicals are packed in heavy cartons about 36 inches in height and 12 inches wide. The usual practice has been to mark and ship the cartons individually to customers, even though the customers usually order a large quantity. The cartons are heavy in construction to withstand rough handling. Cartons are loaded in freight cars and also unloaded by hand truck. One carton constitutes a load for one truck, and a man is required to handle each truck.

The company has been experimenting in developing a less expensive method of shipping. The engineering department has developed a cheap type of wooden pallet, which has five strips of wood on the upper face and three strips on the lower. The size permits the placing of twelve cartons of the chemical on a pallet. The engineers have also developed a cheaper type of cylindrical paper carton to replace the heavier cartons now being used. Investigation shows that customers usually buy 12 cartons of the chemical at a time. The company proposes to pack the chemicals for shipment in the lighter weight cartons packed in units of 12 on each pallet.

The method of packing for shipment would be as follows: The pallet is placed on the floor, and the bottom of a corrugated shipping box is placed on the pallet. The 12 cartons of chemicals are then placed in the shipping box. The top of the shipping box is then placed over the shipment, and steel strips are fed through the pallet and around the shipping box. The strips are fastened to make the box secure. The unit is then picked up by a lift truck and loaded into a railway car. They are unloaded by the customer in a similar manner. Customers are permitted to keep the pallets for their own use.

With the new method, one man can load and unload 12 cartons at a time. Loading and piling inside the car can be done without lifting by employees. The accident hazard is reduced. The container weight is reduced because of the lighter weight cartons. Damage in transit is expected to be reduced substantially. Only one unit needs to be labeled and entered on a bill of lading. Similar economies will be realized by the customer. As far as can be determined, all customers own and operate lift trucks.

Questions:

1. What expenses would be increased and what expenses would be decreased by the new method?
2. What complications would be encountered if customers ordered less than 12 cartons at a time?
3. Should customers be consulted before the change is made?

20. TECHNOLOGICAL IMPROVEMENTS IN THE TELEPHONE INDUSTRY

In 1950 the Communication Workers of America, C.I.O., commented as follows on technological developments in the telephone industry:

"Part of A.T.&T.'s program involves conversion to dial handling of phone calls. Thousands and thousands of telephones have been cut over to dial since the end of the war. Long distance operator toll dialing has been introduced and is spreading across the country. . . .

"Included in the wonder gadgets of A.T.&T. is an automatic billing system called the Automatic Message Accounting Device. With this device it will soon be possible for a subscriber to dial direct to a suburb or to a city thousands of miles away. This device threatens to eliminate thousands of clerks as well as operators since it records, times, and bills the subscriber in a single operation.

"Improved cross-bar dial equipment, unattended exchanges, radio-telephone links, coaxial cable, a telephone with a volume adjuster making it possible for the subscriber to regulate the loudness of his phone bell, and countless other devices are cutting down the work available in the telephone industry. . . .

"Telephone developments present an impressive picture but are less impressive to the phone worker thrown out of a job. Less obvious but equally important is the overall unemployment problem which is becoming more pressing as time goes on."

Questions:

1. What provision should the company make for workers displaced by technological developments?
2. What should be the policy of the union concerning technological improvements?

CHAPTER XI

LAYOUT

LAYOUT is a problem that confronts the manager in any type of business or activity. The arrangement of a workplace may be economical and effective, or it may be uneconomical and ineffective. In any enterprise the management must decide what departments or workplaces are necessary or desirable, must fix their location in relation to each other, must determine the proper amount of space to be assigned to each, must plan the boundaries of aisles and gangways for transportation and communication, and must provide for the location of facilities for clerical work and for personal needs of workers. These are some of the problems of layout.

Purposes in Planning Layout. The plant is like one large machine which cannot operate efficiently unless all the parts function properly in relation to each other. Layout should be designed to accomplish the following specific objectives:

1. The flow of work should be rapid.
2. The cost of production should be as low as possible without sacrificing the quality of the product. Savings in cost may be achieved in the elimination of unnecessary handling of materials. Further economies may be achieved by a careful planning of the layout of individual workplaces.
3. Supervision should be easy.
4. The layout should be designed to improve working conditions. This means that the layout should be planned with due regard to lighting, the control of fumes and gases, noise control, and fatigue. Departments should be placed with regard to their special requirements. Equipment for the handling of materials may reduce the amount of handling which is required and may relieve the worker of heavy lifting.

5. The layout should eliminate or reduce accident hazards. It should eliminate hazards incident to the movement of materials, provide for sufficient aisle space, and make provision for the safe storing of materials where storage is necessary.

Essentials of Good Layout. There are many requirements for a good layout.

The material should move progressively from one workplace to another. This arrangement is sometimes described as "straight-line" layout. The essential feature is that the material not be required to double back across its previous course. This ideal is difficult to accomplish in practice because material may be processed twice at the same machine or in the same department. Some departments must be placed out of line because of the vibration of machines, the fire or explosion hazard, or other special requirements.

The capacities of various departments should be balanced. The ideal arrangement would provide that, when one department is working at capacity, all others would be working at capacity. Balance is not always possible because the capacities of workplaces vary and because some machines must be provided for stand-by equipment in emergencies. Capacity utilization can seldom be achieved because some machines are occasionally out of production for repairs, change-over, or adjustment. In most industries, daily, seasonal, yearly, and cyclical variations in production cannot be entirely eliminated. Interruptions are caused by labor turnover and transfers and the necessity for training new workers on the job.

Equipment should be efficient in operation. It should make efficient use of the plant space, including overhead space.

The method of transferring materials between jobs should fit the type of material to be moved. Manual handling of materials should be at a minimum, and the distance for moving should be as short as possible. Moving materials adds only to the cost; it adds nothing to the value by changing their form. Continuous movement of materials would decrease the value of the inventory of work in process and thereby would reduce costs. However, in many industries, it is desirable to arrange for small banks of materials at each workplace in order to avoid delays. If there are no reserves of materials at any workplace, the temporary absence of any worker or any other interruption will stop all work at subsequent operations.

Figure 17 shows a workplace which is designed with special reference to the varied requirements of materials and equipment. Materials are stored in shelves and in circular rotary bins which are divided into

Courtesy of Monarch Machine Tool Co.

FIG. 17. Workplace with Store of Materials

A store of parts at various workplaces reduces lost time due to machine breakdown and other causes.

compartments. The storage space allows for adequate supplies of materials for one week's work.

Layout by Processes. In a factory which is organized by processes, all of the machines performing the same or similar operations are grouped together to constitute a department. Since most companies make more than one product, the operations would never be precisely the same for any two products; but several operations might be performed on similar machines. To illustrate, the operations required to make a wood circle saw would include the following general steps:

Withdraw materials from stockroom and send to first manufacturing department.
Cut to size.
Punch center hole.
Punch teeth.
Round and clean teeth.
Heat and shape.
Harden and temper.
Polish.
Block and etch.
Sharpen and set.
Ship to customer.

If the company made only circular wood saws, the departments could be arranged with eleven departments, placed in the order in which the work is done. However, the factory might make such other products as hacksaws, knives, printers' steel rules, hand saws, and crosscut saws. The manufacturing of each of these products would require some, but not all, of the operations required for circular wood saws. The total number of departments might therefore be from fifteen

to twenty. In addition, a number of service departments would be necessary, such as purchasing, storage, engineering, manufacturing standards, accounting, general offices, and employee services. The location and arrangement of the service departments, except for the storeroom and shipping room, are not considered in the present illustration; and it may be assumed that they are located on the second floor, on balconies, or adjacent to the manufacturing departments.

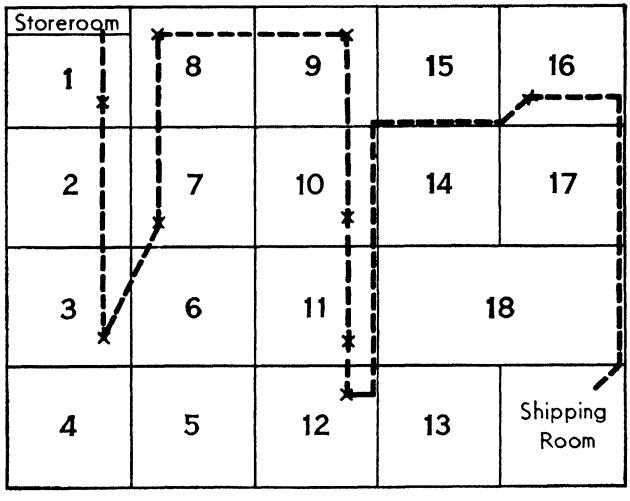

FIG. 18. Layout of a Factory by Processes

Product A is worked on at workplaces indicated by X. Numbers indicate processing department.

The layout of the plant by processes is shown in Figure 18, assuming that eighteen manufacturing departments are required. The possible course of a product through the plant is indicated by the dotted lines in the figure. The points where work is done on the product are indicated by X. This type of layout has the following advantages:

1. Workers and supervisors become specialists in one type of work, such as stamping, heat-treating, polishing, etching, or finishing. The skill thus developed is fully utilized.

2. The total investment in machines may be smaller because some machines can be used in the manufacture of more than one type of product. It is easy to keep a group of similar machines in operation if each machine can be shifted from the production of one product to another.

3. Maintenance is facilitated when machines of the same type are grouped together.

4. Any special requirements of a workplace, such as ducts to remove obnoxious gases, are easily met.

5. Adjustments can readily be made for variations in the volume of output of any one product.

6. The layout need not be changed when the production of a product is dropped or when new products are added.

Process grouping has several disadvantages, which are as follows:

1. The product must be moved long distances. Internal transportation increases the cost and adds to the noise and confusion within a department. The cost is especially large if the materials are bulky or heavy.

2. Damage to materials is likely to be increased, particularly if the goods are fragile.

3. Transportation by a conveyor system of moving belts, overhead carrousel, or other mechanical means is difficult because of the degree of flexibility required. In this type of layout the product does not follow a fixed course from one department to another.

4. The product moves more slowly because of the distances to be transported. The result is delay and uncertainties in deliveries to customers.

5. The inventory of work in process of manufacture is increased because of delays incident to transportation within the plant. A large inventory of finished goods must also be maintained because the dates for completion of work in the plant are not always dependable.

6. Transfers from one department to another frequently require inspection, counting, weighing, and other paper work, which increases the cost.

7. Much time is spent in each department in the verification of incoming and outgoing batches of work in process of manufacture.

Layout by Products. In a factory which is laid out by products, a production line is established for each type of product. Each line is organized in a manner which may be compared with the organization of a separate plant. All operations for the manufacture of one product are under the control of a division chief or general foreman. Each production line may make more than one size or style of product, but the various products are fashioned on the same machines by adjusting the machine or by using different cutting or other machine tools. To provide balance for each line, more than one worker or one machine might be used in one operation. Such a layout is indicated in Figure

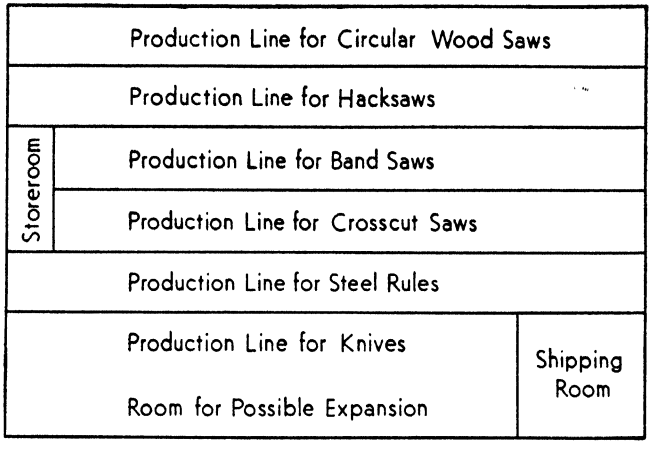

FIG. 19. Layout of a Factory by Products

19. No attempt has been made to indicate the number, shape, or position of machines within the line.

A layout by products is desirable if the number of products made in one plant is not too great and the processes differ materially. For example, a soap company might make toilet soap, granulated laundry soap, shaving cream, and wave set in the same plant. A container company might make tin cans and cylindrical boxes for salt in the same factory. Since the processes differ, a separate line would be required for each product.

Some plants produce a single line of products in a limited number of varieties, and in such a plant a layout by products may be desirable. For instance, a plant may make only frozen orange juice concentrate or refined sugar. Assembly lines for products made of many parts, such as automobiles, electric refrigerators, or computing machines, are laid out by products even though several varieties of the product must be made on the one line. Automobiles are made on a single production line even though the product may be made in more than one color, body design, and combination of accessories. A layout designed for the manufacture of one product is shown in Figure 20.

The advantages of a layout by product are as follows:

1. Distances for the movement of the product are shorter.
2. Damage to materials as a result of handling is reduced.
3. A conveyor system is more likely to be feasible.
4. The product moves more rapidly throughout the line.
5. The inventory of work in process of manufacture is reduced.

Courtesy of Victor Adding Machine Co.

FIG. 20. Production Line for Assembly of Adding Machines

6. The number of transfers from one department to another is decreased. Paper work is lessened.

7. Less time is spent in the verification of incoming and outgoing materials. Interdepartmental friction is minimized.

The advantages of layout by products are the reverse of the disadvantages of layout by processes. Each has advantages which the other lacks, and each in turn has its disadvantages. The limitations of a layout by products are as follows:

1. The workers and foremen are required to have a familiarity with dissimilar processes. The advantage of a high degree of specialization is lost.

2. Investment in machinery and equipment is increased because balance is more difficult. In other words, machines of varying capacity cannot be kept equally busy when only one or two machines are needed in the line. Idle machine capacity means lost overhead as well as idle time for workers. More plant space may also be required.

3. Special requirements of any machine or workplace for air conditioning, noise control, or light can be met only at increased cost.

4. The line is less flexible. If a product is discontinued, it may be necessary to remove the entire line. If a product is added, a new pro-

duction line may be necessary, unless the new product is sufficiently like a former product to permit production on the same line.

Since each method of layout has its advantages as well as its disadvantages, many plants utilize both methods. A large printing plant, for example, might have most of its departments arranged by processes, such as editing, typesetting, engraving, proofreading, composition, printing, and binding. In a line of printing which has a large and stable volume of work, machines and workers may be organized in a department to handle that work.[1]

Relation of Layout to Other Problems. The layout should be planned after a study has been made of the requirements of the individual plant. A layout plan cannot be adopted by one plant merely because another has found it to be feasible and economical. Some of the special problems which affect layout are:

The Type of Building. The number of stories will determine the type of materials-handling equipment which can be used. Gravity chutes from one floor to another may be possible. The height of the ceiling affects the plans for overhead cranes, the use of lift trucks, and the installation of offices or employee facilities on the mezzanine floors. Other features of the building which must be considered are possible floor loads, the types of floor covering, the presence of a basement for dead storage, the relation of the building to railway sidings and highways, the location of entrances and exists, the number and spacing of columns, and the total amount of space available in relation to the facilities to be housed. As previously explained, the building should not be leased or constructed without reference to possible layouts.

Number and Nature of Products Manufactured. The layout may be designed for the manufacture of a few products or a large number. If only a few products are manufactured, layout by processes may be preferred. The number and nature of the products also affect the types of materials-handling equipment, which in turn affect the layout. For example, lift trucks require wide aisles, particularly for turning; and pallets require sufficient storage space at the workplace. Maximum floor loads should also be considered because the floors may not support a lift truck and a load of heavy materials. If conveyors are used, the workplaces may be grouped about the conveyor. When materials and parts are pushed by hand or carried from one workplace to another, workplaces may be close together, and aisles

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[1] For a discussion of the advantages and limitations of an assembly line, see Richard Muther, *Production Line Technique* (New York: McGraw-Hill Book Co., 1944), chap. iii.

need not be so wide. Overhead conveyors may also eliminate the need for wide aisles since materials may be lifted above the floor level for moving. Similar considerations apply to other methods of handling materials.

The Nature of the Manufacturing Processes. Manufacturing processes are either continuous or intermittent. In continuous-process industries the material is carried through a series of operations. In intermittent-process industries, several parts are fabricated and then assembled. The first assemblies, called "subassemblies," may be combined with other subassemblies for the final assembly of the finished product.

Continuous-process industries are classified as analytical and synthetic. Analytical processes separate and refine the raw material to make two or more finished products. Examples are meat packing, gas and coke, flour milling, oil refining, lumbering, mining, and smelting, and branches of the chemical industries. The layout of such a plant may spread out like a fan from the point where the raw material is started in process. Each rib of the fan represents the progressive processing of a material which has been separated from the original material.

Synthetic industries combine and process two or more raw materials to make a finished product. Examples are rayon, baking, paper, cement, medicines, and soft drinks. A plant which makes a product by a series of synthetic processes may be laid out like a fan with the ribs converging upon a main line, where the final product emerges. However, the separate materials may be combined early in the process, as in bread baking; and one combined material may then be processed at a series of workplaces arranged progressively.

Type of Material. The material may be heavy or light in weight, fluid or solid, wet or dry, bulky or small, hot or cold, fragile or sturdy. If the material is heavy or bulky, it may be easier to take the machine to the work instead of taking the work to the machine. This is true, for example, in various branches of the construction industry and also in the manufacture of locomotives, streetcars, and large electrical installations. The problem of what to move is illustrated by the early experience in the automobile industry. The initial plan was to assemble a complete car in one place by bringing all parts to that place. The second step was for workers to specialize in a limited number of operations and to move from one car to another to perform their operations. The third plan was for the workmen to remain in one area but to push the chassis along from one workplace to another. The next develop-

ment was to put wooden spacers between the chassis and to push the entire line by means of a power drive at the beginning of the line. The industry finally developed the plan of a continuously moving line for the complete assembly.[2]

Type of Worker. If both men and women are employed, additional employee service facilities are necessary. The layout of the workplace may also be affected, since men have a longer reach and, therefore, a slightly larger, more comfortable working area than women. If women are employed exclusively, some types of internal transportation, such as hand trucks, cannot be used because of the greater demands which they make upon the physical strength of the worker.

The Volume of Production. This phase of the planning problem is further affected by the policy of the management in planning for increased demand by producing for stock. If the company expands production during the busy season to take care of the increased demand, it will be necessary to set up more workplaces and provide more plant capacity.

Company Policy. The policy of the company toward purchasing or making certain parts varies in each enterprise. Many manufacturers make some parts and purchase others. Parts which may be purchased include motors, door locks, carburetors, plate glass, upholstery, lumber, bottles and other containers, wire, screws, nuts, and bolts. In making the layout, the engineer must know which parts will be manufactured and which will be purchased.

Machine Capacity and Hours of Work. These two problems are closely related, since the possible output of a machine for a month or year is determined by its capacity and the number of hours it may be expected to operate. Capacity is also affected by the number of shifts, overtime work, possible work on Sundays and holidays, repair policy, and down time of a machine for change-over. Capacity is increased by a policy of making routine repairs and adjustments on Sundays or holidays.

Possible Changes in the Design of the Product. If the management anticipates a change in product design next year, it might not want to incur the expense of changing the layout of the plant to lower the cost of making the product as now designed. The total cost might be increased as a result of a revision of plant layout. The decision would be made by balancing the following factors: the volume of production anticipated during the year before product design is changed;

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[2] *Ibid.*, pp. 16–17.

the cost of revising the layout; and the extent of the change in product design which is anticipated next year.

Production Factors. If worker output is high, the number of machines and other workplaces as well as the size of the entire plant may be reduced. Productivity of workers is affected by numerous management policies as well as by physical conditions within the plant.

Making the Layout. Planning the layout is a job for the engineer. The following discussion is a brief summary of what he does.

Determines the Products. The engineer learns what products are to be produced and in what quantities.

Makes an Analysis of Each Product. In this way the engineer can determine the parts necessary for assembly. This information should be available at all times.

Prepares Flow Process Charts. A flow process chart is a diagram which indicates the processes necessary for the manufacture of a product. The process chart was originated by F. B. Gilbreth. He classified activities into five types and assigned a symbol to each type. The activities and the symbols used to designate them are as follows:

Symbol	Activity	Description
○	Operation	Any work on the material, such as drill holes, cut threads, or assemble parts.
○	Transportation	Move by truck, conveyors, elevator, or manpower.
▽	Temporary Storage	Place the material in a position to be moved, inspected, or processed.
▽	Permanent Storage	Place the material or part in the storeroom. When material is permanently stored, it can be withdrawn only by requisition.
□	Inspection	Examine or test for workmanship or quality.

A part of a process chart prepared for the flow of material in a linoleum factory is shown in Figure 21. The chart shows the number of feet the material is to be moved from one workplace to another.

After the flow process chart has been prepared, it should be determined whether any changes can be made which will shorten the time required for manufacturing or otherwise lower the cost. Special attention should be directed to transportation and storage, since these activities do not add to the value of the product. Value is added by manufacturing operations, and other activities should be incidental. In

PROCESS CHART

Operation Extruded Cots - Cot Finishing

Subject Analysis of Flow of Extruded Cots

DIST. IN FEET	TIME IN MINS.	CHART SYMBOLS	PROCESS DESCRIPTION
		▽	Rod Storage - 3rd Floor - Bldg. No. 8
6		O	To Carton 5 Rods per Move
		▽	On Flow along Side Racks in Carton 150 per Carton
116		O	To Cot Cutoff
6		O	To Bench
		▽	On Bench
		◯	Cut to Length 36 per Rod
		▽	Under Table in Shaker 1,200 to 1,500 per Shaker
6		O	To Storage in Aisle
		▽	In Aisle
20		O	To Finishing Machine - Change Hopper
		◯	Finish OD
		▽	At Finishing Machine
40		O	To Beveling Machine

Courtesy of Armstrong Cork Co.

FIG. 21. Process Chart Showing Steps in Manufacture of a Product

some cases the manufacturing operations can be improved. The following questions should be asked at each step:

Is the operation necessary to production?

Can one operation be combined with another? A finishing operation might be completed while the material is being moved. Inspection might be made while an operation is being performed, or inspection and packing for shipment may be combined.

Can the procedure be simplified by changing the sequence of the operations?

Can an operation be simplified? Simplifying an operation might mean, for example, rearranging the workplace to improve lighting, to eliminate lifting or carrying, or to reduce the hand or arm motions which are made in doing work.[3]

Determines the Machines Necessary. Since the operating capacities of different machines will vary, it is necessary to determine how many

[3] Allan H. Mogensen, "Plant Layout," *Factory Management and Maintenance,* Vol. XCIV, No. 5 (1936), pp. 246–60.

machines of each type will be required to produce the product in the volume called for by the production budget. The number of machines necessary would be determined as follows:

1. Multiply the number of units of finished product to be manufactured in any period of four weeks by the number of parts in each product.
2. Multiply the number of plant hours in four weeks by a use factor, say 80 per cent, which is the percentage of time a machine may be in actual production, to determine the estimated number of hours the machine will operate.
3. Multiply the number of hours by the output per hour to compute the output for the period of four weeks.
4. Divide the required production for four weeks by the output for one machine for that same period to determine the number of machines required. If the result in each such computation is approximately a round number with no fractional machines required, the layout can be balanced.

Space required for each machine is determined next. Space should be allowed for the materials, the worker, and the repair of the machine.

Determines the Location for Each Machine. In locating machines or other workplaces, it might be best to start with the assembly line at the shipping room and work backward to the raw materials storeroom. In a continuous-process industry, it would be equally advantageous to begin with the raw materials storeroom and arrange the workplaces in order from that point forward. If a conveyor system is installed, the machines and workplaces would be grouped about the conveyor. However, a progressive layout may be impossible because of the requirements of some departments for ground floor locations, for special lighting arrangements, for locations where dust would cause least damage, or for other special considerations. Requirements for power or compressed-air connections or for heat may also be controlling factors.

Determines the Location of the Service Departments. Service departments include the offices, toolrooms, plant library, reading room, toilets, washrooms and lockers, cafeteria, recreation hall, the dispensary and first-aid room, and other nonmanufacturing departments. These would be located near the workers and preferably where the light is not suitable for other work. Frequently, some of them may be located in a mezzanine floor which would be reached by an open metal stairway. The power plant is usually in a separate building.

The layout and arrangement of the service departments requires as much planning as does the determination of their position within the plant. Reference need only be made to the illustrations of layout of the restaurant and the office (pp. 198–200 and Figs. 25 and 26). The amount of space to be allotted to all service departments is usually estimated to be about one third of that of all manufacturing departments. If too much space is devoted to them, excess capacity is created which is seldom or never used. If the facilities are inadequate, workers are required to spend too much time waiting; or they lose time because of crowding. If the facilities are either too large or too small, the layout is lacking in balance.

Prepares a Diagram of the Proposed Layout. A diagram of the plant in two dimensions would show the floor plan of the factory with all elevator shafts, stair wells, doors, windows, and other features indicated. The machines are drawn to scale. The purpose of this procedure is to make sure that all persons who check the layout visualize the proposed arrangement in the same manner. Unless such a diagram is made, some workplace may be overlooked in the original plan and much moving and rearranging of equipment may be necessary.

Models of the proposed layout are often prepared. A model of the plant itself is first prepared on a scale which is carefully and consistently followed. In the usual scale, one-quarter inch equals one foot. If the building is multistory, the model is so constructed that the upper floors can be removed without disturbing the arrangement of the lower floors. In some cases the models may be cutouts in two dimensions. Such models are called templates. Three-dimensional models are usually preferred. A completed model of building and machines is very similar to a completely furnished doll house. Persons who are not accustomed to the reading of diagrams can easily understand the layout by an inspection of a model of the factory and its equipment. A model of this kind is shown in Figure 22.

Frequently, numerous refinements are introduced into the preparation of the models. Plastic floor sections may be prepared with one-inch squares etched into the floors. The scale on which the plan has been drawn is apparent from the etching without the necessity for making measurements. The etched lines will also show in a photograph of the model. Another refinement is the use of colors. Machine tools may be salmon color; stationary equipment, green; conveyors, yellow; and storage bins, red.

Revises the Layout. The initial plan should not be considered final. All persons who will be concerned with the new plant or who

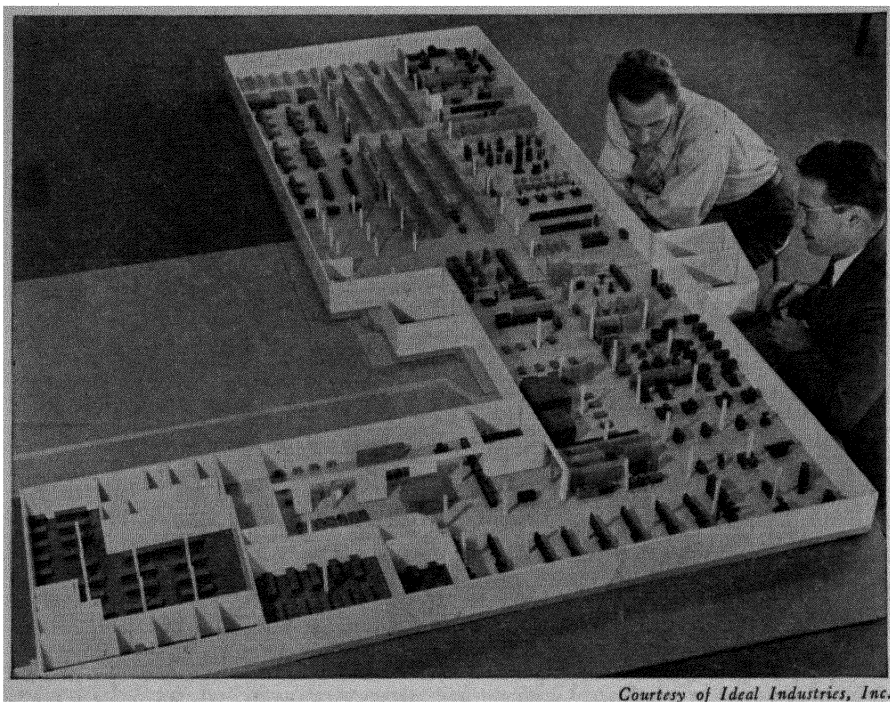


FIG. 22. A Three-Dimensional Model of Plant Layout

may offer constructive criticisms should be invited to inspect the layout. This group would include foremen and shop supervisors, time-study men, the safety director, maintenance foremen, and any engineers who had not previously participated in the making of the plan. Changes are easily made at this stage, and suggestions should be encouraged.

Completes and Installs. The next step is to make drawings and photographs of the new plan. The layout has now been perfected, and authorization to make the installations should be sought.

The new layout cannot be installed until top management has been convinced that it is practical and economical, that the change will not interfere seriously with filling current sales orders, and that the required capital outlay is not excessive. In presenting the plan to top management, therefore, the executives who are responsible for the designing should include data covering the following features:

The time required to make the new installations.

The cost of the change.

The time required for processing the product under the present and the new plan.

The value of the inventories of work in process and finished goods under the present and the new plan.

The monthly operating cost, including labor, depreciation, taxes, insurance, and all other expenses under the present and the proposed layout.

The cost per unit of product under the present and the proposed layout.

The time required for the savings to equal the cost of the new installations.

A favorable attitude of foremen and workers should be developed. Foremen should be encouraged to study and criticize the plan while it is still in the formative stage, and any practical suggestions should be incorporated into the final layout. Their suggestions will probably result in operating economies, and their attitude toward the project is likely to be favorable if they have had a part in it. The foremen's attitude may also determine whether worker opinion is favorable or unfavorable.

The worker should be informed of the proposed changes by the management. He should not be permitted to get this information through the rumor factory or the grapevine. As soon as rumors begin to spread, the worker fears the worst for his job and his pay envelope. As economy is the purpose of the change, each worker may think that his job is one of those to be dispensed with or that his job is to be simplified and that his pay may be reduced. Fear and suspicion should be dispelled by a free discussion of the proposed change and its effects. The worker may receive his information from the foreman, through the public address system, through bulletin board announcements, and in other ways.[4]

Some Examples of Layout Problems. The problems of layout can be illustrated by reference to some concrete examples. A simple example is the layout of an office which handles correspondence through the following steps:

1. Document enters unit at mail desk.
2. Mail clerk passes case to file clerk.
3. File clerk obtains previous correspondence from files.
4. Case goes to supervisor.
5. Supervisor assigns case to clerk A, who prepares in draft the necessary forms.
6. Forms typed by typist C.
7. Bookkeeping clerk reviews case and makes required entries.
8. Case passed to clerk D, who checks forms typed by typist C against draft prepared by clerk A.
9. Case passed to clerk B, who checks accuracy of original draft prepared by clerk A.
10. Case returned to supervisor for review and letter to be written.
11. Letter dictated to stenographer and transcribed.

[4] See George De Vries, "Selling the New Layout," *Factory Management and Maintenance*, Vol. CIII, No. 11 (1945), pp. 116–17.

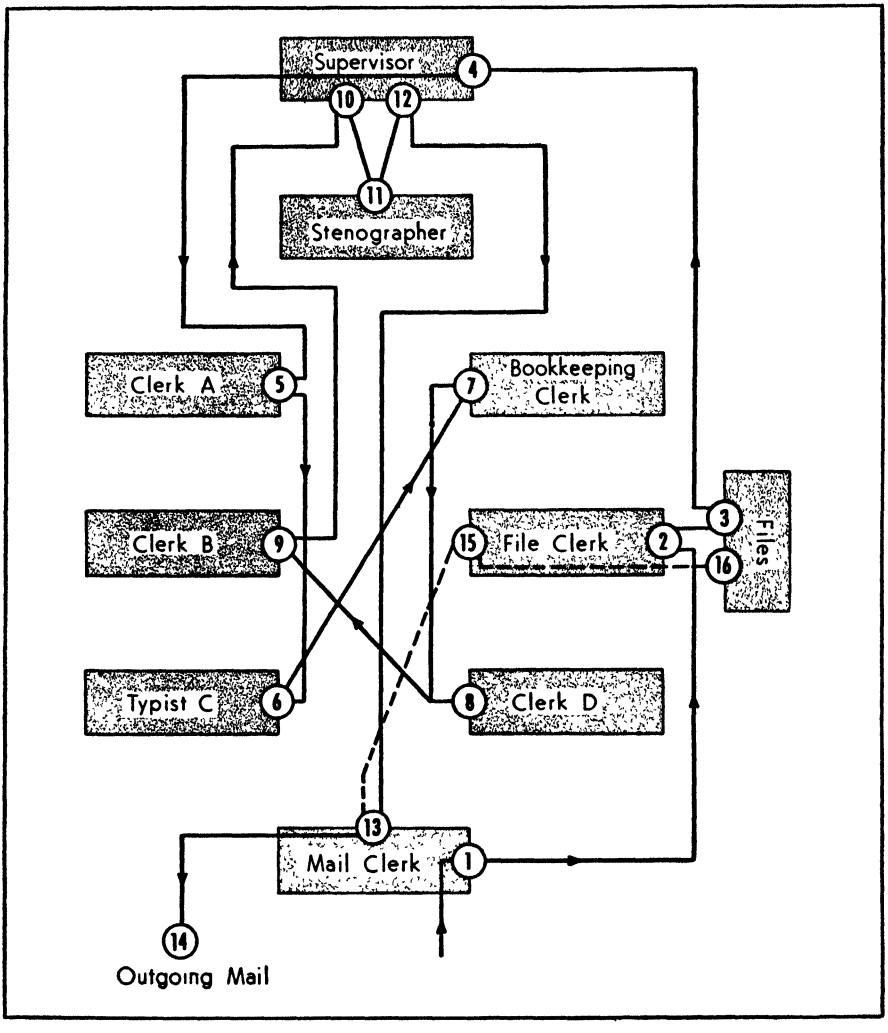


FIG. 23. Office Layout before Revision

12. Letter and forms to supervisor for signature and initials.
13. Entire case sent to mail clerk.
14. Mail clerk sends out original forms and letters.
15. Case sent to file clerk.
16. File clerk returns materials to file.[5]

The original layout for handling correspondence in this office is shown in Figure 23.

In the revision of the layout, the first step would be to prepare a process chart or a flow chart to show each phase of the manufacturing

[5] From *Quartermaster Control Officer's Handbook, 1943*, chap. x, p. 4.

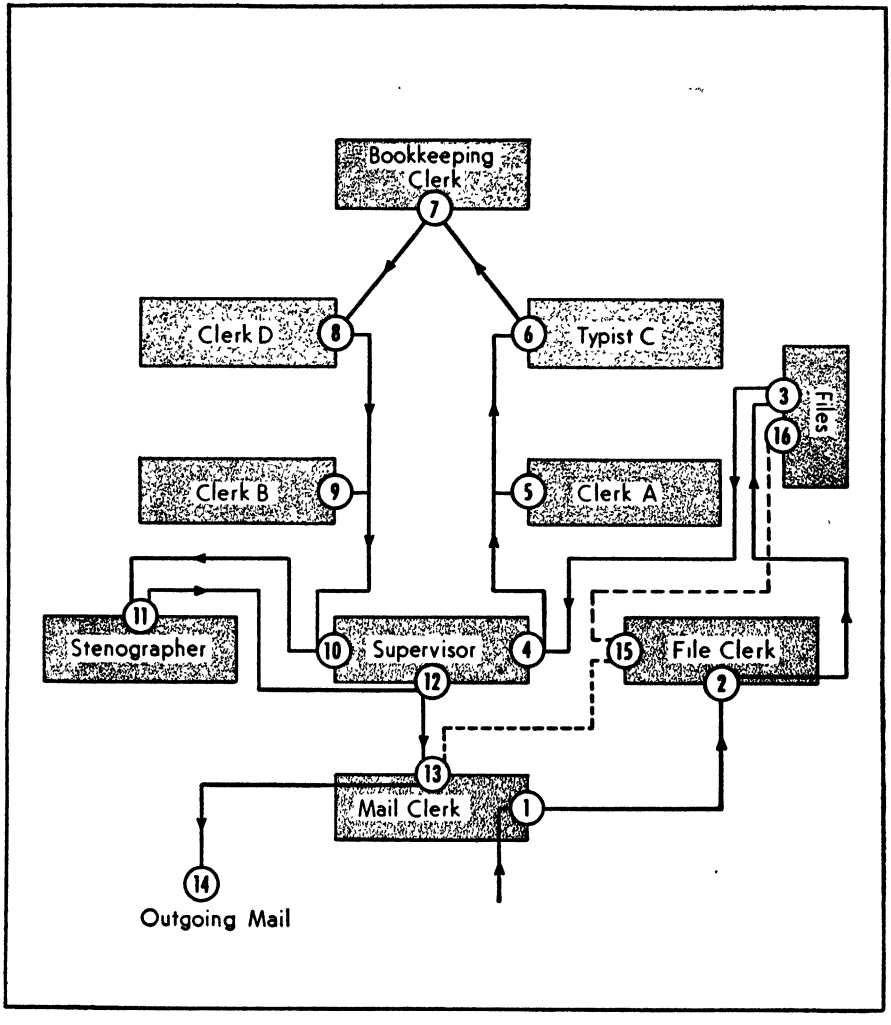


FIG. 24. Office Layout after Revision

processes, which would be designated as operation, transportation, temporary storage, permanent storage, and inspection. The processes would then be studied with the aid of the chart to determine whether any steps could be eliminated or the order of work changed. Such an inquiry might disclose that some steps are unnecessary, or that some other changes would increase production or reduce costs. After the methods of production have been improved, a revision of the layout is planned.

A possible revised layout is shown in Figure 24. In the revision the procedure for handling a case has not been changed. The new layout was designed to permit each case to proceed in an orderly fashion

from one desk to another. The purpose was to reduce the time necessary to dispose of a case, to eliminate the noise and confusion incident to unnecessary walking back and forth, and to reduce the time spent in the transfer of forms and papers from one desk to another. The saving of time in the handling of papers should increase the volume of work which can be handled and might, therefore, make unnecessary an expansion of office space in the future.

The layout of a restaurant is shown in Figure 25. The arrangement includes a number of significant features. The customer can sit at a table or at the counter. Two persons can enjoy semiprivacy at the counter because of the angular seating arrangement. This arrangement also permits a larger number of persons to be served in the available space. The circular shape of the counter creates a pleasing effect and is also economical of space. The greater amount of space is devoted to the serving of customers rather than to the kitchen. Customer services, such as telephone, seats, and rest rooms, are conveniently located in relation to all parts of the dining room. Within the circular counter area are kept prepared foods quickly served over the counter, such as sandwiches, beverages, and refrigerated foods. The layout can be adapted to a smaller room by providing two circular counter units without table space.

The layout of a restaurant is determined in large part by other management policies, such as number of customers to be served, price of

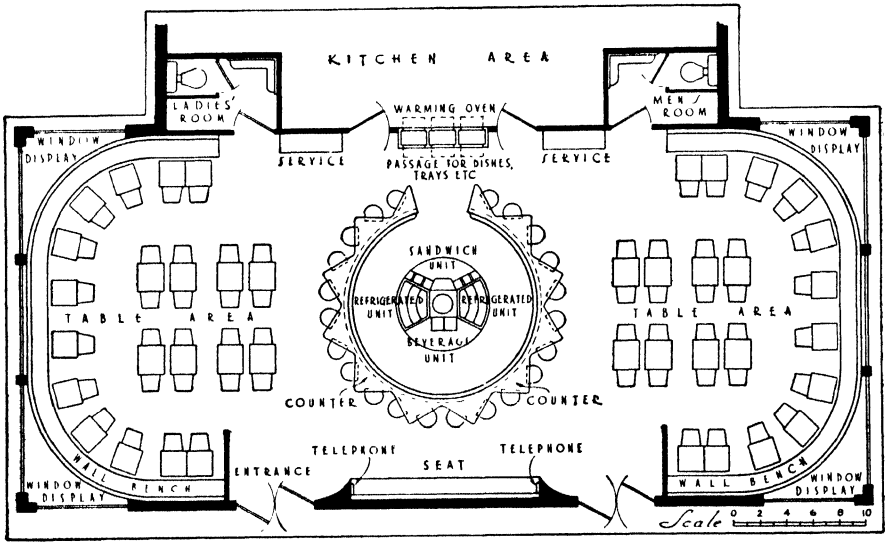


FIG. 25. Layout of a Restaurant

(Designed by the makers of Armstrong's Linoleum. Used by permission.)

meals, payment to cashier or to waitress, entertainment to be provided for patrons, and extent of variety in the menu. These factors affect both the allocation of the space and the arrangement.

QUESTIONS

1. Indicate whether layout by products or by processes would be desirable in each of the following, and give reasons in each case:
   a) A soft-drink bottling company which produces soda in five flavors.
   b) A bakery which produces bread of four kinds, cake, and doughnuts.
   c) A cement mill.
   d) A meat-packing plant which produces dressed, cured, and canned meats.
   e) A flour mill.
   f) A furniture factory which produces various kinds of cheap furniture.
   g) A job printing plant.
2. What would constitute an ideal layout for a factory? Is the ideal arrangement always possible? Why?
3. What is meant by "progressive layout"? Is it the same as straight-line layout?
4. A manufacturer makes a product requiring two coats of paint which are dried in the oven. His method is to apply the first coat and move the parts into the oven on racks for drying. The parts are then returned to the paint department for the second coat of paint and again moved into the oven. Suggest a method of improving the processing and the layout.
5. A manufacturer makes a product in which the operations are: degreasing, copperplating, rough polishing, and fine polishing. The parts, which are small and lightweight, are moved on hand trucks from one operation to the next. The plating department is located on the fourth floor. Parts are moved to that department by means of hand trucks and freight elevator. They are then moved by hand trucks and elevator to the first floor for further processing and assembly. Suggest a method of improving the layout.
6. How can the overhead conveyor be used as a traveling stockroom?
7. A manufacturer of a mechanical device arranged for the assembly of the power unit on a small platform mounted on wheels. Each worker assembled a complete unit at one location. Completed units were then pushed into the storeroom, where they were kept until required in the final assembly. Suggest an improvement in the method of assembly and in the layout. What economies would be effected by the new arrangement?
8. A small control instrument is assembled in ten operations at ten workplaces. At each workplace, several small parts are required. Banks of materials or parts at each workplace are not considered desirable, and all the parts required for the assembly of one instrument are moved from the head of the line when the assembly is started. Suggest a layout and an arrangement which would make this plan feasible.

9. Show how the layout is affected by type of building, number of products manufactured, and nature of the manufacturing processes.
10. How are machine capacity and hours of work related to plant layout?
11. The Apex Company assigns to the plant engineer the problem of planning the layout of a new factory. What information would the engineer require in order that he might plan a good layout?
12. Why is the employee interested in the problem of plant layout?

CASES

21. USE OF PROCESS CHART

A furniture manufacturer authorized the chief engineer to study materials-handling methods and to make suggestions for improvement. The engineer found that when lumber was received by freight car, it was unloaded onto hand trucks and moved to the storage area. The lumber was stacked for seasoning. After three months the lumber was piled on kiln trucks which were pushed to the dry kiln. After drying, the lumber, still on the kiln trucks, was moved to the sawing room, where it was unloaded and piled on the floor in position to be put into process. When the operator needed a piece of lumber, he walked to the pile, picked up a piece, and returned with it to the machine.

The engineer proposed that when the lumber was unloaded from the freight car, it should be placed on kiln trucks. The trucks would have flanged wheels and would move on rails of wood with a thin strip of iron to prevent wear. A small motor truck would pull the load to the storage room for seasoning, and the lumber would be left on the kiln truck until the next move. After seasoning, the lumber would be moved to the kiln for drying. After drying, while still on the kiln truck, the lumber would be moved to the sawing room and placed in position on a hydraulic lift similar to those used in automobile service stations. The top of the pile would be at the proper height to enable the worker to remove the lumber without stooping. As the lumber was used, the load would be lifted gradually so that the worker would always be working at the proper level.

Required:

1. Prepare process charts to illustrate the old and the new methods. Use symbols as shown on page 193.
2. Explain how the management could determine whether the new method would effect savings in cost.

22. DETERMINING BALANCE IN LAYOUT

Capacities for various machines per day in a proposed factory layout are as follows:

Machine number	665	879	994	960
Number of units	100	75	225	50

Required:

Determine the minimum rate of production that will be required to achieve balance.

23. PROCESS CHART FOR FRUIT CANNING

The first step in the canning of peaches at the plant of the Sun Valley Fruit Company is unloading the truck of boxed fruit at the receiving platform. Boxes are placed in such position that the conveyor automatically grasps each box, lifts it, places it in position above a conveyor belt, and empties the box by pouring the fruit onto the belt. Peaches then move to a grader which sorts them by size. They then move by other conveyor belts to work stations at the halving machines. A worker at each machine places each peach in position for movement to a knife, which halves the peach and removes the stone and seed. Peach halves then move by conveyor belt past inspectors who inspect the fruit for blemishes, imperfect cuts, and stones not removed. Halves continue on the conveyor to the peeler, which gives them a lye bath, removes peelings, and bleaches and washes them. The conveyor moves the fruit past other inspectors who remove imperfect fruit. The conveyor automatically turns each piece of fruit to permit inspection of both sides. Halves are next moved to the grader, which grades them by size. At the next work stations, workers place the fruit in cans. Next, the can is filled with syrup by a fully automatic machine and moved to the closing machine, which puts the end on the can. The conveyor passes through an oven, where the fruit is cooked, and then through the cooler. Labels are put on the cans by a fully automatic machine. The cans are then placed in shipping cartons which are sealed and piled on a truck.

Required:

Prepare a process chart of the operations. Use the form on page 193.

24. REVISION OF PLANT LAYOUT[1]

The Laney Machine Works was successful in obtaining a government contract which would utilize its production capacity for at least a year. A change in layout to take advantage of the economies incident to line production was approved by the management; and Mr. Rice, the plant engineer, was given the assignment of revising the layout with as small an amount of down time as possible.

Rice first planned the new layout by means of a scale model of the plant and two-dimensional cardboard cutouts of machines and equipment. The cutouts were placed in position with due allowance for aisles, space required for materials-handling equipment, storage of materials and work in process, and various service equipment. Rice conferred constantly with the plant superintendent, foremen, and others in the management in making the revision. When the plan was completed, a drawing was made of the new layout.

The first step in making the change was the connection of the service lines for steam, air, and water to facilitate a quick hookup of the machines in the new location. Then the machines were numbered in the order in which they were to be placed in the production line in the new location. The position of the machine in the new location and the location number were marked on the

[1] This case was adapted by permission from John W. Colody, "How to Move Machines Fast and Like It," *Factory Management and Maintenance,* Vol. CIX, No. 8 (1951), p. 96.

floor. When a machine was to be moved, it was disconnected from service lines and placed on a skid. Work in process at the machine was placed in tote boxes and marked with the machine number. The machine and work in process were then moved by tractor to the new location and placed in position; and the machine was connected. Machines first in the line of production were moved first. By this plan, down time of each machine was kept at a minimum.

Questions:

1. What precautions taken by the plant engineer assured that machines would be properly placed as soon as they were moved?
2. What expenses would be incurred by delay and possible rearrangement?
3. Why was the co-operation of other persons in the management important?

CHAPTER XII

WORKING CONDITIONS: LIGHT AND COLOR

GOOD working conditions include adequate lighting, proper use of color in the work areas, air conditioning, elimination of unnecessary noise, possible use of music and other broadcasts, and control of monotony and fatigue. Working conditions depend partly upon the physical equipment, such as buildings, machinery and equipment, and methods of work.

LIGHT

Reference was made in Chapter II to the Hawthorne experiments in lighting and other working conditions. Although these experiments indicated that the effect of changes in physical environment can be overemphasized, they should not be interpreted to mean that such changes are unimportant. They suggested that changes in lighting can affect output by changing employee attitudes. They indicated that when one event precedes another, the first is not necessarily the cause of the second, unless the causal relationship is interpreted to include worker attitudes.

Advantages of Good Illumination. Much information has been collected to show that good illumination soon pays for its cost. Although the results of experiments in lighting should not always be accepted without reservations, the installation of a good lighting system has been shown to have several advantages. Production may be increased with good light because the worker perceives tools, materials, and machine controls more readily and can perform his tasks more quickly. In certain types of work, quality of product may be improved because the worker makes fewer mistakes when he can clearly see the work. This is true, for example, of such operations as matching pieces of cloth to make a garment, making buttonholes or performing sewing operations, painting by spray or brush, grinding, or polishing. An

automobile manufacturer found that a better lighting system enabled workers to detect more readily slight changes in shades of paint. In tobacco processing, better light aided in the grading of tobacco. In metalworking operations, micrometer scales were read more quickly and more accurately. Increased production has been found to be accompanied by less spoilage in the manufacture of such products as castings, electrical equipment, automatic machine tools, and other work made to close specifications.

Lighting conditions are closely related to other conditions of work. Floor space may be more effectively utilized because machines and workplaces can be located in space which could not otherwise be used. Good lighting also encourages better housekeeping. Poorly lighted areas and passageways afford convenient places to throw trash and to store excess material which should be returned to the storeroom or thrown into the scrap collection. Dirt is often permitted to accumulate in poorly lighted areas, while well-lighted areas are more likely to be kept clean. Accident hazards are decreased by better illumination because good light increases perception, lessens fatigue, and permits quicker nervous and muscular responses.

Lighting affects employee mental attitudes and also physical conditions. Consciously or unconsciously, employees react to better working conditions and respond by increased co-operation. Poor lighting eventually leads to eyestrain, which in turn causes defective vision, headaches, and nervousness. Workers who suffer from eyestrain feel the need for more rest and relaxation. They may seek relief by taking unauthorized rest periods, by using extra motions to delay the flow of work, or by taking days off because of illness.

Phases of Illumination. The provision of adequate lighting requires attention to two problems: the effective use of natural light and the installation of a good artificial lighting system. For day shifts, natural lighting may be used as much as 90 per cent of the time. The exact percentage varies with the type of buildings and equipment, the location of workplaces within the buildings, and the location of the plant in relation to other buildings. Artificial lighting is used for the remainder of the time for day shifts and 100 per cent of the time for night shifts. A building which makes effective use of natural light is shown in Figure 26.

Essentials of Good Lighting. An important quality of light is the absence of glare from the direct source of light or a reflecting surface. Glare is defined as excessive brightness within the field of vision. Reflected glare is caused by glossy paper, polished metal parts, or pol-

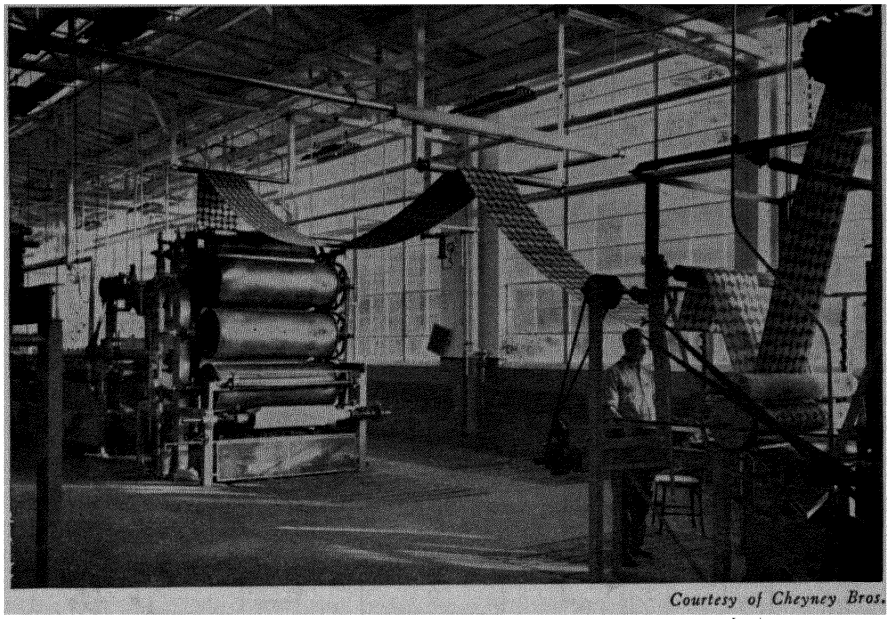


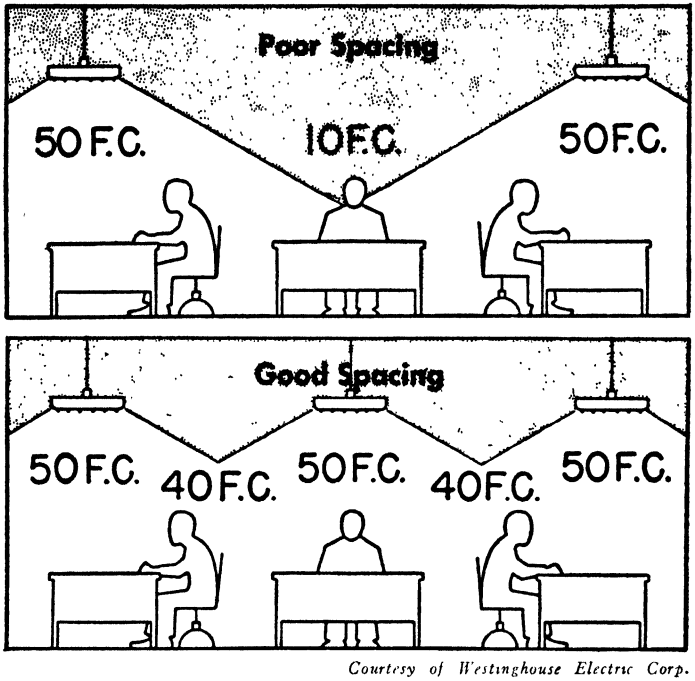
FIG. 26. Textile Mill Which Makes Effective Use of Natural Light

ished wood or glass surfaces. Glare causes eyestrain and fatigue because the eyes attempt to adjust themselves to varying and changing conditions, and a flickering light will exaggerate the effect. Glare is corrected by using a less intensive source of light, by diffusing light at the fixture, and by changing the position of the source of light.

The color of light is an important quality when the work requires color discrimination or the matching of colors. The selection of lighting equipment for a workplace where this kind of work is done is a technical problem which requires the services of an expert. If color discrimination is not important to the work, the color of light is a matter of personal preference. Most persons prefer a color which is similar to that of daylight. Women workers object to a color of light which detracts from their personal appearance. Some colors of lights when combined with the colors within the room result in a cold or displeasing effect. When this situation is found, it may be necessary to experiment with different colors of lights to find a pleasing combination.

The proper intensity of light depends upon the industry and the nature of the work. The recommended intensities in foot-candles[1] are as follows:

[1] The foot-candle is the usual standard for the measurement of light intensity. It is the amount of illumination produced by a standard candle at a distance of one foot.



Courtesy of Westinghouse Electric Corp.

FIG. 27. Spacing of Light Fixtures

Rough work, such as loading, packing, washrooms, cafeteria, conference rooms, and reception rooms: 10 foot-candles.

Casual seeing tasks, such as classrooms, filing, casual desk work, and foundry work: 20 foot-candles.

Critical seeing tasks, such as bookkeeping, stenographic work, sewing, typesetting, general fabrication, and general assembly: 50 foot-candles.

Detailed seeing tasks, such as drafting, fine assembly, inspection, and proofreading: 100 foot-candles.

Specialized applications, such as color inspection, extra-fine assembly, and fine inspection: 200 to 500 foot-candles.[2]

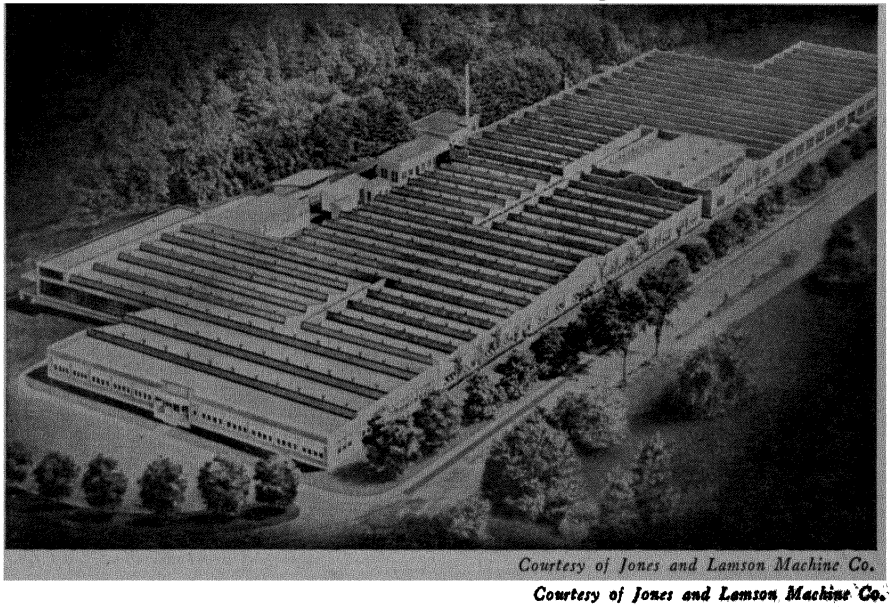
Light intensity is measured by the light falling on the workplace and is not entirely a characteristic of the light source. Intensity is affected by the distance of the sources of light, the type of reflector or lamp fixture, the arrangement and distribution of the light sources throughout the room, and the reflecting surfaces throughout the room. The effect of the spacing of light fixtures upon the intensity is illustrated in Figure 27.

Light intensity is measured by a light meter. Inadequate intensity may be manifested by employees taking work to a window on dark days to see or to inspect it, by employees squinting as they work, by a

[2] Harris Reinhardt, "Plant Lighting," *Factory Management and Maintenance,* Plant Operation Library No. CIV (1947).

gloomy and cheerless appearance of the shop or office, and by a spotty appearance caused by dark areas. Inadequate lighting may also manifest itself in a high accident rate and other results of a poor lighting system.

Effect of Building Construction. The most important feature of the building in its relation to natural lighting is the type of construction, that is, light wood-frame, brick wall-bearing, mill or slow-burning, reinforced-concrete, or steel construction. Possible window space is less in the first three types because the walls must be strong enough to carry the weight of the upper floors and the roof, whereas in the other two types the frame carries the weight, thus leaving the walls free for window space. In single-story buildings, window space can be 30 per cent of floor space, which is adequate, though no maximum percentage can be prescribed. Since light fails in intensity as it passes toward the center of the building, provision is usually made for lighting single-story buildings from above. This is sometimes done through a saw-tooth roof with the glassed side toward the north, which provides good lighting without glare; or it may be done with monitors which may cover one third to one half of the building area. A saw-tooth type of structure is especially desirable in such industries as textile manufacturing and printing, where direct sunlight is objectionable. A building with saw-tooth roof is shown in Figure 28.



Courtesy of Jones and Lamson Machine Co.

FIG. 28. A Building with Saw-Tooth Roof

Note ventilators in roof and side wall.

The color of walls is another factor in light reflection. Walls may be painted white; but gray, cream, and off-white colors are frequently used. The type of floor is another factor. Concrete floors aid in the diffusion of light, particularly in work which is done on the underside of a machine or bulky product.

Glass blocks in wall construction contribute to the effective use of natural light. They have experienced a growing popularity even though they are more costly than brick. The blocks permit the installation of greater window areas because they will carry a part of the weight of the wall above them and because no window sash is used. They are frequently used in monitors as well as in side walls. Glass blocks have a minimum of glare, and they aid in the diffusion of light.

Glass blocks in building construction have many advantages in addition to diffusing the light. The dead-air space in the blocks gives them an insulating value and helps in the control of temperature and humidity. They prevent the entry of dust and dirt, protect precision machinery, and reduce distracting sounds which may enter through an open window. The blocks are easily cleaned. Rows of glass blocks lend themselves to sweeping, flowing lines which are architecturally pleasing. Figure 29 shows a type of building construction in which glass blocks are used.

Cleanliness of Walls and Windows. It is estimated that vertical

Courtesy of Pittsburgh Plate Glass Co.

FIG. 29. A Building Constructed with Glass Blocks

windows lose from 50 to 60 per cent of their efficiency through six months' accumulation of dirt and grime on the inside and outside.[3] The exact amount of loss depends on the conditions in the city where the plant is located as well as on the air conditioning within the plant. Vertical sashes are partly cleaned by wind and rain, but windows on a slope accumulate dirt very rapidly. The glass in monitors or sawtooth roofs should therefore be vertical. The difficulty of keeping the glass clean is a serious objection to skylights.

Methods of Lighting. Three methods of lighting are used in industrial and commercial establishments — namely, general lighting, localized general lighting, and local lighting. The general lighting system provides for light which is diffused at a substantially uniform level throughout the room. Reflectors are spaced symmetrically and in uniform rows throughout the lighted area.

Localized general lighting distributes the light according to the varying requirements for illumination at the machines or workplaces. If machines or materials-handling equipment cast shadows or interfere with the diffusion of light in some areas, extra fixtures may be required to provide the necessary illumination. In the localized general lighting system, the fixtures are not arranged in a straight line or in a formal pattern. Some fixtures are out of line, and some may be nearer the work floor than others.

Local lighting directs the light toward the point of the tool or the individual workplace. Examples are desk lamps, floor lamps, bridge lamps, lighting on the underside of a lathe, light at the point of the needle on a sewing machine, and lights near the floor at the end of a row of seats in a theater. Local lighting should never be used alone because it causes a sharp contrast between the lighted area and the rest of the room. Local lighting without supplementary general lighting would cause eyestrain and fatigue.

The Source of the Light. Light may be received directly from the source, or it may be reflected. Four types of source are possible: direct, indirect, semidirect, and semi-indirect. Direct lighting is supplied by a fixture which directs all the light to the workplace. In an overhead fixture, for example, the reflector is above the light, thus preventing any of the light from reaching the ceiling, except that which is reflected from lower areas. The danger of glare from direct lighting

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[3] L. P. Alford and J. R. Bangs, *Production Handbook* (New York: Ronald Press Co., 1948), p. 796. Also Albert S. Low, "What's What in Plant Design," *Factory Management and Maintenance,* Vol. XCV, No. 4, Part 2 (1937), p. 56.

is very great, unless the fixtures are located well above the line of vision.

In indirect lighting the reflector is placed between the source of the light and the workplace, thus directing the light toward the ceiling or the wall from which it is reflected and diffused throughout the room. This type of fixture eliminates much of the danger of sharp contrasts. The difficulty is that this arrangement may not provide sufficient intensity of light. The reflecting surface should be painted a cream, white, or other light color to prevent the absorption of an excessive amount of the light, and the surface should be kept reasonably clean. Indirect lighting systems have limited application, unless they are supplemented by some other system. The cost of operation is increased by the fact that a part of the light is lost by absorption.

In semidirect lighting, some of the light proceeds from the source toward the work area and some is directed toward the ceiling which reflects it. This may be accomplished by placing a glass fixture over the light globe. The light rays may penetrate the fixture in all directions. In semidirect systems, from 10 to 40 per cent of the light is distributed upward, and the remainder is distributed downward.

In semi-indirect lighting, some of the light may proceed downward through a fixture, while some of it is directed toward the ceiling. The fixture in semi-indirect lighting is partly metal and partly glass. The metal part of the fixture provides the indirect light. In semi-indirect lighting, from 10 to 40 per cent of the light is distributed downward, and the remainder is distributed upward.

Types of Lamps. Incandescent lamps are the most familiar type of light bulb. No special equipment is required for the use of incandescent lamps. There are clear glass, frosted glass, and silvered bowl bulbs, and some other special types. The principal precaution in the purchase of incandescent lamps is to obtain them in the right size and wattage for the equipment in which they are to be used. If the lamp is too large, it may extend beyond the reflector and cause glare. If it is too small, a large percentage of the light may be trapped within the reflector, with a resulting loss of efficiency.

The mercury vapor lamp consists of a long tube in which mercury is vaporized, similar to the familiar fluorescent lamp. When first introduced, it achieved great popularity. Other forms of lighting have now partly supplanted it. Its principal limitation is that it is deficient in red rays and thus cannot be used where color discrimination is necessary. Another disadvantage is that, when the current is turned

off, the lamp cannot be lighted again until the mercury vapor has cooled. The time required is about seven minutes.

The operation of fluorescent lamps requires the use of auxiliary equipment to regulate the electric current and to make possible the operation of the lamps at low voltage. Reflectors are also especially adapted to the fluorescent light. Lamps vary in length from 6 inches to 60 inches. The color of the light produced by fluorescent lamps is determined by the color of the powders inside the tube. The colors commonly used are white and shades of off-white resembling the color of daylight.

Maintenance of a Lighting System. A system which is efficient at the time it is installed will gradually become inefficient. The causes of deterioration are the collection of dirt on the reflectors and lamps, the collection of dirt on the ceilings and walls, and the decrease in the light output of the lamps. Maintenance is likely to be neglected unless a regular maintenance schedule is established. The need for maintenance may be tested at any time by a light meter. If the illumination is no more than 75 per cent of the required standard, the equipment should be cleaned and perhaps the bulbs replaced.

COLOR

Workplaces were formerly dull, uninteresting, and lacking in color. The first change occurred when machines were painted gray instead of black and the walls were painted cream. Recently, color has been used in the workplace, with machinery painted medium green and other parts of the workplace painted yellow, orange, red, or blue. The use of color is promoted not only by manufacturers of paint but also by consultants in management.[4] The object in using color at the workplace is to induce clear, three-dimensional seeing instead of the dull, flat effect produced by use of one or two dull, dark colors.[5] Better color schemes have three definite purposes: they provide (1) better visibility because of contrast, (2) color conditions which are not too harsh for continuous comfortable seeing, and (3) color conditions which are pleasant and easy to live with.

Some Effects of Color. The color scheme should be planned in relation to the lighting system. Some colors reflect light, and others

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[4] For example, see *Color in Industry,* published by U.S. Gutta Percha Paint Company; *Color Dynamics,* published by Pittsburgh Plate Glass Company; Faber Birren, "Color in the Plant," *Factory and Management and Maintenance,* Vol. CIII, No. 2 (1945), pp. 143–50.

[5] Alford and Bangs, *op. cit.,* p. 810.

absorb light. The colors which are used overhead should be a neutral gray or perhaps white to reflect the light. A darker hue in the ceiling is objectionable because it would attract the eye to overhead pipes and girders, which are unsightly. The colors within the field of vision should not offer severe contrasts. If some of the colors used at the workplace reflect light while others quench it, the effect is similar to glare and causes eyestrain and physical discomfort. The color of the walls and machinery should be planned to avoid such contrasts. The color of materials used should be considered in choosing the colors of machinery and walls. For ease in distinguishing the details of the work, the color of the machine should complement the color of the material rather than blend with it.

It has been found that blue tends to attract the eye and that a background of blue behind the work will aid the worker in concentrating his attention upon the job. Medium green is a favorite color for machinery, and slowly moving parts of machinery are often painted buff. Bins, racks, and shelving are painted a neutral color because they are unimportant and should not attract the eye of the worker. Some colors are used as warning signals. Red is commonly used to designate fire-alarm boxes and fire-fighting equipment. Yellow is used to warn against protruding parts of machinery or equipment. Green designates first-aid equipment.

Color has a desirable effect upon the attitudes of employees and the satisfactions which they derive from their work, provided that colors are not used to excess and the scheme is carefully planned. Although persons differ greatly in their color preferences, some effects of color upon individuals are almost universal. Some colors, such as the shades of blue and violet, are cold and tend to have a subdued or even depressing effect. Other colors, such as the shades of red and orange, are relatively exciting in their effect, while yellow has a cheerful influence. Greens are usually regarded as tranquil in their effect. While these influences are weak in comparison with such forces as hunger, noise, music, or poor lighting, their effects should not be disregarded.

A motley array of color may give the effect of clutter and confusion even though the worker may be unconscious of the fact. For example, if machines are installed in a variety of colors as they are received from the manufacturer, some of which are bright and some subdued, and if alongside the new machines are old ones in dirty gray or black, the effect is certain to be disturbing. A consistent and well-planned color scheme has been found to improve worker attitudes, to encourage better housekeeping, and to result in better care of the machines. When

a color plan has been tried in one department, workers in other departments frequently ask that the plan be extended to their surroundings.

More attention is now being given to the use of color in offices, and more than one color is frequently used in the same room. For example, if the natural light is excessive, the wall opposite the windows may be painted in a color that will absorb light rather than reflect it. It is also desirable that the wall in front of the desks be soft in color to relieve the strain upon eyes raised from paper work. The color should also be so planned that the wall in the line of vision of an interviewer will have a restful rather than a glaring effect. On the other hand, the window wall may be painted a color that will reflect light since the wall on the window side is usually the darkest in the room and contrasts sharply with the windows. Likewise, the wall behind the desks may be painted a color that reflects light rather than absorbs it. If the ceiling is marred by pipes, ducts, or beams, the color of the ceiling may be planned to reduce the glare that might be caused by the shadows on the ceiling. These suggestions are not intended as a comprehensive discussion of the planning of color but are given to indicate some of the factors that should be considered.

An excessive use of color will cause fatigue because the eyes become tired of a continuous display. Some colors cause discomfort much sooner than others. Visual efficiency is decreased if a large mass of color is constantly within the field of vision, though the loss of efficiency varies with distance. Bluish green causes the greatest loss of efficiency, while yellow is least fatiguing. The color scheme should be planned to reduce fatigue and to prevent light absorption, color contrasts, and distracting effects.

The planning of color schemes is a problem which requires the services of a specialist. Advice on the use of color may be obtained from representatives of paint manufacturers or from management consultants.

QUESTIONS

1. A company installed a new lighting system and during the next six months found improvement in worker performance in the following respects:
   a) Output increased.
   b) Rejects in inspection decreased.
   c) Absenteeism decreased.
   d) Accidents decreased.
   e) Fewer workers complained of headaches during the workday.
   Should the company conclude that the lighting system was the cause of the better performance? Why?

2. Compare the methods used in the Hawthorne experiments with the methods used by Taylor and Gilbreth. Can the Hawthorne experiments be said to be more scientific?
3. What did the Hawthorne experiments prove concerning the value of a good lighting system? What did they prove concerning the method of determining the worth of a management device or technique?
4. What is glare? Why is it objectionable? How may it be prevented?
5. Show how the following are related to the control of glare at the workplace: glass as a top for a desk, type of material or product, relation of the workplace to the windows, nearness and type of adjacent buildings, painting of walls and equipment.
6. Why is the color of light an important quality?
7. What factors affect the intensity of light in artificial lighting systems?
8. Show how the following are related to the effective use of natural light: plant location, height of building, type of roof, type of building construction.
9. What are the difficulties in the effective use of natural light?
10. Under what conditions is general lighting satisfactory? Under what conditions is local lighting desirable?
11. Distinguish between direct, indirect, semidirect, and semi-indirect lighting. Under what conditions is each desirable?
12. What are the advantages of incandescent light and fluorescent light?
13. What is required for the maintenance of a lighting system?
14. Is a color scheme which is suitable to a living room suitable to a workplace in an office or factory? Why?
15. Does the use of color about the workplace sound like a plan for pampering the worker?
16. Is bright blue or green suitable as a color of paint for the ceiling? Why?
17. Show why the colors to be used in an office or factory should be chosen with reference to the following: light required at the workplace; color of materials; temperature of the workplace; accident hazards, such as moving parts and the possibility of fire.

CASES

25. MAINTENANCE OF LIGHTING SYSTEM

A company installed a new lighting system in an office to provide illumination of 400 foot-candles, which was the amount of light recommended by the Illuminating Engineering Society for the type of work done in the office. Eighteen months later, a representative of an electrical manufacturer who happened to call checked the illumination with a light meter and found that the illumination was only 330 foot-candles. This amount was considered inadequate, but the decrease in illumination had not been noticed by the office manager because it had occurred gradually. An inspection for the causes disclosed that the reflecting surfaces of walls and ceilings had become darkened

by dust and smoke. Dirt and the bodies of insects had accumulated on the light fixtures. The glass in many of the light bulbs was found to be darkened. After the walls had been repainted, the fixtures cleaned, and darkened light bulbs replaced, the efficiency of the lighting system was restored to normal.

Questions:

1. If the decrease in light had not been noticed, would the efficiency of the office force have been affected?
2. What should be done to prevent a recurrence of the deterioration of the lighting system?

26. USE OF COLOR IN THE PLANT

A manufacturer of storage batteries employs about one thousand workers, of whom 75 per cent are women. The company has painted each machine a different color in order to please the workers. Colors used are various shades of red, orange, and green. The machines have also been rearranged to permit each worker to have a clear view of all machines in the department in which she works. Protruding parts of machines and piping which constitute accident hazards have been painted different colors according to the generally accepted color code used in the industry. The walls have also been painted in a variety of colors. Lower walls are pastel green, upper walls are yellow, and roof girders are a lighter yellow.

After six months of experience with the color scheme, the management reports that production has increased 20 per cent. Visits to the plant dispensary for treatment of headaches and nausea have decreased substantially.

Questions:

1. Can the company safely conclude that the color scheme is the cause of the increased production and decreased illness?
2. Is any significance to be given to the fact that 75 per cent of the employees are women?

CHAPTER XIII

WORKING CONDITIONS: AIR, NOISE, MUSIC, MONOTONY

AIR conditioning implies that all the various properties of air are controlled. The earliest and most common phase of air conditioning was heating the workplace. Natural ventilation, which was provided by opening windows, was relied upon to circulate the air and to cool the workplace in the summertime. However, in some factories the manufacturing processes give off sufficient heat to warm the place all or much of the time; and air conditioning requires attention to some other factor.

AIR

Temperature. An ideal condition would exist if, irrespective of the weather, workers were not distracted by the temperature of the air and the quality of their production were not impaired because they felt too hot or too cold. Room temperatures should not be so low as to require the wearing of gloves, sweaters, or other garments which hamper the freedom of movement; and they should not be so high as to create a feeling of oppressiveness.

The ideal temperature for all persons seldom prevails. One reason for this is that people differ as to their desires and possibly as to their needs, although each person has a comfort zone. Differences as to the desire for a certain room temperature may be due to the amount of clothing worn, health, age, sex, and possibly race. People who are engaged in different kinds of work require different temperatures. Persons doing clerical work require a higher temperature than those engaged in more active work.

In some industries the temperature must be controlled to produce a quality product. Examples of such products are candy, chocolate, and

pharmaceuticals. In high-precision manufacturing, more accurate performance is obtained from gages if they are stored and used in air-conditioned rooms.

Air may be warmed by steam radiators, hot air, or steampipes along the walls. In a small room, radiators should be placed under windows because they can warm the air as it enters the room. The principal disadvantage of this position is that the space next to the windows becomes unavailable as a workplace. In a large room, small unit heaters are often placed overhead. Such heaters are equipped with fans to provide for the circulation of air.

Radiant heating is a new system of heating the wall and floor surfaces about the worker instead of heating the air. Coils for steam or hot water are placed in the walls, floors, and ceilings. Advocates of this system contend that, since the radiant heat passes through the air without disturbing it mechanically, alternate strata of warm and cold air are eliminated. No dependence is placed upon the circulation of air to warm it. The result is that air temperatures are extremely uniform and remain at about the average temperatures of the walls and floors. The worker is never required to stand on a cold floor. Consequently, the temperature can be kept five to ten degrees lower than in rooms heated in the conventional manner. The system cannot be changed after the building has been constructed, but it has flexibility because the heating units are built in panels or units which are separately controlled. Partitions between rooms can be changed, and the units in parts of the building not requiring large amounts of heat can be separately controlled.[1]

An interesting application of the principle of radiant heating is its use for melting snow on outside loading areas in winter. Pipes are enclosed in the concrete when it is poured. The pipes, which are filled with an antifreeze solution, are connected with the heating system. When snow begins to fall, the system is turned on; and the snow is melted as it falls on the warm concrete. After the snowfall has ceased, the system is turned off and is not used again until the next snowfall. The pipes are not drained in summer and do not require refilling in winter. The same system has been used to clear runways and walkways of ice and snow.

Temperature control includes cooling the air during warm weather as well as heating it in winter. The usual system for cooling air

[1] See "Industrial Radiant Heating Pays Its Way," *Factory Management and Maintenance*, Vol. CIV, No. 7 (1946), pp. 110–13.

operates by forcing it to pass over coils which contain a substance at low temperature. The principle is essentially the same as that embodied in the construction of automatic refrigerators and ice-making plants. A compressor places pressure upon a refrigerant, such as ammonia or carbon dioxide. When the pressure is released by the operation of valves, the refrigerant vaporizes inside the lines within the refrigerating unit, cools rapidly, and absorbs heat from its surroundings. The refrigerant is again placed under pressure, and the cyle is repeated. In indirect systems the refrigerant cools a liquid which in turn cools the air. In direct systems the refrigerant cools the air. The cooling system is installed as a complete unit as it comes from the factory.

Humidity. The amount of moisture in the air is closely related to temperature, and the body temperature is controlled by the evaporation of moisture from the skin. If the surrounding air contains an excessive amount of moisture, the moisture of the skin is not readily evaporated; and the person has a feeling of discomfort due to heat. If the air contains less than the proper amount of moisture, the skin dries too rapidly.

Humidity is stated as a percentage of the capacity of the air to hold moisture. When air has all the moisture it can carry, the humidity is 100 per cent. When air cools, its capacity to hold moisture is decreased; and it may drop a part of the moisture as rain, dew, frost, or other precipitation. When air is brought inside the house and heated, its capacity to hold moisture increases. Consequently, air which was comfortable before being warmed becomes dry and uncomfortable after it has been heated. Moisture should therefore be added. A relative humidity of from 60 to 70 per cent is usually considered comfortable if the temperature is no more than 70 degrees.

In some industries the amount of moisture in the air will affect the quality of the product. In the processing of cotton or cotton cloth, for example, the air must carry a substantial amount of moisture to prevent the breaking of threads. Air that carries too much moisture, however, will cause a swelling of the thread and may result in an uneven piece of cloth. The moisture content of the air is also important in the manufacture of paper, gelatine, and some other products.

Moisture is removed by passing the air over a cool surface. Since cool air will carry less moisture than warm air, the air will drop some of its moisture when it has been sufficiently cooled. The principle is the same as that which causes moisture or frost to be deposited on walls or windows in the winter or dew on the grass in summer. In another

type of system, very cold water is sprayed into the air from which moisture is to be removed. If the temperature of the cold water is below the dew point of the air, the air is compelled to drop a part of its moisture. It may be necessary to reheat the air after the moisture has been removed. Other types of systems operate on the same principle.

Moisture may be added to air by sprays, by steam jets, and in other ways. The amount of water to be added is automatically controlled by a humidiostat, which regulates the opening and closing of valves or vents. This instrument makes use of a substance which responds to humidity, such as human hair, certain types of wood, or paper.[2]

Smoke and Dirt Removal. Unless measures are taken to purify the air, smoke and dust may be present in sufficient amounts to be objectionable, particularly in cities where much manufacturing is done. Each manufacturing plant may have some departments which cause dust in the air. Organic particles are generated in the processing of rugs, flour, cotton, and woolen products. Inorganic, insoluble dust particles are disseminated into the air in the processing of metals or stone. Inorganic particles from arsenic or mercury are soluble. All of these particles are injurious to health. Germs which cause diseases of the respiratory system may be spread through the air. This condition is especially likely to prevail in winter, when natural ventilation is at a minimum and the air is not properly conditioned.

The removal of smoke and dirt is sometimes necessary to the making of a quality product. Painting and enameling can be done only in rooms that are free of dust. Examples of products to which such finishes are applied are refrigerators, washing machines, and automobile bodies. A company making spray-painted instrument panels reduced its rejects by two thirds by air conditioning the finishing room.[3] Dust from a tennis court in an areaway adjacent to a machine shop has been known to double the cost of maintenance of machine tools.[4]

In the filtering of air, the early air-conditioning systems used a piece of coarse cloth as the filter material. The particles of dirt adhered to the cloth as the air passed through the filter. The cloth proved to be an inefficient material, however, since it was not easily cleaned and offered too much resistance to the movement of the air. Filters now

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[2] For description of various systems, see G. A. Van Brunt, "Air Conditioning: What It Is and What It Does," *Factory Management and Maintenance,* Vol. XCIV, No. 8 (1946), pp. 113–20.

[3] C. D. Goodsell, "Clean Air Reduces Product Rejects," *Factory Management and Maintenance,* Vol. CIV, No. 2 (1946), pp. 143–44.

[4] Earle Buckingham, *Production Engineering* (New York: Wiley & Sons, Inc., 1942), p. 175.

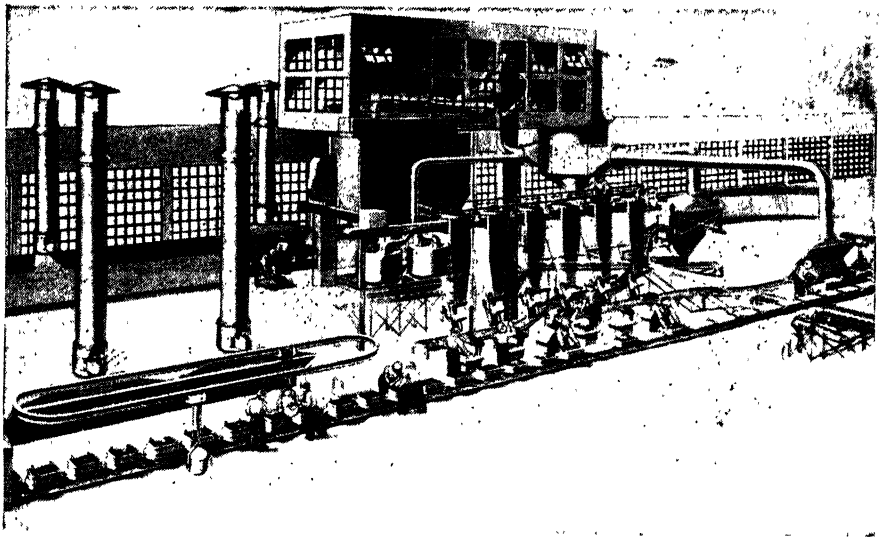
are made of spun glass, vegetable fiber, or some type of metal fiber such as steel wool. When the filters are dirty, they may be discarded, cleaned, or renewed by replacing one or more of the layers. Washable filters are cleaned by dipping them in a bath of specially prepared liquid. The fluid washes the filter and coats it with a substance which causes dust particles to adhere to it when the filter is put back into use. In some systems the filter is automatically cleaned and replaced. An instrument which is actuated by the resistance of the filters to the flow of air causes the filters to be dipped into a bath when air resistance has increased to a certain point. The filters are automatically returned to the proper position. Some air-conditioning systems provide for washing the air to remove dust, dirt, and disease germs.

Air-conditioning systems may be local or central. In local systems a separate control and air-conditioning unit is provided for each room or other area. This system permits conditions to be varied according to the requirements of different departments. In central control systems, one unit regulates conditions throughout the whole building. Some systems control all phases of air conditioning; others are designed to control only one feature, such as heating, humidifying, or dust removal.

Removal of Gases and Fumes. In some industries or in some operations, the gases and fumes given off by manufacturing processes may seriously contaminate the air. Fumes may cause irritation of the eyes, nose, skin, or throat. They also lower vitality and may cause disease. Air vents or condensing and burning devices may be necessary to neutralize or remove the fumes and to prevent discharges from a machine from becoming disseminated throughout the plant.

A department which may require especially adapted equipment for air conditioning is the foundry, which is likely to be dirty and hot unless dust and fumes are removed and fresh air is introduced. Figure 30 shows a composite view of foundry workplaces, operations, and possible locations of air-conditioning units. The operations which are shown in this illustration include molding, pouring, conveying and cooling (under insulated enclosure), shakeout of the cope or top of the mold, and clamp removal. Ducts are placed over each workplace to remove hot and dirty air. Clean air, which may be warmed or cooled as the situation requires, is admitted at a distance from the exhaust hoods in order that clean air of the proper temperature will sweep the general operating area without creating drafts.

Movement of Air. The movement of air is related to both temperature and humidity, for it is associated with the control of body



Courtesy of Claude B. Schneible Co.

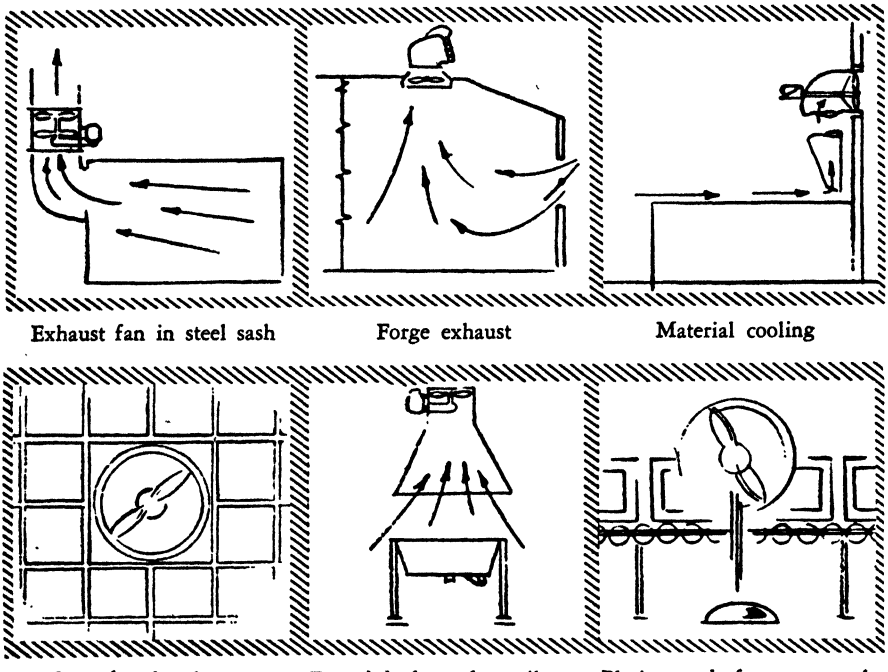
FIG. 30. Composite View of Foundry Ventilating Equipment

temperature. If air is kept moving, the temperature and humidity may be increased somewhat without causing great discomfort. Experiments have shown that people cannot endure high temperatures unless the air is kept in constant motion. However, if the air is cool and relative humidity is high, the circulation of the air may have undesirable effects upon the health of workers.

In many cases, no especial attention to the movement of air is required because sufficient movement is caused by differences in temperatures or pressures or by the movement of trucks and other equipment. Fans to move the air are sometimes used when heat is generated by manufacturing operations or heated materials require slow cooling. Figure 31 shows six uses of propeller fans for removing warm air or air that has become contaminated by spray painting or fumes from tanks of chemicals. These illustrations do not require extended explanation.

Relation to Building Construction. For satisfactory air conditioning, certain features should be incorporated in building construction. Unless the building is well constructed, air-conditioning costs will be excessive. Roof decks, as well as walls, may be insulated to prevent loss of heat in winter and to offer protection from outside temperatures in summer. Double window sash is necessary in cold climates.

Windowless factories are designed for complete control of both lighting and air conditioning. The windowless factory is the opposite



Exhaust fan in steel sash | Forge exhaust | Material cooling

Spray booth exhaust | Forced-draft roof ventilator | Plating tank fume removal

Courtesy of Hartzell Propeller Fan Co.

FIG. 31. Use of Fans for Movement of Air

extreme of the daylight factory. It eliminates all reliance upon natural light with its varying intensities and affords a complete control of lighting conditions through proper artificial lighting. Since no window space is provided, all air is forced into areas inside the building through the air-conditioning system. Although some air may be admitted from the outside, the air within the building is continuously rewashed and reutilized. Heating costs are reduced because no heated air is lost around the window sash, and little is lost through radiation. Windowless buildings have been proved to be entirely practical. Their use depends upon their first cost, the psychological effect upon the workers, and the nature of the manufacturing processes.

All air conditioning is expensive. The cost of a complete system is justified by the savings effected in plants which have a high employee density, which carry on dusty or contaminating manufacturing processes, or which manufacture a product requiring special air conditions.

NOISE

Noise control is partly a problem of physical equipment and partly a question of employee attitude. A reduction of noise at the work-

place, like the changes in illumination and other working conditions at the Hawthorne plant of the Western Electric Company, may result in an improvement in production because employees more willingly co-operate with management. Excessive noise, however, is objectionable and should be controlled.

Many work improvements follow noise reduction. An example of a company which found favorable results to follow noise reduction is the Aetna Insurance Company. The company tested the efficiency of its office workers for two years before and after the installation of acoustical coverings for walls and ceilings. It found the following changes in efficiency to follow the installation:

Increased efficiency of office employees	8.8%
Reduction in typists' errors	29%
Reduction in errors of machine operators	52%
Absences reduced	37%
Labor turnover reduced	47%[5]

The improvement which follows noise control is explained on biological grounds. Noise is most objectionable if it is loud and intermittent. However, continuous noise has undesirable effects upon the body functions and particularly upon the nervous system. It is believed to interfere with the regular rhythm of the heart, to increase the pulse rate, to cause transient changes in the blood pressure, and to disturb the proper functioning of the digestive system. In an effort to absorb the strain of the noise the nervous system uses energy in setting up inhibitions, and the muscles become tense. The result is nervous and physical exhaustion.

Continuous low noises may not be harmful, and many authorities contend that workers may become adjusted to these noises within a few days. Upon first exposure to noisy conditions, oxygen consumption and muscular activity increase. But after a few days, nervous excitement decreases; and the reactions gradually return to the level maintained during quiet conditions.[6] The worker ceases to be distracted by noise when he accepts it as a background. He may even do better work if the noise is no more than a general hum of low intensity. However, if the sound is meaningful, as it would be in a radio program, or if it is loud or intermittent, it adversely affects work.

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[5] George H. Sherwood "The Noise Factor in Office Fatigue," *Journal of Accountancy*, Vol. LXXXII (1946), pp. 252–53.

[6] See e.g., Edwin E. Ghiselli, "How Psychology Is Used in Industry," chap. vii in J. Stanley Gray, *Psychology in Use* (New York: American Book Co., 1941).

Noise may be reduced, isolated, or absorbed. Noise may be reduced by lubrication and oiling of machinery and by adjustment to eliminate vibration. The foundation of machinery may be built to absorb noises instead of transmitting them. In some cases the departments which are responsible for the noise may be segregated by moving or enclosing them. The most effective step for the absorption of noise is to cover the underside of the roof or ceiling with perforated material. The walls are made to absorb sound by using an inner layer of porous masonry material or by lining them with a material which has sound-absorbent qualities.

MUSIC AND SOUND SYSTEMS

Workers have long been known to sing at their work and to work in harmony with the rhythm. One of the first companies to provide music for workers on the job was Westinghouse Electric Corporation. The company is said to have discovered by accident, while testing radios, that the workers appreciated music on the job.[7] A public address system was then installed to provide sound broadcasting for all work areas.

The relation of music to production is uncertain.[8] No reliable method of testing the effect of music has been developed. Some observers believe that music on the job increases production, decreases spoilage, and lessens fatigue.[9] These results are said to be achieved by varying the tempo of the music according to the work. However, many companies use their sound systems only for announcements and for music at lunch periods.

Although some companies broadcast music to workers continuously throughout the day, many observers believe that music should be played only intermittently and should be planned principally to break monotony. If it is played continuously, workers may tire of it; and it may have a deleterious effect. Lively tunes may be played for a few minutes in the morning to aid the workers in falling into the tempo of the work. After an interval of music the broadcasts may be resumed in the middle of the morning to break the monotony. When familiar

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[7] F. K. Berrien, *Practical Psychology* (New York: Macmillan Co., 1945), p. 260.

[8] For a good discussion of this subject, see Barbara Elna Benson, *Music and Sound Systems in Industry* (New York: McGraw-Hill Book Co., 1946).

[9] This was the conclusion of Harold Burriss-Meyer on the basis of the study of production records in several factories before and after the introduction of music. Results were reported by him in a paper read before the American Society of Mechanical Engineers in October, 1942. See also Robert Lee Morrow, *Time Study and Motion Economy* (New York: Ronald Press Co., 1946), pp. 157–61.

tunes are played, workers may whistle the tune or sing. It seems best to play music which the workers readily recognize and which has a sustained melody. The volume should be constant. Outlets should be provided at each work area and perhaps at each workplace, and they should be so constructed that the workers cannot regulate the volume.

Some companies purchase the flow of music from outside service companies, and others provide their own music from a library of records or from borrowed records. Workers may be permitted to suggest some of the records, and selections not requested should also be played to prevent the music from becoming monotonous. The program will depend in part upon the weather, the age, and the sex of the workers. The broadcasting of music also depends upon the size of the plant, the noise, and the monotony of the work. However, noise does not preclude the broadcasting of music, since the broadcasts are on a different pitch.

The broadcasting system may be used to bring the management closer to the workers. It gives the management an opportunity to build up group solidarity and to show an appreciation of the accomplishments of foremen and workers. Broadcasts may relate human interest stories, departmental safety or production records, years of service of older employees, birthdays and wedding anniversaries, births, and other personal events. The system may be used to announce athletic events, plant parties, rehearsals, and band concerts. Some companies use it to make announcements at any time of day when they have something important to tell the workers. Others make announcements only at fixed times, such as the beginning of the workday, at lunch, or during rest periods.

MONOTONY

Much has been said concerning monotony in industrial occupations. A well-known feature of modern industry is the subdivision of tasks into small repetitive operations. Some observers believe that the simplication of jobs has proceeded so far that the effect of monotony upon the work has offset a large part of the gains to society from mechanization and increased production.

Monotony results largely from the fact that the series of motions necessary to do the work is short and that the same work cycle is continuously repeated. The tendency in industry is to subdivide the tasks at each workplace further and further and to limit the worker to the performance of only one work cycle, or a very few types of cycles. The worker repeats day after day a series of motions which may require

only a few minutes and possibly no more than a minute to complete. In many cases the cycle may be quickly learned and may require little initiative, skill, or imagination.

In the fabricating departments of any plant, much automatic equipment has been so highly developed that the worker has only to see that the machine is kept supplied with material and is in proper operating condition. In operating semiautomatic machines, the worker merely inserts the materials and removes the finished work. Other semiautomatic machines require the worker to see that the device which holds the material is properly cleared at the end of each work cycle, that the next job is properly seated and locked in position, and that cutting tools are working properly.[10] This work requires attention, care, and a feeling of responsibility on the part of the worker; but it does not require a wide range of skill. Although much of the work is classed as semiskilled, it is monotonous.

Some critics of the industrial system say that the worker has become a slave to the machine.[11] He must adjust his pace to the speed of the machine. The small part that any one person performs in the manufacture of the product is said to destroy his interest and his pride in his work. A worker becomes dissatisfied with his job and all that is associated with it. He fails to derive any pleasure from work which requires most of his waking hours, and even life itself seems drab and unattractive. His objective becomes that of getting by as easily as he can and of doing just enough work to keep out of trouble.

In highly repetitive jobs the possibilities for improvement in the methods of work are limited. The worker also feels insecure because someone else can be quickly trained to take his place. His personal freedom and his liberties are limited because he is under constant pressure to maintain a fixed pace of production and to keep up with the line. A further objection is that the worker has no opportunity to increase his pay by improving his skill and by increasing his output, since he cannot produce faster than the line brings the work to him.

Monotony is affected not only by the character of the motions performed but also by the attitude of the worker. Some workers prefer a variety of motions and soon tire of work that is repetitive. Others prefer highly repetitive work because they find that the task does not make heavy mental demands upon them. In so far as possible, a

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[10] See discussion by Buckingham, *op. cit.*, pp. 132 ff.

[11] For discussion, see Richard W. Husband, *Applied Psychology* (New York: Harper & Bros., 1934), pp. 294–96.

worker should be placed in work that he prefers and that is suited to his mentality.

The reason some workers do not object to a repetitive task is that the demands of the work from one day to another are uniform. Frustrating and irritating delays are eliminated by the certainty of the assembly or production line. Furthermore, the worker on a line does not work alone. He is part of a group whose workplaces are close together, and he may be able to talk or sing with his associates as he works.

Since the work makes few demands upon the mental capacities of the worker, he can think about other things. What he does think about is very important to management. By offering rewards for constructive suggestions, management may encourage the worker to think about ways of improving the methods of work, eliminating waste motions, or bettering the layout. The worker may think about the pleasant aspects of his work, or he may allow his mind to dwell upon his personal or family problems or upon real or imagined difficulties which he may have had with the foreman. He may develop an attitude which causes him to become maladjusted and dissatisfied and to feel frustrated.[12] This attitude can be prevented by proper association with other workers in what is sometimes referred to as an "informal organization." The monotony of the job is a factor in such management policies as plant athletics, entertainment, and musical broadcasts.

One way to lessen the effect of monotony is to supply the work in batches rather than in a continuous stream on a processing line. When the worker has finished a batch of material, he has a feeling of accomplishment — he can see how much work he has done. Production is increased, possibly because the interest of the worker is stimulated as he nears the end of a batch. This is true even though the next batch is waiting. When work is supplied in a continuous and endless line, a feeling of helplessness may be created. To work against an assembly line is futile.

The worker may assume a more wholesome attitude toward a monotonous job if he is shown the relation of his work to the entire production process. The service rendered by the product to the consumer should also be demonstrated. An explanation of the usefulness of the product to consumers and the relation of each task to the total manufacturing operations may be made a part of the induction procedure.

[12] See F. J. Roethlisberger and W. J. Dickson, *Management and the Worker* (Cambridge, Mass.: Harvard University Press, 1939), p. 573.

Another possibility is to break the monotony by rest pauses, vacations, and the development of an interest in social and recreational activities. Shifting workers to other jobs is also a possibility, although this measure has limited application. Some companies permit certain workers to shift to three or four positions each day. For example, workers who inspect and pack glass jars for shipping may be shifted to work stations that enable them to handle several sizes and shapes of jars each day. In other cases a plan of rotation at longer intervals may be followed. In any such plan, however, productivity may be lowered because a period of adjustment is required each time a shift is made.

FATIGUE

Fatigue is the effect of physical activity upon the mind and body of an individual which is reflected in a decreased capacity for work. It is closely related to the creation of certain chemical products in the body as the by-products of muscular and mental activity. The principal chemical wastes are carbon dioxide and acids. Some are known only as fatigue poisons or toxins. The effects of fatigue, however, are not confined to the muscles but reach the various parts of the nervous system.

Fatigue is both mental and physical. It is partly a result of muscular activity, and it is also affected by mental attitude. Some experiments indicate that attitude is the dominant factor.[13] If the worker likes his supervisor and trusts him, he may be relieved of anxiety and nervous tension. The result is that he can do a greater amount of work before he begins to notice a feeling of fatigue. A worker who is anxious about his job and who is afraid of his boss will use up more nervous energy than the one who is properly adjusted.

The effects of fatigue are reflected in many aspects of the work situation. The experiments of Taylor, Gilbreth, and others indicate that fatigue is a cause of decreased hourly and daily output. It also increases turnover because workers hope to find less tiring work in a new job. Absenteeism will be increased because workers who feel that their jobs require too much physical or mental effort will find excuses for staying away from work. Spoilage is increased because tired workers are inefficient or indifferent. Fatigue is a factor in accident rates because

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[13] L. P. Alford and J. R. Bangs, *Production Handbook* (New York: Ronald Press Co., 1948), p. 494.

tired workers are slower to react to danger. Slowness of reaction also may be either physical or mental.[14]

Fatigue is affected by all the conditions of work. Phases of work conditions which affect fatigue include automatic or other laborsaving machinery and particularly materials-handling equipment which makes unnecessary much lifting or carrying of materials. Such work conditions as lighting, air conditioning, the use of color, noise, music and other broadcasts, and monotony of work have a bearing upon the problem. Still other factors are the nervous demands of the job, such as uncertainties and irregularities in the flow of work and interruptions due to breakdowns of machinery, poor quality of materials, accidents, and other causes.

Today, fatigue is a problem of decreasing importance in industry. When Taylor was beginning his work in management about 1880, fatigue was a real problem because much of the work was done with hand tools or manually operated machinery and hours of work were long. Whiting Williams found in 1920 that fatigue was still one of the pressing problems.[15] Mr. and Mrs. Gilbreth made fatigue a subject of major study along with motion study.[16] However, many of the causes of fatigue have been eliminated; or their effects have been minimized through the continuous development of laborsaving machinery and a careful attention to all the conditions of work. The reduction in the hours of work has also been a factor. Roethlisberger and Dickson said in 1939 that organic unbalance was not a major problem in industry, except in a few industries where heavy muscular work was still required.[17]

REST PERIODS

Taylor's experiment with the pig-iron handler is a famous study of the effects of rest periods in increasing production through enabling the worker to overcome the effects of fatigue.[18] Gilbreth also made provision for rest periods at regular intervals. Gilbreth said that, when a man is prevented by causes beyond his control from doing his regularly assigned work, he should be told to use the opportunity to rest.

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[14] See *The Problem of Absenteeism* (New York: National Industrial Conference Board, 1943), p. 14.

[15] Whiting Williams, *What's on the Worker's Mind* (New York: Charles Scribner's Sons, 1920).

[16] See Frank B. and Lillian M. Gilbreth, *Fatigue Study* (New York: Macmillan Co., 1919).

[17] *Op. cit.*, p. 571.

[18] F. W. Taylor, *Scientific Management* (New York: Harper & Bros., 1911), p. 63.

He found that, if rest periods were not authorized by the management, the worker would take such rest as he could by making slow and useless motions that would give an industrious appearance to the casual observer.[19] Rest periods were also a part of the experiments at the Hawthorne plant of the Western Electric Company. Most investigators conclude that rest periods result in an increase in production.[20] A part of the increased output is attributed to a reduction in unauthorized rest periods, the elimination of an early wash-up, and a reduction of the amount of time lost in other ways.

Many questions pertaining to the rest period are still undetermined. One question is how often and how long the rest periods should be. Some companies have found that a ten-minute rest period after fifty minutes of work is desirable. Others have satisfactorily tried one rest period of twelve minutes in the morning and another of the same length in the afternoon. A textile mill considered it a successful plan to have six rest periods, ten minutes in length, each day. Three were placed in the morning and three in the afternoon. The proper arrangement of rest periods, if any, depends upon the type of worker, the nature of the work, and the work conditions.

What the worker does during the rest period is also important. He should do whatever is most effective in overcoming the effects of fatigue. On the football field the players usually use any time out to get a sip of water, to sit, or to lie down on the ground. In the factory, workers sometimes use rest periods to lie down on the floor beside the machine.[21] In some plants the rest period is used for coffee, fruit juice, pastry, and other refreshments. The rest periods may also be used for singing, dancing, calisthenics, or smoking.

QUESTIONS

1. Is uniformity in air conditions at all times desirable, or is some variety preferable?
2. Why is slight movement of air desirable?
3. How is a more uniform temperature achieved through radiant heating?
4. What is meant by the "dew point"? Why is the dew point important in the control of humidity?
5. Some authorities state that three factors contribute to common colds: prevalence of disease germs, exposure to sudden changes or variations in

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[19] Frank B. Gilbreth, *Motion Study* (New York: D. Van Nostrand Co., 1911), p. 291.

[20] See Morrow, *op. cit.*, pp. 153–56.

[21] Elton Mayo, "The Irrational Factor in Human Behavior," *Annals of the American Academy of Political and Social Science*, Vol. CX (1923), pp. 117, 129.

temperature, and low body resistance. Explain what management may do in regard to each of these causes.

6. In cold climates, moisture often collects on walls and windows because of condensation which is caused by differences in the temperature of the air inside and outside the building. Why is such condensation objectionable? Might the condensation be partially controlled by double sashes in the windows and by the release of warm dry air along the walls and windows?
7. As an employee, would you like to spend all your working hours in a windowless building? Would the worker do better work when he is permitted occasionally to see the outside, or should he be placed in a position where he never has an opportunity to look out through a window?
8. Should employee attitudes and employee comfort be considered in planning a building, or is the building plan strictly an engineering problem?
9. What kinds of noise are most objectionable? Will a low, constant hum or meaningless noise seriously interfere with work?
10. What is the purpose of music at the workplace?
11. Should music be played continuously throughout the day?
12. The president of the Apex Company uses the public address system to develop better personnel relations. At any time during the day when he receives important news concerning the company, such as the receipt of a large order from a customer or a good production record in a department, he talks to the workers in an informal or conversational manner. What is to be gained by this practice? Do you see any objections to it?
13. If a worker objects to a job because it is monotonous, will all other workers object to the job for the same reason?
14. Can monotony be avoided in modern industry?
15. Why is fatigue a problem of decreasing importance in industry?
16. Under what conditions are rest periods desirable? What questions arise in planning for rest periods?

CASES

27. AIR CONDITIONING IN A CANDY FACTORY

The Acme Candy Company at Oakland, California, had difficulty in controlling the quality of chocolate candy. In warm temperatures, such as are usually required for the comfort of workers, the candy did not become firm as quickly as was desired for purposes of packing and shipping. Often, the room became very warm because of the heat from the cooking operations. A very cold temperature was undesirable because the candy would take on a light color in a cold room.

The departments of the plant for making candy included mixing, cooking, cooling and cutting or shaping, forming and wrapping (for taffy), nut sorting and processing, and dipping (for chocolates and bonbons). No temperature problem arose in most of the departments because the facilities for heating the building were adequate, and the climate was sufficiently cool in summer. No equipment for cooling the air in the plant had ever been considered necessary.

The plant manager proposed that the difficulty in controlling the quality of chocolate be met by segregating the chocolate processing department in a corner of the building and air conditioning only that part of the building. Workers in the chocolate department would be expected to wear somewhat warmer clothing than would be needed by workers in other departments, although a temperature of 68 degrees was believed to be proper. After the chocolates were dipped or formed, they would be placed on trays and loaded on an enclosed conveyor. The conveyor would move the candy from the processing department to the packing room, where it would be placed in boxes for storage or shipment. The enclosed conveyor could be air conditioned at relatively low cost.

Question:

What are the advantages of the air-conditioning plan as outlined by the plant superintendent?

28. METHOD OF NOISE REDUCTION

The Browning Tube Company has received numerous complaints from foremen and employees that noise in the plant is disturbing. In one building a row of punch presses extends along the center of the room, and finishing operations are located on both sides of the presses. The punch presses are quite noisy and disturb workers in the entire building. Operators are unable to enjoy the wired music, and telephone conversations can be conducted only in enclosed booths. Although the effect of the noise cannot be precisely measured, it is believed to increase absenteeism and labor turnover.

The plant manager has proposed that a continuous row of sectional baffles of sound-absorbent material be mounted from the ceiling to within a few feet of the floor on each side of the presses. The ceilings of all areas would be finished with noise-reduction paneling. This paneling would lower the ceiling heights, which are believed to be greater than necessary for good ventilation. To reduce noice in the punch press section, vertical baffles about three feet wide would be installed at ceiling height across this part of the room between every third and fourth press.

Question:

What would be the advantage of noise reduction as proposed by the plant superintendent?

PART IV

The Product

CHAPTER XIV

PRODUCT RESEARCH

IN PRECEDING chapters, our discussion was concerned with two of the major groups of problems pertaining to the management of industrial enterprises. These problems relate to the organization of the enterprise and the provision of physical facilities. Other problems pertain to the product to be made and sold. In the development of any new product, the first step consists of research and experimentation in product development. Next, the product is designed with reference to such structural features as lines, color, general appearance, materials to be used, and serviceability. Then the specifications of the parts and other exact features of materials or parts are fixed. At various stages in the process of manufacture and also at completion, the parts and the finished product are inspected to assure that the product has been made according to plan. Although these four phases of management of the product are not always handled in this chronological order, they will be treated in this order in the following chapters.

The significance of research arises from the fact that modern industry is characterized by rapid change in both products and methods of manufacturing. Change is the result of the discovery of new applications of scientific principles and business methods. Improvements in methods and devices have continued since man first discovered fire, the needle, the loom, the wheel, the lathe, and the use of writing to convey ideas. What is new in modern industry is the rate at which improvements are made and new products introduced. The tempo of modern industry is so rapid that most large enterprises find it necessary to make steady and constant improvements in products and methods of production.

Purposes and Types of Research. Research activities may be

classified on the basis of the purpose or objective. From this point of view, research is classified as pure, applied, and developmental.

Pure research consists of investigation and experimentation for the discovery of scientific principles. Much pure research lies in the fields of biochemistry, physics, bacteriology, and inorganic chemistry. Its purpose may be to discover the properties of organic and inorganic matter and the nature of sound, light, electricity, or other forces, without regard to possible applications of the principles. Manufacturing establishments formerly looked to the universities, various endowed institutions, and the government for its research in the basic sciences. However, as corporate manufacturing enterprises have increased in size, they have made significant contributions to scientific knowledge through their own investigations. Notable examples are General Electric Company, Standard Oil Company (N.J.), and Eastman Kodak Company.

Applied research is investigation and experimentation in the use of scientific principles to develop a new product, improve a product, or improve the container. Improvement of a product may be achieved by developing a cheaper or more economical method of manufacture, by improving the appearance or the operating efficiency of the product, or by developing new materials to be used in manufacture, such as magnesium, aluminum or steel alloys, plastics, synthetic rubber, and rustless steel. Most industrial research is applied research.

Developmental research is investigation and experimentation for the purpose of lowering the cost of producing or marketing the product. Developmental research is usually conducted by the line or the operating departments rather than by a staff research department. This type of research begins after applied research has been completed. It is conducted continuously for the purpose of eliminating minor troubles in production and defects which become apparent as the product is used by consumers. Much developmental research is the result of complaints received from distributors or customers. Market and consumer surveys are often conducted for the purpose of obtaining consumer and distributor comments on the product and suggestions for improvement.

The types of research may be illustrated by almost any product. For example, the development of the electric refrigerator resulted from experimentation with methods of compressing gases and releasing the pressure by the operation of valves and the effect of changes in pressure upon temperature. The application of the scientific principles to a definite problem resulted in the development of mechanical methods

of refrigeration. Later applied research improved mechanical efficiency, temperature control, the capacity of freezing units, insulation, and other features. The reader can readily multiply the illustrations with reference to such products as the electric light, motion and sound pictures, electric motors, and atomic weapons.

Who Conducts Research. Many of our most notable inventions were the products of persons who toiled on their own responsibility and assumed the risk of failure. The number of such persons is legion. Well-known examples are Eli Whitney, Robert Fulton, S. F. B. Morse, Alexander Graham Bell, Henry Ford, Harvey Firestone, and the Wright brothers. The radio was the product of many minds, although Guglielmo Marconi is usually credited with the invention of wireless telegraphy. Thomas A. Edison produced a total of 1,097 patentable inventions, including the phonograph, the motion-picture camera, a telephone transmitter, and the incandescent electric light. Much research is now being conducted by individuals. The principal disadvantages of research by individuals are, first, the limited amount of time and money which most persons can devote to research and, second, the duplication of effort because of the lack of co-ordination in the research of many persons working individually.

Industrial and commercial enterprises now conduct much of the most significant research which is being done in this country. In 1920, about 300 corporations in this country employed 9,300 persons in research. By 1930, the number of corporations with research laboratories had increased to 1,625, with a personnel of 34,200. Corporate research work increased markedly during World War II, and the expansion continued even after the end of the war. By 1952, corporations maintained about 3,000 laboratories for scientific research.[1] These figures do not include the numerous half-laboratories and workshops or the part-time research which is conducted in odd plant corners throughout industry. The greatest amount of industrial research is conducted in the newly developed mass-production industries, such as petroleum, rubber, chemicals, automobiles, telephone, and electrical appliances. Corporate research has the advantage of strong financial support for projects which afford the promise of profitable commercial development. The continuous life of the corporation enables it to take a long-range point of view. Moreover, in corporate research the work of specialists in various fields may be correlated or integrated. A possible

[1] Peter F. Drucker, "Management and the Professional Employee," *Harvard Business Review*, Vol. XXX (May, 1952), p. 84.

limitation of corporate research is duplication of effort by companies in the same industry or in related industries.

Much pure and applied research is conducted at universities and colleges. Some of the research is financed by grants from the government, trade associations, and corporations. During World War II, research was conducted by universities in co-operation with the federal government on various projects essential to the prosecution of the war. Among the trade associations which have established research fellowships or made research grants to universities are those in the industries of dry milk, fertilizers, steel construction, meat packing, petroleum, and food canning.

Much research is financed co-operatively by members of a trade or industry through trade associations. The research activities of trade associations assume many forms. Some associations co-operate with commercial laboratories, universities, privately endowed institutions, or government agencies for carrying on research projects. Other associations serve only as a clearinghouse through which the members exchange the results of their investigations, and still others maintain laboratories for research and report the results of their experiments to the members. Industries in which trade associations conduct research include baking, dry milk, gas (for cooking and heating), steel, asphalt, car wheels, meat packing, food canning, bituminous coal, textiles, fertilizer, paint and varnish, and cement.[2]

Trade association research has the advantage of low cost to the industry as compared with separate research programs for the various companies. Centralized research programs are not more generally conducted because each company wishes to outdistance its competitors by developing a product which is superior or unique. Co-operative research is beneficial to the industry, but it benefits all companies rather than the individual company.

Research is also conducted for the benefit of industry by a limited number of technical and professional associations. Probably the best known of the technical research organizations is the National Research Council, which was established in 1916 by the National Academy of Sciences and a number of technical societies. Its membership is composed of representatives from government agencies and scientific and technical societies. Financial support is received as grants from the Carnegie Foundation, the Rockefeller Foundation, and other private

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[2] See Charles A. Pearce *et al., Trade Association Survey,* T.N.E.C. Monograph No. 18 (Washington, D.C.: U.S. Government Printing Office, 1941), pp. 301–7.

organizations. The function of the National Research Council is to assist in co-ordinating and publicizing scientific work in the United States, rather than to manage research projects directly. This is a very important function because it tends to reduce simultaneous research on the same project by various agencies or individuals. Technical and professional societies for research include the American Dental Association, the American Pharmaceutical Association, the American Society of Mechanical Engineers, the American Association for Testing Materials, and the United States Institute for Textile Research.

Much scientific and applied research which is of value to industry is conducted by the federal government. The number of federal agencies engaged in research is estimated at about 125.[3] One of the best-known agencies is the Bureau of Agricultural and Industrial Chemistry, which conducts investigations and experiments in chemistry, physics, and other fields. The bureau has assisted in the improvement of processes for the production of dehydrated meats, eggs, fruits, potatoes, and other vegetables. It contributed to the development of penicillin and developed a palatable syrup from apple juice known as "apple honey." The Bureau of Dairy Industry has contributed to the development of dairy products. Other federal research agencies include the Bureau of Mines and the Bureau of Standards. Much of the research work of the federal government is done in universities and in the laboratories of private corporations. The projects are initiated and financed by the government, while the personnel and physical facilities are provided by universities and corporations. Much of the research on atomic energy and in weapons for war was organized in this manner.

Research by the federal government is usually undertaken in fields which are likely to be neglected by individuals and private corporations because the benefits are general, the cost is excessive, or the prospects of success are not promising. Such fields include projects for national defense, agricultural research for farmers, and programs which are designed to improve the health or general welfare of the people.

An Example of Industrial Product Research. An illustration of industrial research is afforded by the American Can Company. The company produces various types of containers which are used in other industries. Improvements in its products, therefore, result in changes in other manufacturing industries before the advantages are passed on to the ultimate consumer.

[3] A. C. Fieldner, "Research by Government," in *The Future of Industrial Research* (New York: Standard Oil Development Co., 1945), pp. 113–23.

The first chemical laboratory in the can industry was established by the American Can Company in 1906, and it opened its general laboratories in 1921.[4] Formerly, all canned food was packed in cans which were sealed at one end when the cans were manufactured. The other end of the can had an opening about the size of a silver dollar through which the food was inserted at the cannery. The hole was then covered with a metal disc which was soldered to the can. A new type of can, which is now widely used by food canners, was developed by the company. The new can was made with a seam at each end, and both ends of the can were of the same construction. The change in the type of can was accompanied by the development of machinery which automatically closes and seals the can after the food has been packed. The new processes resulted in increased speed and economy in the canning factory and also afforded better protection for the packaged food. A further advantage of the new type of can is that it permits the packing of sliced pineapple, larger pieces of fruit, and even whole fruits which could not be packed in the old hole-in-the-top type of can. Foods which formerly had to be packed by hand because of the small size of the opening are now packed by machinery.

In co-operation with the steel manufacturers, the company developed in 1928 a new type of tin plate and a new type of can which made possible the commercial canning of fruit and vegetable juices. Since that time the canning of tomato juice, orange juice, and grapefruit juice has grown to large volume.

Another new type of container was a round fiber can with a metal pouring spout for the packing of salt, which formerly was sold in white cloth bags. In 1934 the company introduced a fiber container for the marketing of milk and cream. Later, it developed a container with fiber walls and metal ends for use in the frozen food industry. Canned motor oil, which permitted the refiner to control the marketing of his product under brand name without possibility of substitution, was the result of a sales idea rather than a scientific development. However, the development of a process of canning beer depended upon the perfection of an improved type of can because beer is pasteurized after packaging. The high pressure caused by carbon dioxide required a very sturdy can which would not burst at the side seams or buckle at the ends. This type of can was perfected in 1935. The beer can is lined with plastic material and is filled by an especially designed machine which prevents foaming. Developments of a similar nature made possi-

[4] Data from annual reports of the American Can Company.

ble the packing of coffee in cans from which all air has been extracted and the economical manufacture of oblong containers for varnish, olive oil, and many other commodities.[5]

The company has conducted research in can-making machinery as well as foods and containers. Better machines have increased the quality of the can and have lowered cost by increasing the number of cans produced per minute. The perfection of machines for closing the can caused the company to enlarge its activities to make machines as well as containers. Since the closing machines are sold or leased to food-packing companies, the sales department of the company changed from a seller of cans to a merchandiser of service to the canning and packing industry.[6]

The American Can Company now has a research staff of about three hundred persons. It conducts research in bacteriology, biochemistry, food chemistry, food inspection, industrial hygiene, nonmetallic containers, organic coatings, packaging, sealing compounds, and thermal engineering. Much of the research is conducted in co-operation with customers who use the containers and the closing machines. The results of the research are made available to various members of the canning and packing industry.

Location of Research Laboratory. Opinions differ concerning the most desirable location of the research laboratory. Most businesses consider that the laboratory should be located near the factory in order that the laboratory personnel may be informed of production requirements and problems. The objection to such a location is that the research staff may be called upon to study the day-to-day problems of the factory which the executives of the line organization or the plant engineers should handle for themselves. This practice would prevent continuity in the research program which is necessary to success and might reduce the position of the research specialist to that of a "glorified repairman." A compromise arrangement followed by some companies is to locate the research laboratories at a distance from the plant which is equal to an overnight trip.

Research a Staff Function. The research department has no power to authorize the manufacture of a product which it develops. As the case of the American Can Company shows, many problems must be satisfactorily settled before production can be initiated. The company which manufactures the raw material must be in a position to make

[5] An oblong can is a container with flat sides which are parallel or nearly so.

[6] American Can Company, *Fifty Years of American Can Company* (New York, 1951), p. 31.

the material in the necessary specifications and the required quantities. Industries which use the new product, such as the canning, dairy, beer, and frozen food industries in the case of the American Can Company, must be ready and willing to package their product in the new container. In some instances, this requires the development of new packaging machinery. The ultimate consumer must also be convinced of the advantages of buying the product in cans or fiber containers. In some cases an advertising program has attempted to convince consumers that vitamins are not destroyed by the canning process. Milk commissions in some jurisdictions have delayed the introduction of fiber containers for milk. These problems require the assistance of the sales division and legal counsel. Other departments within the organization which are concerned with the introduction of a new product are engineering and production control.

Planning the Research Program. The idea for a new research project or a new product may originate with the research department. Ideas for research may also be suggested by persons in the sales division or elsewhere in the company. Occasionally, the idea may come from someone outside the company, including customers, or from scientists in government or universities. After preliminary discussion, a search of the literature may be made to determine whether anyone else has made a study of the field. The files of the company would also be consulted to learn whether the idea has been previously considered. If the idea has been proposed earlier and then rejected, the reasons for the rejection should be carefully reviewed. New developments since the idea was considered at an earlier time would be investigated to determine whether the chances for success have increased.

If the probabilities for the development of a new product seem to be favorable, it would still be necessary to inquire whether a profitable market for the product can be developed. Market possibilities might be investigated by the market research department. Promising ideas then go through the stages of laboratory research, product formulation, survey of the technical and market possibilities of the product as developed, and the formulation of a recommendation for abandonment or further development.

Before a new product is introduced on a national scale, it may be produced in a small factory or workshop known as a "pilot plant." In such a factory, equipment for the manufacture of the product in limited quantities is provided; and the product is sold to consumers in a small area. Production difficulties are corrected; the product itself may be improved; and consumer acceptance is studied. If production

on a large scale appears feasible, manufacturing and distribution may be expanded to cover the national market. If large-scale production is not feasible, further research may be made, or the project may be abandoned. In this manner, serious errors may be avoided.

An extension of the plan of the pilot plant is found in the semi-works, in which a production line is set up and placed in operation. The purpose of the semi-works is to discover defects in manufacturing methods and procedures before the risks incident to production on a large scale are incurred. When the new plant is built, both product and manufacturing processes have been sufficiently improved to assure success.

Budget Control of Research Expense. A careful control of research expense through a budget is necessary because of the uncertain nature of the work and the time required to perfect a project. Some of the programs may require several years for completion. Some companies estimate that the research program must be ten to fifteen years ahead of the product.[7] To avoid excessive and wasteful outlays for research, management should carefully plan all projects and should control the total amount of money spent in the work.

The total amount to be spent in research is usually stated as a percentage of sales. This method has the advantage of placing a definite limit on the amount spent for research and of permitting an increase in the expenditure as the company increases in size. Some companies use a percentage of the average sales for the preceding five years. This method of computation eliminates large year-to-year variations and permits the research director to plan a program with the assurance that it can be carried to completion. The research budget may also be planned each year to provide specifically for the cost of certain programs, with an allowance for any new programs that might be intiated during the year. The estimates may also indicate the amounts to be spent for various types of research work. For example, General Motors Corporation divides its research program into three parts, as follows:

Service to the various divisions of the company.

The making of models or samples, from which products are to be designed.

Research in pure science, such as the properties of paraffin, fuels, and lubricants, or the causes of knock in an engine.

In a large company, research activities may be conducted in more than one place or laboratory. When this situation exists, the total research allowance is apportioned to each location and also to the

[7] *The Future of Industrial Research*, p. 69.

various projects. A part of the appropriation may be allocated to product testing and improvement.[8]

The estimates are next reviewed by top management. The most common practice is a review by the president of the company, by a committee of which the president is a member, or by the general manager. However, the estimates may be submitted to a vice-president, the chief engineer, the research director, or the production manager. The budget may be approved as submitted, or a revision may be required. Before the budget is finally approved, top management should be sure that the total amount is not excessive, that the projects recommended give a reasonable promise of success, and that the results of successful research can be used by the company. A new product developed through research should be related in some way to the existing line of products. The addition of the new product might be justified because it can be sold in the same market through the same channels of distribution as present products, because it can be manufactured with the same equipment, because it provides a use for waste or scrap, or because it offers some other definite advantage in production or marketing.

Periodical reports of cost and accomplishment for each project should be submitted to the budget committee, and all major projects should be reviewed at least semiannually. If the success of a program becomes questionable, the work should be suspended until the difficulties can be appraised or until a decision for abandonment or continuance can be made. When a project is abandoned, a complete record should be made for future reference, in order that the work will not be duplicated later. This record would indicate the original objectives, the methods pursued, the results (which might be negative or positive), the amount of money spent, and the reasons for abandonment.

Patenting of a Product or a Design. A successful project may pass through six stages, which are as follows:

Discovery of a scientific principle.
Application of the principle to a practical problem.
Perfection of an invention.
Granting of a patent by the government.
Manufacture and sale of the product on a small scale in a pilot plant.
Manufacture and sale of the product on a mass-production basis.

A patent is granted for 17 years. Protection begins when the application is filed, and the time limit of 17 years begins when the patent is issued. The patent does not confer the right to manufacture and sell

[8] Paul E. Holden, Lounsbury S. Fish, and Hubert L. Smith, *Top Management Organization and Control* (Stanford University, Calif.: Stanford University Press, 1941), p. 186.

the product or to use a process, since under the law each person already has such a right. What it does confer is the right to exclude others from the use of the processes or from the manufacture of the product protected by the patent. Such protection is socially desirable because it affords the motive for extensive and intensive research which characterizes modern production. Industrial research results in continuous improvement in the products of industry. The benefits are in time extended to labor and consumers as well as to management.

QUESTIONS

1. Why is industrial research more necessary now than it was at the beginning of the nineteenth century? Why is it easier for such research to be conducted now than it was at that time?
2. Are the results of pure research made known through scientific magazines? If so, how can a private corporation afford to conduct pure research?
3. Distinguish between "applied research" and "developmental research."
4. Which type of research is usually conducted by individuals? By universities? By the government?
5. Do individuals probably conduct a larger or a smaller percentage of the research work at present than was the case during the nineteenth century? Why?
6. If the results of research by a trade association are made known to all manufacturers in the industry and to the public generally, how do any of the manufacturers gain?
7. How was the research program of the American Can Company unique? How does research in the product of that company differ from research in the development of a new dye for textiles, plastics for the manufacture of various products, or a new type of automobile tire?
8. Indicate the relation of the following departments or divisions to the development of new designs of the product: sales, finance, budget, purchasing, stores, plant engineering, and production standards and methods.
9. A manufacturer has developed a new type of breakfast cereal. Before undertaking to manufacture and sell the product on a national basis, he would like to know whether the public would continue to buy and use it month after month. Suggest a program by which he may proceed on an experimental basis.
10. How does the budgeting of research differ from the budgeting of ordinary expenses of manufacturing, selling, and general administration?
11. A manufacturing concern conducts a broad research program in the development of new products and processes. In some cases, two or three years may elapse before management can determine that the projects will be successful. How should the budget appropriation for such projects be controlled?
12. A patent has been said to confer "the right to litigate," that is, the right to bring suit for infringement. Explain the meaning of this statement.

CASES

29. PLANNING A RESEARCH PROGRAM

The Gamma Chemical Company has regularly appropriated 3 per cent of its net sales for product research. The research manager has found this method unsatisfactory because the sales fluctuate considerably during periods of prosperity and depression. In good years the sales may increase as much as 25 per cent over sales during slack years. The research manager believes that the research program should make provision for the needs of the company for 5 to 10 years in advance of production and that the expenditures should not be based upon current sales. He finds also that important long-range projects sometimes must be discontinued during slack years because the appropriation is reduced as sales decline. It is as illogical, he argues, to base the research allowance upon sales from year to year as it would be to base it upon sales from month to month.

The proposal of the research manager is that the amount of the appropriation for research should be based upon the needs for various programs that show promise. If a research project appears likely to succeed, and if the new product would be profitable to the company, the research should be undertaken regardless of the total amount that might be spent for other projects.

Question:

How should the amount spent for research be determined?

30. A CO-OPERATIVE RESEARCH PROGRAM

The Western Engineering Company, with its main office in San Francisco, California, makes motors, compressors, and various types of processing equipment for use in manufacturing. The company has received a suggestion that it develop equipment for reducing the moisture content of fresh milk. It is believed that a method can be developed whereby three fourths of the moisture content could be removed without affecting the taste and the food values. The customer could then purchase one quart of milk at a local store, restore the moisture content by adding three quarts of water and obtain four quarts of fresh milk. This process would reduce handling costs and be advantageous to the customer in many ways.

The research manager of the engineering company believes that the proposed equipment can be developed at a reasonable cost. His principal difficulty is that the dairies which now process the milk would be unwilling to change to the new method. A special type of metal container would be required. Containers could be manufactured most economically by one of the large container companies.

Questions:

1. What would be the advantages of the new method?
2. How should the engineering company proceed to develop the new process?

CHAPTER XV

DESIGN OF THE PRODUCT

DESIGN is the outline or pattern of something to be produced. It is the plan for the composition, form, structure, and appearance of the product. It includes the basic and structural features as well as the lines, color, and appearance. A well-designed product is one which will perform the service expected of it and which can be profitably manufactured and sold at a price the consumer is willing to pay. A poorly designed product is one which fails to perform the service expected or which requires excessive costs to manufacture or sell.

Design is essentially an engineering function because it is closely related to manufacturing methods and costs. The product should be designed with reference to manufacturing processes, the machines necessary in production, materials-handling methods, plant layout, and production costs. However, in product design the needs and desires of the consumer as determined by market analysis are also important.

Phases of Design. The problem of design may arise in connection with the development of a new product. The problems pertain to the size of the product and its parts, the size of the package or container, and structural features of the product. Problems of design also arise in connection with changes in styles or models of an old product. Sometimes annual models are placed on the market at a regular time each year, and sometimes improvements are gradually introduced and incorporated into existing models. Annual models are usually introduced at fairs or shows, such as those conducted by automobile, machine, furniture, and dress manufacturers or designers.

In most industries, continuous improvement in the product is necessary if a manufacturer expects to assume or maintain leadership in the industry, for leadership must be incorporated into the product. Leadership in buildings and equipment, personnel policies, and busi-

ness methods is important but inadequate unless the product is kept abreast of developments. This fact becomes obvious if one compares the design of products as now manufactured with the design of similar products at an earlier period, such as flat irons, coffee grinders, railway sleeping cars, furniture, kitchen ranges, or motion-picture projectors. The continuous improvement in the automobile is generally recognized. Automotive engineers have developed hundreds of features which have made cars safer, more efficient, and easier to drive. The early models often could be bought with or without certain accessories which now are standard. On 1925 models, for example, accessories for which an extra charge was made included bumpers, bumper guards, demountable rims, gasoline gauge, parking light, rear light, steering lock, rear-view mirror, water pump, sun visors, spare tire, speedometer, stop light, dash thermometer, safety glass, and windshield wiper.[1]

With some types of product, the problem of design arises principally in the planning of the size, shape, or appearance of the container. The container is an important feature of the design of the product in the candy, cosmetics, canned or packaged food, and other industries. Shape may add to the attractiveness of a product displayed in the store or in the home. It may facilitate storing in the refrigerator or the storeroom; and it may perform an important service in use — for example, the salt package which aids in pouring. Protection of the product, size, color, ease of opening, and uses after emptying are other significant features of the package.

Influences upon Design. In planning for design, the engineer should take into consideration the service expected of the product, the importance of appearance, the shipping costs, the manufacturing cost, consumer preferences, and the availability of certain types of materials. Each of these factors requires brief discussion.

Service Expected. Some products will be used in places where they can be repaired easily, while other products will be used under conditions which make repairs difficult or costly. A product that will be used in a factory will probably be subject to more regular inspection and repair than a product that will be used in a home. The size and shape of a refrigerator depends upon whether it is to be used in a private residence or an institution. An automobile should be designed with reference to its use in heavy traffic and on certain types of roads.

Some products must be more sturdily constructed because they will receive rough wear. Automobile tires have been improved as auto-

[1] *Automobile Facts*, July, 1947.

mobile speeds have been increased. Railroad rails have been redesigned to carry heavier loads at higher speeds. Textbooks are more sturdily constructed than novels because they receive longer and rougher usage. A tin can which is to be used for beer and which must withstand high pressure during pasteurization must be more sturdy in construction than a can which will be subjected to a lower pressure.

Some products are intended to "last for a lifetime," while others last for a short time. If the manufacturer were to be perfectly frank, he might label certain products as "built for a day." Articles that are intended for limited use range from plated silverware and costume jewelry to souvenirs for tourists, paper-soled shoes, and cheap millinery. Lifetime products would include sterling silver, mahogany furniture, and oriental rugs.

Some products are used under circumstances that require quick visual observation and interpretation. Examples are dials on telephone equipment, switchboards, automobile license plates, clocks, and electric signs. During World War II, airplane pilots, in reporting on accidents and near accidents, stated that errors in reading instruments were due to confusing one instrument with another, confusing the two hands of an instrument, misinterpreting the direction in which the hands moved, reading the wrong instrument, and poor legibility of figures on the dial. This information has been used to improve the design not only of airplane instrument dials but also of dials on equipment used in factory production.[2].

Appearance. The lines of a dressing table, a lamp, a refrigerator, or a bottle containing hand lotion may be a large factor in the acceptance of the product. The first radios to make their appearance were not readily accepted because they did not look attractive in the living room. Even the lines of a streetcar or a railroad passenger car are important.

Color is important in relation to appearance. Margarine manufacturers know that people prefer a yellow color for their product. The color of composition shingles for roofing should be considered in relation to the color of the bricks and the trim of the house, just as the color of linoleum in the kitchen is selected in relation to the furnishings. In fact, in the selection of linoleum, color is far more important than the pattern. Although the customer can be persuaded to switch from one pattern to another if the color is right, she usually will not

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[2] "Using Psychology in Product Design," *Modern Industry,* April 15, 1948, pp. 50–54.

change her color scheme.[3] Color is important in clothing, upholstery, plastic kitchen gadgets, paints, rugs, chinaware, and numerous other articles. In mass markets, color trends change slowly. In high-style merchandise, changes are sometimes rapid.

Shipping Costs. Much equipment can be shipped before assembly if it is designed with this purpose in mind. An automobile company which ships trucks overseas reduced the required shipping space from 878 cubic feet to 389 cubic feet by revising the truck design and by shipping in three small crates instead of two larger ones. Other products which are designed in a manner that permits economical shipment and quick assembly include porch awnings, porch furniture, overhead garage doors, doll carriages, and tricycles. The increased use of pallets in the movement of material has directed attention to the size and shape of cartons in which materials are shipped. The carton should be of a convenient size for interlaced stacking on a standard-sized pallet.

Cost to Manufacture. The cost to manufacture is obviously important in design, if the product is to be sold at a profit. A product which is of a quality sufficiently good for one purpose may be entirely unsatisfactory for another use, or it may be better. For example, no finish is perfectly smooth; but one finish is only less rough than another. A surface which looks smooth may serve satisfactorily for the outside metal case of a vacuum cleaner but not for the roller bearings. For the bearings the surface irregularities which are permitted are measured in millionths of an inch. Cost is also affected by the kind of material used, such as the use of fiber instead of glass for a milk container. Other features of the design which affect costs include such details as the following:

Number of accessories or special features, such as mudguards, horns, and reflectors on a bicycle.

Parts made as one piece instead of several parts which would require additional assembly cost.

The use of commercially standard parts and materials instead of specially manufactured parts. The decision to buy or to make such parts depends upon the quantity to be used, the accuracy of dimensions required, and the reliability of the outside source of supply.

The simplicity of design of parts which will permit them to be stamped or pressed into shape instead of being cut and machined with cutting and grinding tools. This feature of design depends upon the use which is to be made of the product.

The choice of bolts, rivets, screws, or welding to make assemblies.

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[3] For discussion of use of color, see Faber Birren, *Selling with Color* (New York: McGraw-Hill Book Co., 1945).

Consumer Ideas. Consumer desires as to quality, style, color, and cost should be considered by the designer, for consumer ideas may be very different from those of the manufacturer. Henry Ford popularized a low-priced automobile which was cheap in construction and available only in black. As consumer ideas changed, he was forced to make expensive changes in design and to provide a variety of colors. The change was in part the result of increased consumer purchasing power and of a change in consumer ideas. Consumer preferences are also affected by the growth of urban populations and the size of apartments and apartment units. Market surveys are frequently made to appraise consumer needs, desires, preferences, and buying habits.[4]

Various groups of consumers differ in their ideas concerning the features that are desirable in design. Some will prefer a quality product, and some will prefer a low-priced product. Some will prefer a product of long-wearing qualities, and others will be willing to cast the product aside within a short time in order that they may buy something new. Consumers will differ in their preferences regarding style, materials, size, color, and other features. Each company must therefore choose the group of customers who are expected to buy the product. The design should be suited to the ideas and preferences of the group to whom the sales promotional activities will be directed.

Many products of industry are sold to other manufacturers for assembly in a product to be sold to ultimate consumers. Many such products are especially made according to specifications supplied by the manufacturer, while other parts or accessories are made according to standard specifications for sale to any manufacturer. Products which are often sold to other manufacturers for assembly in an article to be sold to consumers include motors, cables, fuses, batteries, plate glass, upholstery, sheet metal, wire, ball bearings, hinges, gaskets, chains, belting, pipe fittings, and metal or fiber containers.

If the product is designed to meet the general needs of the market and not the specific requirements of the customer, the design can be changed only by persuading manufacturers to accept the changed design. In some cases the purchaser is required to change the design of his own product. The willingness of any manufacturer to accept a change in his product may depend upon the effect upon costs, serviceability, appearance, consumer acceptance, and other factors.

Availability of Material. The problem of the availability of material was very acute during World War II and the period of active prepa-

[4] Donald Desky, "More than Meets the Eye," *Steelways*, January, 1947, p. 10.

ration for war beginning in the summer of 1950. It promises to be a recurring problem. If the product is so designed that a large amount of a scarce material is required, preparations should be made to alter the design if necessary. During the war and postwar periods, substitute materials had to be developed for use in the manufacture of food containers, household appliances, kitchen utensils, shipping containers, and other products. Glass jars for food came into common use, and new types of alloys and plastics were substituted for scarce or more expensive metals. In many cases the change in design was made permanent.

The design engineer may find it impossible to include all desirable features in one product because he may be required to sacrifice one desirable feature to achieve another. For example, an automobile may be designed for style and beauty regardless of cost, difficulty of parking and handling in traffic, and the extent of damage to fenders and grillwork in case of collision. Design may also disregard the possibility that certain materials may become scarce.

The development of any design is frequently a compromise between the interests of various executives in the company. The engineer may be inclined to emphasize operating efficiency. The plant manager may emphasize simplicity of manufacturing methods. The sales manager may wish to incorporate preferences of consumers, regardless of cost. These considerations may be impossible of achievement in their entirety.

Specifications. By specification is meant the standard of quality for a part or for the finished product. The nature of specifications varies with the product. Standards of quality may be set for dimensions, tensile strength (as in wire or cable), the outline or contour of a part, smoothness of surface, chemical composition, color, and the internal structure. These specifications should be established as a part of the work of design. They determine the nature of the manufacturing processes, and they are enforced through inspection.

In the case of a product made in quantity of a number of parts which are assembled on a production line, specifications are necessary in the design of the product in order that the parts may be made interchangeable. If the product is made in small quantities, specifications are not so important because the parts may be machined to fit when the product is assembled. When the product is made in large quantities, however, the separate fitting of each part is not feasible because of the expense and the interruption of the flow of regular production that would be entailed. Parts may be manufactured and placed in the storeroom prior to assembly, but this is possible only in case specifications are

established in advance of production. The specifications include dimensions, thickness, smoothness of surface, and composition of material.

The specification indicates a basic size, which is the theoretical or standard size from which variations are measured. The part is not made precisely the basic size because allowances are necessary. An allowance is the amount of variation permitted or tolerated in the manufacture of the product. The allowance may be 0.01, 0.001, 0.0001, or 0.00001 of an inch; but the amount depends upon the use to be made of the product and of the part.

The limits are the extreme permissible dimensions of a part and are designated as the "maximum limit" and the "minimum limit." The maximum size is that dimension which leaves the most metal or wood on the part. The limits and sizes are established in relation to the parts which are to be joined. The allowances are established with reference to the tightest possible fit, if the largest internal member is matched with the smallest external member. Tolerance is the allowable variation in size. It is the difference between the minimum and maximum limits.

The cost of any machining or fabricating job depends largely upon the tolerance. To remove metal or wood from a part is relatively easy. The difficulty and the cost arise from the necessity for determining the proper place to stop. Close tolerances increase the cost of machine adjustment, machine repair, inspection, and rejects. Much of the cost of manufacture is due to the establishment of small tolerances, some of which could be made larger without impairing the efficiency of the product. Variations from the basic sizes are due to such causes as improper location of the work in the machine because of the lack of training or care on the part of the operator or because of chips or dirt in the machine, shifting of the work after it is placed in the machine, inaccuracy of devices for holding the work, inaccuracy of the machine due to the stress of revolving or cutting parts, and inaccuracy of cutting or finishing tools as to size or shape.[5]

Design a Staff Function. In a large enterprise, design is a specialized and technical engineering service performed by a staff department. Product design in some organizations is a major activity, and the person in charge reports directly to the president or general manager. The reason for the emphasis placed upon design is that the entire success of the company may depend upon the appeal made to consumers by the product in comparison with the products of competitors. The

[5] Earle Buckingham, *Production Engineering* (New York: Wiley & Sons, Inc., 1942), p. 27.

appeal is based upon price, quality, color, service, and other features previously mentioned. Moreover, the work of product design is continuous because of improvements in technology and of style trends.

In most manufacturing enterprises, product design is a department of the manufacturing division. In such an organization the design engineer reports to the director of manufacture. In any event, product design is an important engineering activity; and it should never be thought of as the routine construction of drawings. The design engineer should have a knowledge of both the mechanical and the artistic phases of the problem. He must be familiar with the methods of manufacturing and of selling, and he must keep informed of the progress of technology in his own and related lines of production and with developments in consumer markets.

The fact that design is a staff function means that the design engineer is not in a position to make changes in the product or to direct the production of a new model. Decisions of this kind are made after recommendations by the design engineer and approval by the line officers, possibly by the president and the heads of major divisions. The decision to change the design can be made after estimates have been made by the sales division as to the probable reception of the product by customers. The cost of manufacturing the product should be estimated by the cost accounting department in co-operation with the methods department. It may be necessary also to revise plant layout. The purchasing department may be consulted as to the availability of materials. If the manufacture of one product is to be discontinued when a new one is introduced, important considerations would be the unfilled orders of customers for the old product, the supply of the old product in the storeroom, the necessity of supplying customers with repair parts, and the time required to make the change-over to the new product. These problems indicate the reason that a change in the design of the product must be authorized by top management.

In small establishments the design of the product is frequently the work of the line organization. The enterprise may not be large enough to support a separate staff department, and the proprietor or manager may originate changes in design with the aid of his managers or department heads. In custom-made merchandise the product may be made according to blueprints and specifications prescribed by the customer.

Importance of Speed. In many industries, speed in the development of new product designs is essential to success. This is especially

true of industries characterized by rapid changes in fashion, such as coats, dresses, millinery, and other articles of clothing. Slow development of designs may cause a manufacturer to miss the market. A slow development may be caused by the necessity for consulting various persons. This fact explains the persistence of the small enterprise, operated as a single proprietorship or a partnership, in many branches of manufacturing.

QUESTIONS

1. Mention industries in which the design of the product is very important. Mention industries in which design is less important.
2. Indicate features of the following products which you would expect to be stressed in advertising by the manufacturer. Mention other features which might also be important.
   a) An electric iron.
   b) A college textbook in business.
   c) A floor lamp.
   d) A lawn mower.
   e) Flat silver for the table.
   f) A vacuum cleaner.
3. Mention products for which the container is an important feature of design, and give reasons.
4. Mention products which may be designed to permit shipment in parts, with assembly by the distributor or the customer.
5. Should a manufacturer endeavor to design his product to establish a fashion, or should he be content to follow the trend? What risks are incurred by each policy?
6. One manufacturer designs a new type of belting for use in a machine, and another designs a new type of fiber container for milk. How do the problems of the manufacturers in gaining acceptance for their products differ?
7. What is included in the artistic problem of design? What is included in the engineering problem?
8. Why are tolerances necessary in the establishment of specifications for the parts of a product? Why can the parts not be made exactly alike?
9. Why is time required for a radical change in the design of the product? What departments should co-operate in making the change?
10. A dress designer, who manufactures and sells for an exclusive trade, finds that his successful designs are soon copied by manufacturers who sell in the medium- and low-priced market. This practice, often called "design piracy," destroys the value of the design in the exclusive market and requires a continuous development of new designs. What can the dress designer do about it? The copyist claims that the practice aids the creator of the original designs because it creates a continuous market for new designs. Is he correct in this contention?

CASES

31. DEVELOPMENT OF A LOW-PRICED PRODUCT

The Wagner Pump Company with its main plant in St. Louis, has an established reputation for making industrial water pumps for deep and shallow wells. Until 1950 the company had confined its product line to pumps of a capacity of 350 gallons per hour or more. In 1950 the market for pumps of this capacity appeared to be filled, and sales declined sharply. Salesmen urged the company to develop a pump for shallow wells with a capacity of no more than 250 gallons per hour. The pump would be sold at a lower price than any pump now manufactured, and it would be designed to permit easy installation by the purchaser or a local mechanic.

The company began its study of the design of a low-cost pump in March, 1950. Within four months a pilot model had been completed, and four pumps were made for experimental purposes. The pumps were placed in operation, and their performance was studied. Salesmen made several suggestions for improving the design, and their suggestions were incorporated in the plans for the new product. During the experimental stage a meeting of representatives of the engineering staff, the sales division, and the manufacturing division was held every two weeks to evaluate the progress of the work. The new item was placed on the market in the spring of 1951.

Questions:

1. What were the reasons for the development of the new pump?
2. Why did the development of the new pump require the co-operation of various divisions within the company?

32. PROBLEMS ARISING FROM DESIGN CHANGES

A manufacturer of vacuum cleaners perfected a new design of the product. The principal difference is in the case for the cleaner, which has been changed to give more pleasing lines and to eliminate any possibility of marring or scarring furniture. However, a change in the case has required changes in the size of certain parts. The number of parts has also been reduced.

The change in design was not properly co-ordinated with the schedules for production and the purchase of fabricated parts. The result is that a large inventory of some parts has been accumulated in the storeroom. The storekeeper has suggested that the parts be scrapped or sold as scrap metal. The controller points put that a loss will be incurred in scrapping the parts and that the loss might be avoided by carrying the parts on the balance sheet at cost as inventory. The service manager believes that dealers and customers may require spare parts for old machines for perhaps 10 or 15 years. Just how many parts will be required is difficult to determine, but the service manager believes that an effort should be made to meet all requirements of dealers and customers.

Questions:

1. What expenses would be incurred by continuing to keep the parts in the storeroom?

2. Could the parts properly be carried in the inventory at cost?
3. Does the company owe an obligation to customers to carry repair parts? For how many years does the obligation continue?
4. Would it be preferable to scrap the parts and make new ones from time to time?

CHAPTER XVI

SIMPLIFICATION AND STANDARDIZATION OF PRODUCT

SIMPLIFICATION and standardization of the product are two different but closely related practices. Simplification is the reduction of the number of sizes, colors, styles, or other variations of the product. Standardization is the establishment of uniform sizes, dimensions, or other properties of a product and is technical in nature rather than commercial.

Simplification may precede or follow the standardization of the product, or the two programs may be accomplished simultaneously. In other words, the unprofitable lines of the product may be eliminated by a program of simplification; and standards may then be established for the lines which are to be continued. Or the various styles and sizes of product may be standardized, and the reduction in lines of product may be accomplished later. However, attention to either problem usually shows the need for the other; and the two programs are preferably conducted at the same time. Simplification may be the work of one company or of all the companies in an industry. Standardization is usually a co-operative activity embracing an entire industry.

The Need for Simplification. A program of simplification for a company or an industry may be necessary because many varieties of the product are manufactured for which the consumer has no basic need and on which the manufacturer may not make a satisfactory profit. For example, before the simplification program was effected, manufacturers were producing 480 sizes of paint and varnish brushes. They were making composition blackboards in 90 lengths, 18 widths, and 3 colors. They were making salt packages in 72 different sizes and styles and were making wheelbarrows in 125 styles. No one manufacturer made all the styles and sizes, but each manufacturer made a needless variety.

The multiplicity of styles, sizes and colors of product resulted largely from difficulties encountered by the sales division in marketing and from recommendations for new designs by that division. During seasons or years when sales are difficult to make and buyers' markets prevail, the salesmen endeavor to give the buyer what he wants or what he thinks he needs, even though he requests a product which is not included in the regular line. The sales division also may recommend additions to the regular line of products in order that it may offer the customer something different from products offered by competitors. Varieties of product may be added at the suggestion of the research or design departments, which endeavor to create improvements or to develop new products.

The addition of a new product or a new variety usually requires the approval of a committee of top management, such as an executive or a policy committee. Officers of the company most likely to question the addition of a new product are the vice-president in charge of manufacturing and the controller. The executive in charge of operations may object to the expansion of the product line because a multiplicity of products complicate such problems as purchasing, inventory control, production planning, and plant layout. The controller may question expansion of the product line because he is often conscious of costs or profits. Many companies have at times added products and varieties that were unprofitable.

The extent to which excessive and needless varieties of the product are created may be illustrated by the experience of the manufacturers of paving brick. Prior to the initiation of a program of simplification, manufacturers were regularly making 66 sizes of vitrified paving brick. A study of sales figures disclosed that 11 sizes accounted for more than 80 per cent of the total sales.[1] The remaining 20 per cent of the sales were thinly and unprofitably distributed over the other 55 sizes. This situation required further study to determine whether the 55 sizes which were made in relatively small quantities performed a worth-while service to certain consumers. After consultation with highway engineers, contractors, and other interested persons, the industry decided that not all the 11 popular sizes were needed. An agreement was reached to eliminate 59 sizes and to continue producing 7 sizes. Later, the number of sizes to be produced was reduced to 5. The result was a reduction of 92 per cent in the number of sizes produced.

[1] National Bureau of Standards, *Simplified Practice,* Circular Letter LC–590 (1940).

Costs of Diversity. The costs of manufacture which may result from the production of needless varieties include the following:

1. The inventory of finished stock is increased because reserve supplies of each item must be kept on hand. Much of the capital is idle, excessive inventory space is required, and the merchandise may deteriorate before it is sold.
2. Manufacturing costs are increased because of the necessity for more frequent changes in machine setup and adjustment. Down time or idle machine time is greater, and labor cost is increased.
3. The inventory of raw materials is increased when the product is made from materials of varying qualities or with a varying assortment of accessories.
4. Deliveries to customers may be slow because the inventories of large numbers of varieties are not easily controlled. For the same reason the chance of error in shipment is increased.

Diversity of product creates many problems for jobbers, wholesalers, and retailers. If each distributor attempts to carry a complete and diversified line, his inventories are unduly increased, the rate of inventory turnover is lessened, more storage space is required, and sales effort is less effective because it is spread over more lines. A distributor who does not carry a complete line may lose sales in all lines because many customers will buy where a greater assortment is offered.

The question of who pays the costs of diversity is not easily answered. A large part of the cost may be borne by the manufacturer because he may be unable to increase his selling price to cover his own inefficiency. If the costs are due to a multiplicity of varieties that characterize the entire industry, and if the costs are incurred by manufacturers generally, selling prices may be increased to cover all or almost all of the increased cost. The same considerations would apply to wholesalers and retailers. Aside from the matter of selling prices, the consumer may be inconvenienced because of his inability to obtain prompt repair service or quick deliveries of repair parts.

A Program of Simplification. Simplification may be effected by a single company acting on its own initiative. This procedure may be feasible for a manufacturer of breakfast cereals, linoleum, alarm clocks, table china, or other products sold under a brand name. However, in many lines of products, a simplification program when undertaken by one manufacturer is questionable business policy. The company which undertakes to eliminate the slow-selling varieties may find that it loses sales on all other lines as well. A distributor is not likely to purchase the product in its popular sizes and grades from one manufacturer and

the unusual sizes and grades from another. Consequently, competition will usually compel a manufacturer to make and sell a variety of products, unless the simplification movement is broad enough to include most of the industry.

The program of simplification is frequently organized by a trade association whose membership includes most of the firms of the industry. The suggestion for such a program may come from a consumer of the product or from a manufacturer. If the officers of the association believe that simplification would be desirable, they may appoint a committee to assemble the information which is to be used in the formulation and execution of the program. The committee compiles a complete list of the sizes, colors, types, and grades of the product and the volume of production and sales of each variety. It makes a study of the service rendered to consumers by each variety of the product. Items of small production may be found to be essential because of special applications. For example, a circle saw of a definite size might be of great value to sawmills working with logs of a certain kind, although the number of saws they require might be very small. This study includes also probable future trends in respect to the needs of consumers. The committee recommends to the industry the items which it believes can be eliminated to the advantage of the manufacturers, distributors, and consumers. A general conference of interested parties is then called to discuss the recommendation. A simplified-practice recommendation may be adopted. This recommendation lists the sizes or types of the product which appear adequate to meet all normal demands. A standing committee is appointed by the trade association to confer with members and to encourage general acceptance of the simplified-practice recommendation. Each manufacturer is asked to sign an agreement to accept the report and to make only the types of product recommended by the committee and adopted by the industry.

Proposals for amendment of the simplified-practice recommendation may be made to the trade association for consideration at any time. Revisions may be necessary because of technological developments, competition within the industry, or developments in other manufacturing industries. When the original recommendation is amended, the number of types of product to be manufactured may be increased or decreased.

Government Participation. The program for the simplification of the product as conducted by trade associations has received much support from the federal government. In 1917 and 1918 the War Indus-

tries Board issued several reports which disclosed an overdiversity in sizes and varieties of products. The board insisted upon immediate simplification in several fields and required a reduction in varieties in several industries through the agency of trade associations. After the war the tendency to multiply varieties was once more apparent when manufacturers added new styles in the effort to increase sales. During the early 1920's a united effort was made by the government, trade associations, and technical societies to reverse the trend toward undue diversification. In 1921 a much publicized report entitled *Waste in Industry* was made by a committee of seventeen industrial engineers representing the Federated American Engineering Societies.[2] Diversification of product was one of the causes of waste emphasized by the report.

In 1921 the Secretary of Commerce established a Division of Simplified Practice within the National Bureau of Standards. The purpose of the division was to co-operate with trade associations in the holding of conferences for product simplification. It received proposals for simplification within an industry from consumers, manufacturers, or the trade association. Proposals were found to be more likely to be adopted if they came from the trade association because partial agreement had already been achieved. Any agreements reached at conferences for product simplification were essentially the work of the trade association. Observance was voluntary, since the government made no attempt to require acceptance of the program.

In 1927 the work of the National Bureau of Standards was enlarged by the establishment of a Division of Trade Standards for the purpose of encouraging the formulation and adoption of standards for the products of industry. In 1947 the Division of Simplified Practice and the Division of Trade Standards were consolidated to form the Commodity Standards Division.

The program of simplification as conducted by the trade associations in co-operation with the National Bureau of Standards has resulted in a reduction in the number of varieties in many industries. The list given in Table 3 is suggestive of the accomplishment.[3]

Commercial Standard. A standard of commerce is a measure of quantity, quality, or performance agreed upon by producers, distributors, or possibly consumers. It covers terminology, types, classification, grades, sizes, and use characteristics of manufactured products. The

[2] Federated American Engineering Societies, *Waste in Industry* (New York: McGraw-Hill Book Co., 1921).

[3] National Bureau of Standards, Circular Letter LC–693 (1942).

TABLE 3
VARIETY SIMPLIFICATION

Item	Before Simplification	After Simplification	Percentage Reduction
Grocers' paper bags	61	47	23
Steel barrels and drums	188	22	88
Plow bolts	1,500	840	44
Milk and cream bottles and bottle caps	49	4	92
Welded chain	1,831	1,214	34
Cafeteria and restaurant chinaware	700	309	56
Loaded paper shot shells	4,067	262	94
Galvanized and japanned tinware	1,154	873	24
Grinding wheels	715,200	254,400	64

agreement for fixing a standard may include standard methods of testing, rating, certification, and labeling the product in order that a product made in conformity with the standard may be readily recognized by distributors and consumers.

Purpose of Standards. The need for standards arises in part from competitive practices and the difficulty of the consumer in evaluating a product which he finds offered for sale on the market. For example, prior to 1934 the mark "gold filled" on an article indicated merely a process of manufacture without any significance as to the quantity of gold applied. In making a gold-filled article, a gold alloy is soldered to a base metal which is largely copper; and the metal is then rolled or drawn to the required thickness. The weight ratio prior to 1933 varied from 1 part gold alloy to 10 parts of base metal to 1 part alloy to 500 parts of base metal. The cheapest quality was an extremely thin coating. The standard now requires that the label for a gold-filled product indicate both the ratio of the weight of the gold alloy to the weight of the base metal and the karat fineness of the gold. The minimum weight ratio is 1 to 20.

A second need for commercial standards arises from the difficulty which the average consumer has in determining the performance which may be expected from the product. For example, when a consumer purchases a clinical thermometer, he may be unable to test it to determine whether it registers properly, although formerly many purchasers made such tests at great expense. The latest commercial standard, which was adopted in 1932, assures reliable and standard performance. The requirements of the commercial standard include the following:

Construction, in which quality of glass, appearance, marking, range, and details of graduation are specified.

Character of the pigment, in which a test is required to determine the resistance of the pigment to removal by disinfecting solutions.

Test for entrapped gas.

Hard shaker test.

Retreat test, to determine whether the constriction in the bore is properly made.

Accuracy, in which the maximum allowable errors in registration are specified.

Ageing for four months to guard against changes in the constriction.

A certificate to accompany each thermometer to guarantee compliance with the requirements.[4]

A third need for standards arises from the use of specifications in ordering merchandise or parts. A purchasing agent who specifies that materials are to be of "good workmanship" or "best commercial quality" is using a very vague standard. He should not purchase to meet the needs of his company by stating that goods ordered are to "be like the merchandise I bought last time." He should indicate specifications and tolerances. The most satisfactory way of ordering is to indicate the standard as prescribed by the industry or trade. Fuel oil, for example, is bought and sold in specified grades according to distillation, viscosity, carbon residue, flash point, pour point, maximum water, sediment, and ash.[5] The purchaser need only specify the grade required to be assured of getting the proper quality. Similarly, the grades of rope are based upon the kind of fiber, the diameter, the weight per foot, the oil content, and the breaking strength.

Standards of volume and of measurement are also used by purchasers in placing orders or in buying at local stores. Such standards include gallon, quart, pound, and yard. The canners have standardized tin cans in forty-one sizes. The sizes commonly used for canned foods, such as No. 1, No. 2, and No. 2½, are generally known and easily recognized. A housewife may order canned food by can size with complete assurance as to the size of the cans which will be delivered.

A fourth need for standards arises from the desirability of making certain parts interchangeable. A standard of this kind which was reached many years ago is the standard distance between wheel flanges of railway cars. The observance of this standard is necessary for the transfer of railway rolling stock from one line to another. Transferability of cars also requires the standardization of couplings, bumpers, air brakes and brake connections, clearances, and other features.

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[4] National Bureau of Standards, *Commercial Standards and Their Value* (Washington, D.C.: U.S. Government Printing Office, 1940), p. 11.

[5] *Ibid.*, p. 13.

A standard of great convenience to consumers is the base and socket of the incandescent electric lamp or bulb. All electrical manufacturers have adopted the standard which was first fixed by Thomas A. Edison. The standard indicates a diameter of the lamp of 1.031 to 1.037 inches and a thread depth of 0.033 of an inch. Although some lamp sockets and bulbs are larger or smaller than the usual size, the purchaser of a bulb is not required to try the lamp in the base to determine whether it will fit. Until threads on pipe connections were standardized, fire-fighting equipment frequently could not be used in neighboring cities because the water hose could not be connected to fireplugs. Another lack of standards which has plagued motorists has been the height of bumpers. In 1947 a standard bumper height for automobiles, station wagons, and light trucks was recommended by the Society of Automotive Engineers and approved by the automobile industry. Automobile manufacturers feel the need for a standard size of license plates, which are now made in 66 sizes in the United States and Canada.[6] The lack of uniformity in size has prevented the treatment of the license plate as an integral part of the body design and has required the continued use of external brackets, which invite theft. In other lines of product the existence and observance of standards is a great convenience to the consumer who wishes to replace a part, such as a slat in a venetian blind, an electric fuse, or a switch.

Who Sets Standards. Since standards are of many kinds and are established for many purposes, it is to be expected that they will be established in many ways. The principal agencies for setting standards are as follows:

The Government. From the earliest times, governments have established some kinds of standards for the convenience of trade and commerce for the protection of buyers. The earliest known systems of weights and measures were those of the Assyrians, Babylonians, Chaldeans, and Egyptians. When the Constitution of the United States was adopted in 1789, Congress was given the power to regulate the value of money and to fix standard weights and measures. George Washington, in his message to Congress in 1790, said that "uniformity in the currency, weights, and measures of the United States is an object of great importance and will, I am persuaded, be duly attended to." Standards of this kind were provided in laws enacted by the first Congress. The system of weights and measures and the monetary standard have

[6] *Automobile Facts*, February, 1952, p. 2.

constituted significant contributions to the movement for standardization. Government standards of quality have been set in many fields, such as textiles, foods, drugs, and cosmetics.

The Individual Business. The manufacture of a product on the assembly line basis requires that parts be made to specification and in accordance with standards established by the manufacturer. All the parts are alike within the limits permitted by tolerances. Industry-wide standard dimensions may be undesirable for many parts of vacuum cleaners, washing machines, typewriters, and other such products which are sold under a trade or brand name. Variations in part dimensions between companies do not greatly inconvenience the consumer, provided the manufacturer has nationwide distribution and maintains an adequate service department. Much of the advertising of a new mechanical device is designed to convince prospective buyers that repair parts and services will be available.

Many standards have resulted from the pioneering work of a few large companies in an industry. The standards as developed by one company have been adopted by others by a gradual process of evolution rather than by formal or group action. In most cases the standards adopted by an industry were first developed by a few companies and later accepted by the industry, with or without modification.

Technical Societies. One of the earliest technical societies in standardization work was the American Society for Testing Materials, which was formed in 1898. Its objective is "the promotion of knowledge of the materials of engineering and the standardization of specifications and methods of testing." The society has formulated several hundred standards and proposals for standards. It has standing committees for each major group of commodities. The committees report each year on suggested improvements in standards and methods of testing.

Probably the most effective agency for the setting of industry-wide standards is the American Standards Association. This society was organized in 1918 by the American Society for Testing Materials and four leading engineering societies. Its membership consists of trade associations, technical societies, bureaus of the federal government, and private businesses. The standards developed by the American Standards Association cover a wide range of subjects in the electrical, mechanical, mining, building, and consumer goods fields. The association has also developed numerous safety standards which contain recommendations for the best methods of meeting the technical problems of accident prevention. These codes are guides to be voluntarily adopted and followed by industry.

Other technical or professional societies which have contributed to the standardization of materials and methods are the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, and the Society of Automotive Engineers.

Trade Associations. Commercial standards are a major activity of trade associations in such fields as lumber, iron and steel, paper and allied products, and electrical equipment and supplies. The Commodity Standards Division of the National Bureau of Standards frequently cooperates with trade associations in a manner similar to that followed in the simplification program. The recommendation for a standard usually originates with the trade association. A committee of producers in the industry studies the proposal and formulates a recommendation for measurements, tolerances, construction, chemical composition, physical requirements, or tests of acceptable performance. A preliminary conference of members and nonmembers of the industry is held under the supervision of the Commodity Standards Division for a discussion of the proposed standard. When accepted by the preliminary conference, the proposal is referred to the National Bureau of Standards and to technical societies for review to insure compatibility with the trend of research and development. If the proposed standard appears feasible, it is submitted to a general conference of producers, distributors, and organized consumers. The conference may adopt the standard with or without amendment, or it may reject it. If the standard is adopted, it is promulgated as the accepted practice of the trade.

The standards which have been promulgated by trade associations in co-operation with the National Bureau of Standards cover many of the products of industry, and new standards are being developed each year. The commodities for which standards have been adopted include artists' oil paints, automotive lifts, sewer pipes, hospital blankets, pajama sizes, cast-aluminum cooking utensils, colors for bathroom accessories, electric portable drills, hardwood stair treads and risers, gowns for hospital patients, insect wire screening, lenses for sunglasses, mopsticks, women's slip sizes, and surgeons' rubber gloves.

Acceptance of a Standard. Neither the trade association nor the National Bureau of Standards can require a manufacturer to accept a standard. Both the acceptance and the observance of a standard are voluntary. Producers are asked to accept a standard as an indication of intention to follow it where practicable, but it is recognized that deviations may sometimes be necessary. The Bureau of Foreign and Domestic Commerce co-operates with the National Bureau of Standards and trade associations in obtaining acceptance of a standard. The

ACCEPTANCE OF COMMERCIAL STANDARD

This sheet properly filled in, signed, and returned will provide for the recording of your organization as an acceptor of this commercial standard.

Date .....

Commodity Standards Division,
National Bureau of Standards,
Washington, D. C.

Gentlemen:

Having considered the statements on the reverse side of this sheet, we accept the Commercial Standard CS67–38 as our standard of practice in the

Production [1] Distribution [1] Use [1]

of karat-gold articles.

We will assist in securing its general recognition and use, and will cooperate with the standing committee to effect revisions of the standard when necessary.

Signature .....
(In ink)

(Kindly typewrite or print the following lines)

Name and title .....

Organization .....
(Fill in exactly as it should be listed in pamphlet)

Street address .....

City and State .....

[1] Please designate which group you represent by drawing lines through the other two. Please file separate acceptances for all subsidiary companies and affiliates which should be listed separately as acceptors. In the case of related interests, trade papers, colleges, etc., desiring to record their general approval, the words "in principle" should be added after the signature.

FIG. 32. Form for Acceptance of a Commercial Standard

form of acceptance for a commercial standard is illustrated in Figure 32.

Advantages of Commercial Standards. The establishment of a commercial standard usually is a part of a broader study of product varieties and sizes and usually results in the elimination of lines which do not meet the requirements of the standards. The adoption of a commercial standard, therefore, effects many of the manufacturing economies of simplification. In addition, standards improve market relationships in the following ways:

1. They create a better understanding between buyer and seller and reduce the possibilities for error and litigation.
2. They provide a fair basis for competition.
3. They reduce the variety of specifications for a commodity.
4. They establish a recognized basis for the certification of quality.
5. They provide the basis for forceful and direct advertising.

Limits of Standardization. Standardization and the related program of simplification have definite limits which are established by the needs of consumer industries and individuals. However, the needs of consumers are recognized and protected in the setting of the standards. If needs of consumers are found to be inadequately provided for, a revision of the standard to authorize the production of additional sizes or other varieties may be adopted. Style features in some lines of manufacture may preclude standardization. However, the standard as promulgated may permit variations in certain specified respects. For example, the standard for china plumbing fixtures provides for lavatories attached to the wall or unattached. It specifies that the prescribed dimensions do not indicate designs. Four basic colors, in addition to white, are regarded as standard — namely, green, blue, ivory, and peach-brown; but each manufacturer may determine the tint in accordance with his individual production problems.

Standards should be regarded as temporary and dynamic rather than permanent or static. Unless provision is made for a revision of the standard, experimentation and improvement in the product may be hindered to the detriment of the industry and the public. For this reason the standard should be regarded as a means whereby the "members of an industry may be permitted to go forward together." It should not be regarded as a means of stabilizing an industry.

Standards are accepted by manufacturers and distributors because they meet recognized needs. The observance of a standard by the producer is good business policy, provided that the needs of consumers are adequately safeguarded. Distributors and consumers find in a standard an assurance of quality and performance.

QUESTIONS

1. "Simplification is primarily a marketing problem, and standardization is primarily an engineering problem." Explain the meaning of this statement.
2. Why is the multiplicity of sizes and varieties of the product often the result of requests from the sales division?
3. What is the interest of the research department in the program of simplification and standardization?

4. Does a small volume of sales of a variety or size indicate that it can be eliminated?
5. A manufacturer of plow seats produces twelve different sizes and varieties of seats. He believes that many of them are unnecessary, but he hesitates to reduce the number of varities because he might lose the business of some customers who purchase two or more varieties. How should he proceed?
6. Why should the federal government be interested in the program of simplification and standardization? What is the part of the National Bureau of Standards in the movement? What is the part of trade associations?
7. How does the commercial standard differ from the standards established by a manufacturer to make parts of a product interchangeable?
8. Mention standards which have been established by the United States government.
9. How is the observance of standards which are established by technical societies and trade associations achieved?
10. Will the general development and use of standards limit individuality and unduly limit consumers in their choice of products?
11. Will the program of simplification and standardization tend to increase the monotony of jobs in industry by reducing the variety of tasks to be performed?
12. Will the program of simplification limit the activities of individuals in developing new products and new varieties?

CASES

33. STANDARDIZATION OF PRODUCT

The Carlson Bottle Company, with a large plant in Pittsburgh, makes an assortment of glass bottles. Several other companies in Pittsburgh make bottles, but the Carlson Bottle Company does about 20 per cent of the business in the area. The bottles are sold to chemical companies, beverage manufacturers, and canning and preserving concerns. Practically all of the bottles produced are made to the order of the customer.

The process of manufacturing bottles is relatively simple. Raw materials include silica, soda ash, and lime. The ingredients are measured and mixed and then heated in tank furnaces which hold from 100 to 1,000 tons. The mixture is melted and refined, and it then flows into a cooler section of the furnace which is separated from the first section by a floating fire-clay partition. The mixture is then fed through an opening, and a sufficient amount to make a bottle is measured and sheared. The molten material drops into a mold which has been especially made according to the specifications of the customer. Three moulding operations and an annealing treatment to remove possible strains in the glass complete the manufacture of the bottle. All of these operations are fully automatic. From one furnace, sufficient material can be fed to keep as many as five sets of molds fully occupied at one time.

The company has no difficulty in making bottles of different shapes, provided they require the same amount of materials of the same color. Orders from different customers are classified by size, and the molds required for making bottles of the same size and color are set up in the molding department at the same time. Since the same amount of mixture is extruded from the furnace each time, no additional cost is incurred in making bottles of different shapes except the cost of making the molds and changing molds in the machine.

In recent years the users of bottles have begun to order special colors of glass as well as special shapes and sizes in order that their products may be readily identified by customers at retail stores. The use of different colors and shades has presented a difficult problem to the Carlson Bottle Company and has substantially increased the costs of manufacturing. The molding operation could not be used to run orders for several customers unless the bottles were of the same color and could be made from the same mixture. The making of bottles of different colors meant frequent changes in the mix in the tank furnaces. Bottles of especially colored glass could not be sold at a profit at the usual prices.

The company has been considering the possibility of installing a series of small tank furnaces. However, the initial cost would be large; and operating costs would also be larger than the cost of operating the large furnaces. Another possibility is that of obtaining orders from customers far enough in advance to permit the grouping of a number of orders by size and color. An effort might be made to induce customers to accept one of a limited number of special shades and colors. If the customer would not accept a standard shade, he would be charged a higher price.

Questions:

1. Should the company attempt to supply any color of bottle in any size and shape?
2. Should higher prices be charged for special colors and sizes?
3. Should the company approach its competitors in an effort to obtain agreement on a program of standard sizes, shapes, and colors?

34. REDUCTION OF PRODUCT LINE

A manufacturer of men's dress shirts makes white shirts in three price lines. Each type of shirt is made in 6 sizes ranging from 14 to 16½. In the size 14 shirt, three sleeve lengths are made, namely 31, 32, and 33 inches. Some sizes are made in four sleeve lengths. For example, size 16½ is made with sleeve lengths of 32, 33, 34, and 35 inches. Each shirt is also available with French or plain cuffs and with or without a center pleat down the front. In all, each price line is made in 92 varieties, counting size, sleeve length, cuff style, and type of pleat. With three price lines the varieties total 276 for white shirts.

The manager of the merchandising division believes that the company should plan to market its white shirts in new-style fabrics now being made by textile manufacturers, but he does not believe that the company should discontinue the conservative broadcloth material which it has been using. He thinks the new material should be used to give variety to the line. The vice-president in

charge of manufacturing is opposed to any increase in the number of varieties manufactured because of the effect upon operating costs. He advocates a reduction in the number of sleeve lengths and the elimination of one type of cuff. He would also eliminate the styles that provide for center pleats because few customers are aware of the difference. He believes that few dealers can carry a complete line in the details of sizes, sleeve lengths, pleats, and cuffs, and thinks that dealer profits are decreased by the necessity of closing out broken lots and off-sizes. The manager of the sales division is opposed to any reduction in varieties. The question of varieties was discussed at a meeting of divisional executives, but no agreement was reached. The president has taken the matter under advisement.

Questions:

1. What information should the president request as a basis for reaching a decision in this case?
2. What would determine whether the number of varieties should be reduced?

CHAPTER XVII

INSPECTION

INSPECTION is the testing or examination of materials purchased, work being processed, completed parts, and completed and fully assembled products. Inspection is closely related to the other phases of product development — namely, design, research, and standardization. It is the activity of management which assures the manufacture of the product according to the accepted design. It provides for the maintenance of standards which have been established for parts and for the finished product.

Purposes of Inspection. The major purpose of inspection is to assure that the standards for materials, parts, and the finished product are maintained. The inspection of raw materials is necessary to compare materials and purchased parts with the standards and to prevent payment for defective materials. Unless they are inspected, defects would not become known until sometime after materials or parts have been issued for use. Production schedules would be delayed, and excessive labor costs would be incurred by payment for work on defective materials. At various stages in production, work in process may require inspection to prevent the expenditure of additional labor on work that does not meet the required standards.

The maintenance of standards through inspection is necessary to the manufacture of a product with interchangeable parts. A worker on the assembly line should not be expected to try a number of parts to find one that will fit, and he should not be expected to machine a part to make it fit. Although the parts need not be exactly alike, they should be of the same dimensions within the limits established by standards and tolerances.

The maintenance of standards by inspection is designed to assure that the product will meet customer approval in such respects as satis-

factory mechanical performance, the finish of enamel or paint, cleanliness of fabrics, and other details. Public safety also requires inspection of such parts as electrical appliances, cables, cranes, and automobiles.

One objective of inspection may be the prevention of excessive costs in labor or materials on products of a quality in excess of the required standards. For example, a worker may continue to wax furniture or to polish chromium grillwork or jewelry even after the work has been satisfactorily completed. Tin may be wasted by giving sheets a heavier coating than the specifications require. In the manufacture of tin cans, sheets that are suitable for fruit cans might be used for making antifreeze or oil cans at unnecessarily high cost. In fruit canning, excessive cost would be incurred by the use of large-size unblemished fruit as materials for fruit cocktail.

Another purpose of inspection is to permit the correction of defects. Metal parts which are too large after processing may be refinished to size, although parts which are too small may be no more than scrap. Imperfect finishes may be corrected by polishing or by sanding and refinishing. Uneven threads in a shirt may be removed and replaced by reweaving. Packages of granulated soap or sugar that contain too much or too little of the product may be brought up to standard by removing or adding the necessary quantity. Errors made by a typesetter are corrected after they have been discovered by a reading of the proof.

Inspection may be designed to rate or grade the product as standard, seconds, or rejects. Although the manufacturing division strives to produce as large a percentage of standard products as possible, a percentage of seconds and rejects may be expected. The seconds or imperfect articles are marked as such and sold to the trade or perhaps to employees at a lower price. Examples are shirts, shoes, linoleum, bedspreads, towels, and ceramics. Materials classed as seconds may be used in making a lower grade product. Examples are small fruits used in making cocktail or the bruised portions of animals used in making fertilizer or soap.

The use made of rejects depends upon the nature of the product. Irregularly shaped or dented bars of soap, broken lumps of sugar, and improperly shaped glass jars may be remelted and recast. Dented cans of fruit are sometimes sold locally at reduced prices. The shaving cream from dented tubes may be used to reclaim certain ingredients such as glycerine. Printed forms in which holes have been improperly cut or in which the printing is out of line are only waste paper.

Another purpose of inspection is to provide information concerning the efficiency of certain persons in the management or in the work force. For example, inspection may indicate that the most suitable material is not being purchased, that the employment procedure is not resulting in the selection of the best workers, that a training program is needed, that the wage system does not adequately reward good workmanship, or that defective or spoiled work is not being properly reworked. If the number of rejected pieces is large, management may find that the tolerances are too close, that supervision should be improved, or that machine tools are not being properly repaired or maintained.

Inspection should provide information to show the amount of good and poor work done by each worker. An employee who has done too much poor work may require more training or additional supervision. He may be transferred to another job, or he may be dismissed. If workers are given a bonus for quality, or if they are paid a piece rate, inspection may be necessary to determine the number of good pieces produced. As a check on the worker, the report should indicate the number of parts inspected, the number accepted, and the number rejected. Defects should be traced to the worker, the vendor in the case of defective material, the machine, or any other person or equipment to which the defects may be attributed.

When Inspection Is Done. The time of inspection varies in part with the nature of the product being inspected, which might be raw materials, purchased parts, work in process of manufacture, or finished products. Materials and purchased parts are usually inspected when they are received and before they are placed in store or sent to the factory for processing. In some cases, materials or products are inspected in the plant of the vendor during or after completion of the manufacturing processes. A shirt manufacturer, for example, sometimes contracts with textile mills for the manufacture of special fabrics of a specified weave or pattern. To assure that the materials will be of the desired quality, the shirt manufacturer may place an inspector in the plant of the textile mill. A fruit-packing company that contracts to buy the fruit from an orchard may inspect the fruit before it is picked to assure the quality of the fruit and to determine when it should be picked. A milk-processing company may protect itself as to the quality of milk by inspecting the barns and the cattle of the farmer.

When put into manufacture, a product may be inspected after each operation, prior to assembly, or after assembly. Usually, a number of inspections are necessary at various stages of manufacture. In the

automobile industry a car and its parts are subject to about 2,300 inspections before it is sent to the customer.[1] The inspections include approximately the following checks: chassis and chassis parts, 1,600; body, 475; steering system, 100; and cylinder block, 50. The cylinder block is inspected for size and location of cylinder bores, valve stem guides, crankshaft bearing holes, and valve seats. The block is inspected after every operation.

The product is usually inspected when it is finished. A motor is tested and broken in on a test stand for several hours. A washing machine, an electric iron, or an electric fan is connected with power lines at the completion of the assembly operations and its performance checked. Electric fuses and lamps are inspected by trying them in electrical connections. Tin cans and other containers are tested to assure that none have holes. The final inspection serves as a check on the inspectors at earlier stages of production.

Who Inspects. On the basis of who does the inspection, the work is usually classified as professional inspection, voluntary or worker inspection, automatic inspection, and machine inspection.

Professional inspection is conducted by a member of the inspection department, which is a staff department. Organization of a separate department for inspection was a part of the plan of Frederick W. Taylor, who designated one of his eight functional foremen as an inspector. Since the inspector serves as a check on the work of the line departments, the head of the inspection department should not be responsible to the foreman or the division chief but may report to either the director of manufacturing or the general manager. He reports to the general manager only in industries where quality is considered of primary importance.

Voluntary or worker inspection is, as the name suggests, inspection by the worker himself. In many types of mechanical work the operator may be supplied with a simple gage which he can use to inspect his work as it comes from the machine. A common type of gage is a "go-and-no-go" gage, which is used to test the size of a piece or the threads of a bolt or pipe. This gage consists of a piece of metal with two openings of different sizes. The openings indicate the outside limits of the piece or the tolerance. If the part can be inserted in both openings of the gage, it is too small. If it cannot be inserted in either opening, it is too large. The part must be of such size that it can be inserted in one opening but not in the other. The worker may use such a gage to inspect the first parts produced after the machine has been started.

[1] *Automobile Facts*, February, 1940, p. 5.

If the first parts do not pass inspection, he adjusts the machine and tries again. After the parts appear to be standard, the machine may be operated continuously, with occasional testing. If parts are found to be nearing the limit of tolerance, the machine should be adjusted before the limit is reached, to prevent the necessity for rejecting defective parts. In other words, the worker should always aim at the "bulls'-eye," which is the mid-point of the limits set by the standard.

Worker inspection is used where visual methods of inspection are employed. For example, a worker who is engaged in the polishing of jewelry or in assembly work should inspect his own work visually before passing the product to the next operation.

Worker inspection also may be employed to enable one worker to inspect the work done at preceding workplaces in the line, as in the manufacture of clothing or the assembly of an instrument. A worker who discovers a defect should report it before any further operations are performed. Worker inspection should be checked at some later stage in production by a member of the inspection department. The advantage of worker inspection is that the defects are discovered at an early stage and at less cost than would result from professional inspection after each operation. The limitation is that defective materials or parts may be passed by the worker because of indifference, carelessness, or inability to distinguish defects.

Automatic inspection results in the acceptance or the rejection of a part at the assembly line when one part is mated with another. Ordinarily, this method cannot be used because the progress of the work requires that all defective or nonstandard parts be rejected before they reach the line.

Machine inspection is usually a part of the work of the professional inspection department. However, some machines have been perfected to the extent that machine inspection may be regarded as a separate type of inspection. For example, in an automobile factory, each car passes over a steel plate in the floor as it nears the end of the production line. If the wheels are not properly aligned, the steel plate moves to one side and makes an electric contact that rings a bell. A can manufacturing company uses a machine to inspect tin cans for leaks. The cans are moved to the machine by conveyor. The machine automatically rejects any defective can and passes the good cans to a conveyor belt that carries them to the shipping room or the loading platform. Machines are commonly used to inspect for weight certain packaged products such as sugar or soap. Packages that are over- or underweight are automatically set aside.

How Much to Inspect. When work is done by manual labor rather than by machine, it is usually necessary to inspect every piece. An example is the work of a typesetter who sets the type for a book or of a typist who writes letters. The fact that a part of the work is correctly done cannot be accepted as evidence that no mistakes have been made in other parts of the work. However, the decision depends in part upon the importance of the job and upon the need for careful workmanship throughout. The auditing of accounting records is one type of inspection; but auditors do not usually consider that the verification of every entry is necessary, unless the sample selected for verification is found to have a number of errors. Inspection is usually regarded as adding nothing to the value of the product. No more inspection should be done than is necessary to accomplish the purposes.

When work is done on a semiautomatic or an automatic machine, it is usually necessary to inspect only a part of the work. The worker may adjust the machine and inspect the first few parts by the use of a gage or other simple inspection device. As the parts are processed by the machine, the operator may put them in numbered trays or boxes in order that the professional inspector may know which parts were produced first. The inspector would later check some of the parts in the first tray, some from the middle tray, and some from the last tray. If these parts meet the required standard, he can be assured that the machine was properly set for the first part and that it continued to operate in proper adjustment. If defective parts are found, it may be necessary to inspect the entire lot. The judging of an entire lot by the inspection of less than 100 per cent of the number of units is called "sampling" or "partial inspection."

The increased use of machines for inspection has decreased the cost and has made complete or 100 per cent inspection feasible in many cases where partial inspection was formerly employed. Many such machines have been developed. Examples are the steel plate used to check wheel alignment in an automobile and the machine usd to inspect tin cans for holes. Complete inspection by a machine is cheap after the machine has been made. The principal cost of machine inspection is the first cost of the machine. Complete inspection affords additional protection to manufacturers and consumers.

Use of Statistical Methods in Inspection. In the inspection of many commodities, 100 per cent inspection is not feasible because the cost of complete inspection would be excessive in relation to the advantages. In other cases, complete inspection is impossible because the units inspected are destroyed or made unusable by inspection. For ex-

ample, when cans of food are opened for inspection in a packing plant, the fruit is given to employees. In a glass factory the bottles and jars that are tested in a laboratory are sometimes subjected to increasing weight until they break. Some containers are cut from top to bottom to permit a measurement of the thickness of the glass, and others are broken in the making of tests for stresses and strains in the glass. Other products that may be destroyed in the course of tests for inspection are electric fuses, cartridge caps, coal tested for heat units, and wire tested for tensile strength. In such cases, statistical methods and sampling techniques are employed to answer such questions as the following:

1. How large a sample should be inspected?
2. How should the items in the sample chosen for inspection be selected from the lot?
3. When the number of defective items in the sample has been determined, how can the number of defective items in the entire lot be estimated?
4. What is the possible or probable percentage of error in the estimate of the total number of defective items?
5. What percentage of defective items in the sample is sufficient to justify the rejection of the entire lot?
6. How can the number of defective items in various samples or lots be charted or tabulated from one week or month to the next in order that unfavorable trends may be detected and the causes corrected?

Although the application of statistical methods to inspection is a technical problem requiring the services of a statistician, some general principles may be stated. Statistical inspection is based upon the fact that the measurement of the quality of a manufactured product is always subject to chance variability. In every specific method of production, some stable "pattern of chance causes" exists; and within the stable pattern there is variability. The variability may extend beyond the usual pattern. Any variation outside the stable pattern is due to causes which may be found and corrected. The problem in statistical inspection is to determine the assignable causes of quality variation as distinguished from the chance variability.

A few simple illustrations may be cited to indicate what is meant by "chance variability." An occasional blemish in a piece of cloth may be due to a broken thread or a knot tied to start a new spool of thread. An off-color bottle or jar might be due to an accidental dropping of a foreign substance in the mix or failure thoroughly to clean the hopper. A hole bored in wood or metal at an irregular angle might be due to

the failure of the worker to brush away all shavings before seating the material. In such cases a few defects would not be significant. But if the charting of the variations shows an increase in the number of defective parts from week to week, the cause may be attributed to some basic defect which requires correction.

Statistical quality control employs four techniques that are closely related. Briefly they are as follows:

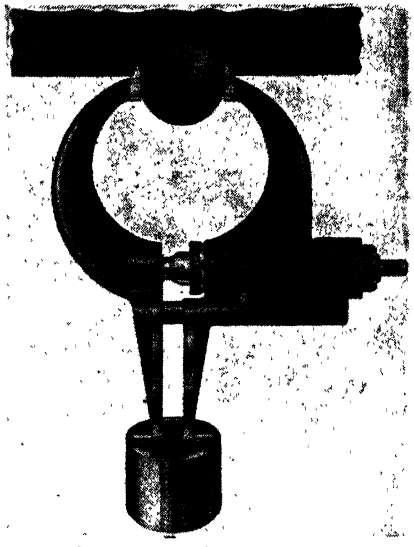
1. The application of sampling theory and probability which deal with the measure of confidence attached to the existence of the desired quality.
2. Control charts for average and range, and control charts for average and standard deviation.
3. Control charts for the number of defective items in a stated quantity in various lots, such as fifty or a hundred.
4. Control charts for the number of defective items, stated as a percentage of the number inspected.

Where to Inspect. The inspection may be made on the production floor or in the laboratory. Inspection on the floor is usually easier if the product is bulky or heavy, if inspection is visual, or if special equipment is not necessary for the inspection. Floor inspection is usually better if the work can be effectively done in the shop because defects are more quickly found and corrected. Losses resulting from the continued production of defective parts are less likely. Laboratory inspection is necessary if special machines or equipment are a necessary part of the work.

In most companies, both floor inspection and laboratory inspection are used. To illustrate, in the making of glass bottles, inspection is made on the floor for weight, shape, color, and flaws in the glass. Inspection for shape is done by a machine, and the other inspections are made by workers. In the laboratory the sampling method is employed for a number of tests such as possible stresses and strains in the glass, ability to withstand changes in temperature, ability to support weight, uniform thickness of the glass, external shape, and capacity. In a fruit-packing plant, floor inspection is used for peaches to assure that all seeds and peelings have been removed, to see that the cut is uniform and proper, and to assure uniformity in size and appearance. Laboratory inspection is used for samples of the canned fruit, which are inspected for vacuum space, amount of head space, gross and net weight, sugar content, color and quality of the fruit, and number of pieces to the can. In a soap factory, floor inspection is used to control

color and shape of bars and to assure clearness of brand name and cleanliness of wrappings. Laboratory inspection is used for chemical analysis and tests of moisture content. Both incoming materials and soap products are given tests of this kind.

Kinds of Tests in Inspection. The nature of the test depends upon the materials, parts, or finished product. Some of the common tests are designed to assure that the standards as established in the design of the product are maintained. They include tests for accuracy of dimensions, contour or profile of parts, strength of material, smoothness of surface, chemical composition, color, and internal flaws.



Courtesy of Richards Machine Tool Co.

FIG. 33. Micrometer for Measuring Inside or Outside Dimensions

Accuracy of Dimensions. Mass-production industries with interchangeable parts are dependent upon scientific measurement, which has made steady progress since the beginning of the nineteenth century. The accuracy of dimensions is measured by instruments that are controlled by the operator through the sense of touch rather than the sense of vision. One of the oldest and best-known measuring devices is the caliper, which was invented in 1631 by Pierre Vernier. The caliper consists of two legs or fingers which are usually curved or bent. The distance between the fingers is controlled by turning a screw or worm wheel in a manner similar to the method of moving the jaws of an ordinary monkey wrench. One complete turn of the worm wheel moves the points of the calipers a distance equal to the width of one thread on the wheel. This distance is subject to accurate measurement. One-half turn or any other fraction of a turn moves the points a corresponding fraction of the width of a thread. The caliper thus permits definite measurements to very small fractions of an inch. Some calipers are so constructed that the fingers grasp or measure the outside dimensions of a part, and others are so designed that the fingers can be inserted inside a part to measure inside dimensions.

An adaptation of the caliper is the micrometer. This instrument is defined as "a caliper gage with micrometer screw attached, used for

very exact measurement." The micrometer is usually adapted for the measurement of outside dimensions, but it may also be made to measure inside dimensions. A micrometer which may be used for the measurement of either inside or outside dimensions is shown in Figure 33. It will be observed that the instrument is equipped with a dial which records the distance between the movable spindle and the anvil or frame. This instrument will measure dimensions to 0.0001 of an inch.

Courtesy of Federal Products Corp.

FIG. 34. Gage for Inspecting Outside Dimensions

Gages for measuring dimensions are of many types. Some of them operate on a principle similar to the caliper. An illustration of such a gage is shown in Figure 34. Some are limit gages with fixed dimensions similar to the "go-and-no-go" gage previously mentioned. Plug and ring gages consist of two parts: a ring with threads on the inside and a plug with threads on the outside. Holes are tested with the plug gage. Special gages, which are equipped with dials similar to the one shown in Figure 34, are made to measure length, width, squareness, thickness, and shape of threads; the location of holes bored in a plate; and the uniformity of the diameter of a material, such as a wire. Especially designed gages are also used to test the accuracy of the shape of a hole as well as its size. The hole which engages a shafting, a piston, or an axle must be free of mechanical defects to prevent undue vibration, weakness, wear, and other unsatisfactory performance. A hole may be tapered, crooked, irregular, or bellmouthed. Accurate modern gages inserted inside the hole will register such irregularities.

During World War II, gages were in short supply because of the great demand in new plants and the limited capacity for production of precision instruments. With the support of the government, industry experimented in the manufacture and use of glass gages, such as the "go-and-no-go" type. The glass gage was found to be very satisfactory.[2] It has the advantage of accuracy because it does not absorb body heat

[2] L. P. Alford and J. R. Bangs, *Production Handbook* (New York: Ronald Press Co., 1948), p. 667.

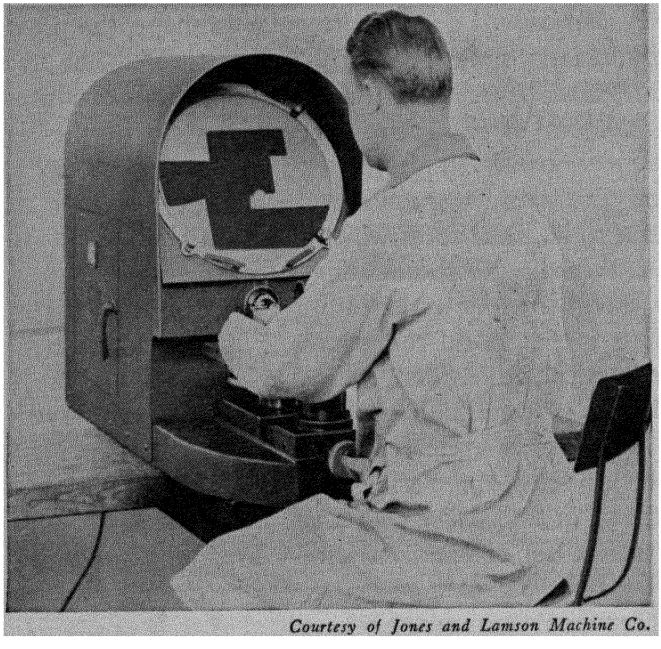
and expand to the same extent as a steel gage. If it is dropped, it may break; but it does not spring out of shape. It has the advantage of long life because it resists abrasives and does not corrode. It has a psychological advantage because the inspector is inclined to handle it carefully, whereas he might be careless in handling a steel gage. Consequently, many companies have continued to use glass gages during the postwar period.

Profile Inspection. If a part is irregular in shape, the prescribing of a series of dimensions may be difficult or impossible. The standard for parts of irregular shapes and a variety of dimensions may prescribe the profile or contour of the entire part and certain of the limiting or over-all dimensions. Examples of such parts are gears, wheels, razor blades, and steel rails. Inspection for profile or contour is made with the use of a rigid metal form which has been made to fit the part or the product according to specifications.

A very useful machine for measuring or comparing the contour of small objects is the optical comparator, which operates on a principle known as "optical projection." By means of a series of mirrors or reflecting devices, the machine magnifies the profile of the object being inspected and throws a clear reflection of the contour upon a glass screen, which resembles the screen of a television set. A master chart, which is drawn in accordance with a prescribed standard, may be placed upon the screen for comparison with the part being inspected. The number of times the profile of a part may be magnified depends upon its size. Very small parts may be magnified to sixty or more times their size. When the profile is magnified in this way, defects which are undetected by ordinary visual inspection show up very clearly. One valuable use of the comparator is to check the wear of gages and other inspecting equipment for scratches and gradual wear. Unless the contour of the gage is compared with a standard outline, the required dimensions of a part may be gradually changed; and the error may become known only after unusable parts have accumulated at the assembly line. The comparator is also used to inspect ball bearings, electric-shaver parts, knife blades, golf balls, threads of lamp bulbs, beads, saw teeth, and numerous other parts. Figure 35 shows an inspector using such a machine to inspect the profile of a part.

Strength of Material. Incoming materials and finished products are frequently tested for strength. For example, steel companies make tests of the strength of sheet steel, bulletproof jackets, and wire. Cable companies test insulated wire for tensile strength and the amount of friction required to remove the insulation. Bottle companies subject bottles to

tests of internal pressure and weight. Tin can manufacturers test tin cans to determine the number of pounds of pressure the can will withstand. This test is made by the use of a machine that puts an increasing amount of pressure upon the can until it bursts. Since the can usually bursts at the seams, this test applies to the seams rather than the material. The machine that is used to test tin cans is shown in Figure 36.



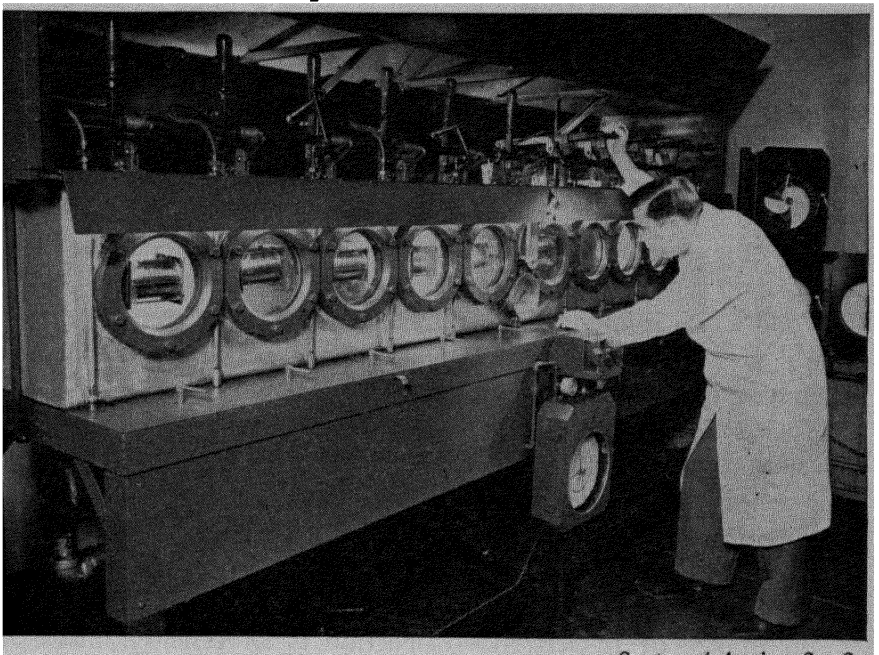
Courtesy of Jones and Lamson Machine Co.

FIG. 35. Comparator for Inspection of Profile of Parts

Smoothness of Surface. The smoothness of the surface is a relative matter. In many products a surface which appears smooth to the eye is satisfactory. This is true, for example, of bricks, linoleum, the base of a stove, or the top of a kitchen table. Visual inspection of smoothness may therefore be sufficient. This method is used for the inspection of costume jewelry, grillwork of automobiles, and many other products. A more accurate method is to use a machine for testing smoothness or roughness of a surface. One type of machine gages the surface roughness by measuring the resistance to the passage of compressed air between the surface being inspected and a smooth steel plate which is placed upon a product.

Chemical Composition. In a great variety of the products of industry, standards have been established for chemical composition and the permissible percentage of impurities. The standards are made by

the manufacturer of the materials and usually by the purchaser. Examples of materials for which chemical standards are important are glass and materials used in making glass, fertilizers, dyestuffs, sugar, soap, alloys, and paints. Tests for chemical composition usually require laboratory or central inspection.



Courtesy of American Can Co.

FIG. 36. Device for Testing Tin Cans

This machine subjects the inside of a can to pressures far beyond the pressure in actual use.

Color. In the mixing of colors for dyeing textiles or making paint, the problem is to make each new batch like the standard. In the automobile industry the method has been to mix colors according to formula and to take frequent samples for inspection during the mixing process. The sample is compared with the master panel by an expert color matcher who relies upon his trained eye to determine when the mix is done.[3] Machines are now being made to compare colors mechanically by measuring the light rays reflected from a painted surface. This device is faster and more accurate than visual inspection. A machine has also been developed to sort cigars according to color.

Inspection for Internal Faults. A new method of testing metals and other materials for flaws, such as cracks, breaks, shrinkage areas, and

[3] *Automobile Facts*, April, 1947, p. 8.

porous conditions, by means of supersonic vibrations has been applied in the inspection of steel, aluminum, magnesium, brass, glass, and plastics. The device has been especially valuable in the discovery of hidden defects in crankshafts, railroad car axles, cylinder blocks, and other solid metal parts. The machine transforms an electrical vibration into a different type of vibration which is called a "high-frequency" or "supersonic" vibration. This change is effected by means of a quartz crystal. The supersonic vibrations are transmitted into the material being tested. The vibrations from the material are directed back to the machine where they are fed into an amplifier and are reflected upon a small glass screen. A flaw or internal defect in the material shows as a break in the line of vibration on the screen. The machine indicates not only the existence of a flaw but also its extent and its depth. This information is of much value in making repairs.[4]

Wood which is imported from areas where fighting occurred during World War II frequently contains metal from shrapnel or rifle bullets. The metal in the wood will seriously damage machine tools if an attempt is made to process the piece. Wood from trees which once served as fence posts may also contain metal. The presence of metal in a piece of wood may be detected with a sounding device which is built on the principle of the mine detector used by the army. Nutshells and cherry seeds in candy may be detected by an adaptation of the X-ray machine.

Importance of Inspection. Inspection is an essential phase of quality control because it constitutes a check on the quality of raw materials purchased, the manufacturing operations, and the work of employees. It is the means of making effective the standards set for the design and the functioning of the product. Although the work of inspection does not provide quality, which can be built into the product only by manufacturing operations, it should assure that the quality is maintained.

QUESTIONS

1. Can inspection be effective without establishment of specifications for materials and parts?
2. The purchasing department places an order for lumber by stating on the purchase order: "Materials to be delivered must be like the sample which you sent to us." Indicate the difficulties which might arise in inspection.

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[4] See G. A. Van Brunt, "Supersonic Equipment Available for Finding Flaws," *Factory Management and Maintenance,* Vol. CV, No. 5 (1947), pp. 94–96.

3. Mention parts or products which can be reworked in case inspection reveals items not up to standard. Mention parts or products which cannot be reworked to remove defects.
4. For what types of product is safety of workers or the public an important reason for inspection?
5. What uses may management make of information shown in inspection reports?
6. For what materials and under what conditions would inspection at the plant of the vendor be desirable?
7. For what types of operations or products is visual inspection satisfactory?
8. What is the advantage of the use of a machine for inspection? How does the machine make possible 100 per cent inspection?
9. For which of the following parts or products would the tolerance be small and for which would the tolerance be much larger?
   a) Gears of an adding machine.
   b) Winding stem in a watch.
   c) Size of a lamp shade.
   d) Threads in the base of a lamp.
   e) Flatness of the surface of a base for a wood stove.
   f) China cups and saucers.
   g) Bearing holes for the crankshaft of an automobile.

CASES

35. MAINTENANCE OF QUALITY STANDARDS

The main office of the National Glass Works, Inc., is in New York. Reporting directly to the president of the company is a vice-president in charge of research and quality control. His function is to develop standards of quality and to see that the standards are consistently maintained.

One of the plants is at Oakland, California. At the Oakland plant, glass containers are made and sold to local canning companies, beverage manufacturers, and other manufacturers. The plant is under the general supervision of a plant manager. The chief inspector, who reports to the plant manager, is responsible for the maintenance of quality standards as established at the New York office. The company has a laboratory at the Oakland plant where central inspection is given by the sampling method to assure proper strength of containers, size and volume content, uniform thickness of glass, absence of internal stresses and strains, and other qualities.

On the production floor, workers regularly make certain tests for quality. In the molding department, workers visually inspect containers as they come from the molds to detect any obvious defects. This inspection is by the sampling method. As the containers move to the packing and shipping department after an annealing process, they are inspected for outside shape and contour by a machine which automatically rejects any container not of the right shape. This inspection is 100 per cent.

All containers move past a floor inspector toward the packing station. The inspector uses visual inspection for color and possible blemishes in the glass.

This worker is under the line control of the foreman of the packing department but observes instructions from the chief inspector as to quality standards. As workers remove containers from the conveyor for packing in a corrugated shipping box, they inspect the bottom of each one for color, air bubbles, and other defects that might be detected by visual inspection.

Required:

1. Draw up an organization chart to show organization for quality control.
2. Explain the relation of the quality control function to manufacturing.

36. WORKER INSPECTION

A company making a small instrument for the panel of an automobile assembled the product at 18 workplaces along an assembly line. The management believed that professional inspection for work in process would be too expensive and decided to rely upon worker inspection. As the product moved along by means of a conveyor belt, each worker was expected to keep no more than one assembly at her workplace, in addition to the assembly being processed. As she completed her work, she was expected to send the partially assembled instrument forward to the next workplace by means of the conveyor. If any worker found that an instrument reaching her had not been properly assembled at preceding work stations, she was instructed to call the supervisor on the floor. The supervisor would bring another instrument correctly assembled up to that point and remove the defective instrument. When the defective instrument had been properly assembled, it would be placed on the reserve shelf to be held until another defective one showed up at that point in the line.

Questions:

1. What was the advantage of worker inspection in this case?
2. Under what circumstances would the plan be feasible?

37. SUBSTITUTION OF WORKER INSPECTION FOR PROFESSIONAL INSPECTION

A manufacturer of calculating machines produces a machine made up of about 1,400 parts. The parts are made on various types of metalworking equipment in a number of departments that are arranged by processes, such as spring, punch press, lathe, and screw-machine departments.

In the assembly of the calculating machine, each worker assembles a number of parts to form subassemblies. In the later assembly operations the subassemblies are combined to form assemblies, and the process of assembling the parts continues until the complete product has been assembled.

Heretofore, inspection in the assembly department has been done by professional inspectors. Each worker accumulates work at his workplace until an inspector appears to inspect and count the completed work. He fills out a report showing the number of units accepted and the number to be reworked. Accepted units are then carried by the worker to the next workplace.

The company has been experiencing some difficulty with this method of inspection. During some seasons of the year, two shifts are employed. Near

the end of each shift, workers are inclined to stop work and wait for the inspector to make the inspection and record the count of units completed. Production is sometimes delayed at some workplaces as much as 20 to 30 minutes near the end of the shift. The company also finds that an excessive number of inspectors is required.

The proposal has been made that most of the inspection be done by employees and that professional inspectors be used only to check on employee inspection. Workers would move the subassemblies to the next workplace upon completion. Each worker would inspect the work received and count and tabulate the number of units. Where several workers were employed in the same kind of work, the employees would be paid by a group piece rate. This method would permit work completed by any worker in the group to be moved immediately to any worker at the next station. The management believed that this method would enable each employee to continue work until the end of the shift.

Questions:

1. What would be gained by the new method?
2. What difficulties would be encountered?
3. What would determine whether the proposed method is feasible?

PART V

Production Standards

CHAPTER XVIII

MOTION STUDY

THE establishment of a standard of production by which to measure the accomplishment of a worker, a group of workers, or a department is an important part of the work of the industrial engineer. Unless management has such a standard, it has no way of determining whether output is average, below average, or exceptional. Past performance is unreliable as a standard because it may result in the comparison of current performance with a poor, average, or excellent rate of output. Standards are necessary not only for determining the pay or other reward of the worker but also for handling many management problems, such as estimating costs, determining completion dates for work planned, establishing a balance in plant layout, and handling worker complaints and grievances.

Two techniques are used in the establishment of standards of production — namely, motion study and time study. Motion study includes an analysis of the movements of the hands, arms, feet, and body of the worker in accomplishing the assigned task. It also includes an analysis of the arrangement of the workplace, tools, and equipment used. Conditions of work, such as ventilation, lighting, noise, and control of obnoxious or dangerous gases, are usually surveyed and improved.

After motion studies have been made, the time required by the worker to do the task may be accurately determined. Time study is necessary not only to measure the savings made by motion study but also to compare two or more motions or sets of motions to determine which requires the least time. Neither motion study nor time study is complete until workers who are assigned to the job have been trained in the new methods.

The Purposes of Motion Study. Motion-study technique was developed in great detail by Frank B. Gilbreth and Lillian M. Gilbreth, who were interested in eliminating useless motions and particularly the body motions which tired the worker. An increase in output naturally resulted from job improvement. Another result is the reduction in the amount of time required to manufacture a product or to complete a task. A shortening of the construction period increases the rate of turnover of work in process and decreases the overhead cost per unit. The savings are greatest when the motion-study technique is applied to the bottleneck jobs or operations, for greater output may be achieved from other workplaces all along the line. This improvement usually results in improved morale, since wasted efforts and exasperating delays create a feeling of frustration on the part of the worker.

Analysis of Motions Required. Before an attempt is made to simplify the task, the investigator should see precisely what the worker does in performing the work. For example, the elements of the job of cutting gears with the hobbing machine which was referred to in Chapter VI might be as follows:

1. Walk to machine.
2. Place arbor of work between centers.
3. Advance hob to work.
4. Engage feed.
5. Cutting by machine.
6. Stop machine when work is completed.
7. Run hob back.
8. Remove arbor of work from machine.
9. Inspect.

While the machine is making the cut, the worker prepares the next arbor of work. He may also perform steps 1, 2, 3, and 4, or 6, 7, 8, and 9 on another machine doing similar work.

Improvement of the Effectiveness of Motions. In Gilbreth's famous motion study of bricklaying, the number of motions required to lay a brick was reduced from eighteen to four and one-half. As pointed out in Chapter II, he designed a scaffold which could be raised by a helper to place the bricks in position along the wall. The helper was required to keep the mortar stirred and free of lumps.[1] The following motions were eliminated:

1. Step for mortar. The mortar boxes were never more than four feet apart, and one box was always within reach.

[1] See Frank B. Gilbreth, *Bricklaying System* (Chicago: M. C. Clark Publishing Co., 1909), p. 148.

2. Work up mortar. The assistant was made responsible for the consistency of the mortar for all bricklayers.

3. Step for brick. Bricks were arranged along the wall by the tender.

4. Select brick. The tenders were required to vary the brick to suit the conditions, that is, to bring the best brick for the outer wall.

5. Spread the mortar. The bricklayer was taught to throw the mortar on the wall in a manner that required no spreading and that caused the mortar to run up on the end of the previous brick laid.

6. Cut off mortar prior to the laying of the brick. No cutting was necessary because the bricklayer brought over approximately the right amount of mortar on his trowel and spread it properly. In the original arrangement the bricklayer cut off and disposed of mortar three times for each brick.

7. Disposing of mortar prior to laying the brick.

8. Tap down brick. If the mortar was of the right consistency and free of lumps, and if the bricks were wet, no tapping was necessary.

9. Cut off mortar after tapping brick.

10. Disposing of mortar after tapping.

The following motions were made simultaneously by the right and the left hands and arms:

1. Reaching for mortar and brick. Two motions were reduced to one.

2. Carrying mortar and brick to wall and spreading mortar. This improvement reduced three motions to one.

The improvements made by Gilbreth reduced by thirteen the number of motions required to lay a brick. Ten motions were entirely eliminated. The making of simultaneous motions eliminated three additional motions because two simultaneous motions replaced five separate motions. Under the improved method a bricklayer could lay a brick with four and one-half motions. The method was as follows:

1. Reach for mortar, reach for brick (simultaneous motion, right and left hands).

2. Carry mortar and brick to wall (simultaneous motion). Mortar was spread when it was deposited on the wall at the end of the motion.

3. Lay brick on mortar. When the brick was laid on the mortar, it pressed the mortar out of the joints.

4. Cut off mortar. This was done on every second brick because Gilbreth found that it took no longer to cut mortar off two bricks than off one. Since this was done on every other brick, it counted as only one-half motion.

5. Dispose of mortar. The mortar was used to butter the end of the last brick laid or carried back to the mortar box.

Therbligs. As a part of the analysis of the task the entire operation is studied, and the separate motions are listed. The three basic phases of any task are: *Get ready*, or preparation; *Do it,* or operation; and *Clean up,* or completion. These parts of the task are further subdivided into elementary motions which vary with the task, although all tasks consist of different combinations of the same elementary operations.

The Gilbreths found that any task can be performed by a combination of eighteen detailed motions, which they called "therbligs." The word "therblig" is Gilbreth spelled backwards, except that the last two letters in the name are not interchanged. The therbligs and their definitions are as follows:[2]

THERBLIG	DEFINITION
Reach	Consists of reaching for an object.
Move	Consists of moving a tool or a part. The object may be pushed, shoved, carried, or moved in the hand.
Grasp	Consists of taking hold of an object.
Position	Means to put material into place for processing, or to line up a part for assembly, or to put a tool to the material for use.
Disengage	Consists of separating two or more parts.
Release	Consists of letting go of a tool, a part, or an assembly.
Hold	Consists of retention of material or part in a fixed position with either hand.
Do	Consists of assembling two or more parts or of applying a machine or hand tool to the purpose for which it was intended.
Examine	Consists of viewing, examining, or testing a part or an assembly to determine whether it meets required standards.
Change Direction	Consists of changing the line or the plane along which Reach or Move is made.
Preposition	Consists of locating a tool or part preparatory to the beginning of the next therblig.
Search	Means the movement of the eye or hand in an attempt to locate an object.
Select	Consists of locating a part or a tool.
Plan	Consists of mental processes of operator preparatory to beginning the next cycle of operations.
Avoidable Delay	Consists of stoppage of work activity for which the operator is responsible.

[2] The therbligs listed here are the revised basic motion elements tentatively adopted by a committee sponsored by the American Society of Mechanical Engineers. See H. B. Maynard, G. J. Stegemerten, and J. L. Schwab, *Methods-Time Measurement* (New York: McGraw-Hill Book Co., 1948), pp. 173–76.

THERBLIG	DEFINITION
Unavoidable Delay	Consists of waiting for material or repairs to the machine or for the machine to make a cut.
Rest to Overcome Fatigue	Consists of seating oneself, changing position, or other activity or relaxation.
Balancing Delay	Means delay of one hand caused by differences in the time required by two hands to perform separate motions.

In work simplification a complete cycle of therbligs is charted for both the right and the left hand. Therbligs are given symbols for quick identification and are also designated by standard colors.[3] A simple motion chart is shown below.

MOTIONS OF RIGHT HAND IN SIGNING A LETTER

Motion	*Name of Therblig*
1. Look for pen.	Search
2. Reach for pen.	Reach
3. Choose a pen for use.	Select
4. Grasp pen with hand.	Grasp
5. Move pen to letter.	Move
6. Put pen into position for use.	Position
7. Sign name.	Do
8. Return pen to holder.	Move
9. Release pen.	Release

The reason for the reduction of an activity into its elements and for the designation of each element by name is to determine whether a more economical sequence is possible and also to determine what steps may be eliminated. The therbligs that do not contribute directly to production should be especially scrutinized. For example, the therblig *Search* may suggest that parts have not been properly positioned for use. The therblig *Select* may be eliminated by teaching the worker to take parts from a certain part of the container or the pile. *Unavoidable Delay* may be eliminated by changing the sequence of motions or rearranging the workplace in order that one hand may not be required to wait for the other to complete an operation, or by permitting the worker to attend two machines if the delay is due to the time required for the machine to process the part. *Avoidable Delay* is due to causes which may be eliminated. The therblig *Plan* may be eliminated or reduced by training the worker in the sequence of operations and by posting the sequence in front of the worker. The therblig *Hold* may be eliminated by providing a fixture for holding.

[3] For charts illustrating the use of colors, see L. P. Alford and J. R. Bangs, *Production Handbook* (New York: Ronald Press Co., 1948), p. 578; also Ralph M. Barnes, *Motion and Time Study* (New York: Wiley & Sons, Inc., 1937), p. 48.

TABLE 4

MOTIONS BEFORE IMPROVEMENT

LEFT HAND		RIGHT HAND	
Name of Therblig	Description	Name of Therblig	Description
Unavoidable Delay	Idle	Release	Aside finished piece
Move	Get part No. 1	Unavoidable Delay	Idle
Move	Give part to right hand	Grasp	Take part No. 1
Unavoidable Delay	Idle	Position	Position part No. 1
Grasp	Take from right hand	Move	Give back to left hand
Unavoidable Delay	Idle	Move	Get part No. 2
Hold	Hold for right hand	Do	Assemble No. 1 and No. 2
Unavoidable Delay	Idle	Grasp	Pick up tweezers
Do	Help right hand	Do	Get and weld No. 3 and No. 2
Unavoidable Delay	Idle	Release	Lay down tweezers
Move	Give to right hand	Grasp	Take from left hand

Table 4 shows how the effectiveness of motions may be improved by a few simple changes. The task consists of the assembly of three parts. Parts No. 1 and No. 2 are assembled by placing them together and making them secure by means of a twisting motion. Part No. 3 is welded in position. The motions before improvement were as indicated in Table 4.

The motions are wasteful because one hand is required to wait for the other hand to perform a motion and also because of the transfer of parts from one hand to the other. The motions can be improved by a rearrangement of the workplace and the placing of a container of No. 1 parts in a position where the part can be reached by the right hand instead of the left. Part No. 3 is prepositioned in such a manner that the use of the tweezers is unnecessary. With these changes the number of motions may be reduced from eleven to five. After improvement the motions are as shown in Table 5.[4]

TABLE 5
MOTIONS AFTER IMPROVEMENT

LEFT HAND		RIGHT HAND	
Name of Therblig	Description	Name of Therblig	Description
Move	Get part No. 1	Release	Aside finished piece
Position	Position part No. 1	Move	Get part No. 2
Hold	Hold for right hand	Assemble	No. 1 and No. 2
Do	Help right hand	Do	Get and weld No. 3 and No. 1
Move	Give to right hand	Grasp	Take from left hand

Principles of Motion. The principles of motion are used as a guide in the improvement of any job. They were first published by Frank B. and Lillian M. Gilbreth in 1923 and have been only slightly changed since that time.[5] The principles are as follows:

1. Both hands should preferably begin their therbligs simultaneously.
2. Both hands should preferably complete their therbligs at the same instant.
3. Both hands should not be idle at the same instant except during rest periods.
4. Motions of arms should be in opposite and symmetrical directions instead of in the same direction and should be made simultaneously.

[4] Adapted from Robert C. Berman, "Better Supervisors Because They Know Their Product," *Factory Management and Maintenance*, Vol. CIII, No. 12 (1945), p. 100. Used by permission.

[5] *Bulletin of the Society of Industrial Engineers*, Vol. V, No. 11, pp. 6–7.

5. Hesitation should be analyzed and studied and its causes accounted for and if possible eliminated.

6. Shortest time demonstrated in one part of the study should be used as a mark to attain, and the reason for other times required in other parts of the study should be known.

7. Number of therbligs required to do work should be counted; for the best way is almost always a sequence of the fewest therbligs.

8. The best sequence of therbligs in any one kind of work is useful as suggesting the best sequence in other kinds of work.

9. Every instance where delay occurs suggests advisability of providing some optional work that will permit utilizing the time of the delay, if so desired, or of making fatigue study of the interval.

10. Variations of time required for any single therblig should be arrayed and causes recorded.

11. Lateness of various parts of the anatomy as compared with other portions should be recorded.

12. All material and tools should be located within the normal grasp area, that is, within the maximum working area.

13. Motions should be confined to lowest possible classifications in order to reduce fatigue; as listed below, those giving least fatigue and most economy are put first.

First: Finger motions.
Second: Finger and wrist motions.
Third: Finger, wrist and lower arm motions.
Fourth: Finger, wrist, lower arm and upper arm motions.
Fifth: Finger, wrist, lower arm, upper arm and body motions.

14. Tools and materials should be located as to permit proper sequence of therbligs. The part required at the beginning of the cycle should be next to the point of release of the finished piece from the former cycle.

15. Sequence of motions should be arranged to build rhythm and automaticity into the operation.

16. Hands should be relieved of all work that can be done by feet or other parts of the body.

17. Tools and materials should be prepositioned as much as possible to reduce the search, find and select therbligs.

18. Gravity-feed containers should be used to deliver the material as close to the point of assembly or use as possible.

19. Ejectors should be used to remove the finished part.

20. Use "Drop Delivery" whereby the operator may deliver the finished article by releasing it in the position in which it was completed without moving to dispose of it.[6]

A workplace which has been designed for economy of motion is shown in Figure 37.

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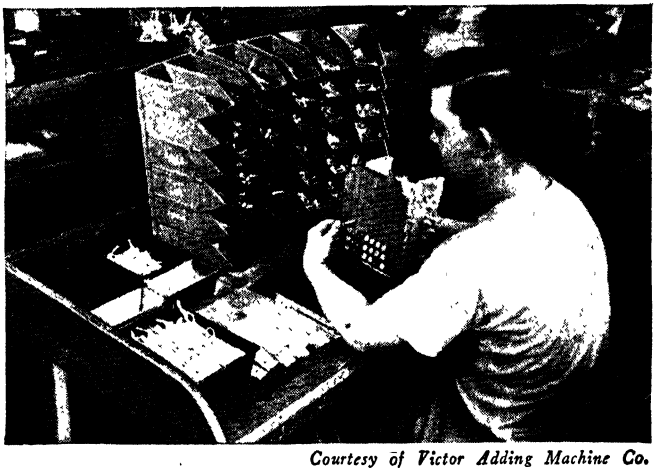
[6] L. P. Alford (ed.), *Cost and Production Handbook* (New York: Ronald Press Co., 1934), pp. 519-20. Used by permission. See also Alford and Bangs, *op. cit.*, pp. 587-88.

Training the Worker. After the best way to perform a task has been determined, all workers on that job are taught the easiest and quickest way to do the work, and all of them are expected to use it. Frank Gilbreth contended that a person who began his training to become a bricklayer should work fast from the beginning, even though his work is not up to standard in quality.[7] He said that, if necessary, a



Courtesy of Victor Adding Machine Co.

FIG. 37. Workplace Planned for Economy of Motion
The worker is making a subassembly for an adding machine.

skilled bricklayer should follow the beginner, tear down the bricks, and relay them. He held that the making of simultaneous motions was the most important feature of the work and that a worker who began by working slowly could not easily learn to work fast at a later time. If he began by working rapidly, Gilbreth said, he could later perfect his motions and attain quality and accuracy. Observers in other fields have not always agreed with this point of view; and some contend that correct motions and accuracy of work, as in typewriting, should be sought from the beginning, even at the sacrifice of speed.[8]

An instruction sheet is prepared for use in training the worker. It indicates the method of performing the task as developed by the motion study. It gives a description of the work to be done, including the specifications for the part and the tolerances or variances that are permitted. It describes the material to be used in the processing and identifies them by number, size, or other exact means. The machine

[7] Frank B. Gilbreth, *Motion Study* (New York: D. Van Nostrand Co., 1911), p. 37.

[8] For views opposed to that of Gilbreth on this point, see Bruce V. Moore and George W. Hartman, *Readings in Industrial Psychology* (New York: D. Appleton & Co., 1931), pp. 252–55.

and the machine tools to be used are indicated; and a drawing of the machine after it has been set up may be included, together with any special instructions for operating the machine. Finally, the motions to be performed by the left and right hands and in some cases by the feet are listed; and the names of the therbligs for each motion are given.

Economies of Motion Study. The savings effected by motion study have been demonstrated many times and are no longer the subject of controversy. They arise from improvements of the workplace and conditions of work, the elimination of useless motions, and the development of more effective motions. Motion study also requires that management pay greater attention to the selection of workers in order that they may be willing and able to learn new methods of work. Since motion studies cost money, management must regularize employment as much as possible to reduce the cost of continually training new employees.

Motion studies effect the greatest economies if a large number of workers are engaged in the same type of work. A reduction of 25 per cent in the time required, for example, means greater dollar savings when more workers are employed in the same operation. If the task is not changed from one year to another with changes in design of the product or changes in equipment, the economies are increased because the savings are continuous. The amount of training, skill, or experience required of the worker is also a factor because jobs requiring such traits are highly paid. Better balance in the output of different work stations may be achieved by increasing output at bottleneck operations.

The worker gains from motion study in that he is usually given an opportunity to increase his earnings. Motion-study economies may be reflected in increased profits to management or stockholders, lower prices to consumers, or higher wages to workers. Just how the economies are distributed depends upon the supply of goods in the market, the competitive position of the company in the industry, the strength of labor organizations, the alertness of labor leadership, and other factors. The long-run effect is also different from the short-run effect. Taylor, Gilbreth, Gantt, and other pioneers in management agreed that, to secure the co-operation of workers in making the economies, a part of the savings had to be passed on to them as higher wages.

The Gilbreths found that motion studies increased the interest of the worker in his job and made him more alert and more efficient.[9]

[9] Frank B. Gilbreth and Lillian M. Gilbreth, "The Effect of Motion Study upon the Worker," *Annals of the American Academy of Political and Social Science*, Vol. LXV (1916), pp. 272–76.

During the period when motion studies are being made, the effect is educative in the highest degree. The worker learns to think of all activity in terms of motions and elements of motions. When he is later assigned to a new job, he learns the work faster and with comparatively little coaching.

As for monotony, the Gilbreths said that a feeling of monotony results from a lack of interest in the job rather than from repetitive motions. Interest is created by motion study. Worker attitude is improved by the elimination of useless and ineffective motions. The worker has a feeling of satisfaction and accomplishment that results from doing the work in the most efficient manner. The change is usually reflected in more suggestions from workers for job improvement, increased enrollment in training courses, a more alert staff of junior executives, and an increased interest in the study of management.

The worker also gains from the elimination of such motions as walking back and forth, stooping, twisting the body, and lifting heavy materials. These motions are the most wasteful and also the most tiring. The elimination of such motions not only increases output but also reduces fatigue.

Objections to Motion Study. From the point of view of the worker, the most serious objection to motion study is that it prescribes a fixed set of motions and tends to destroy initiative and creativeness. This criticism is also made of laborsaving machinery that reduces the degree of skill required of the worker. Modern industry does require less initiative and creativeness than the old handicraft system, but this disadvantage must be offset against its greater productivity. Moreover, the worker, if left to his own devices, will fall into a fixed pattern of motions. Motion study is only an attempt to see that he adopts efficient instead of inefficient and ineffective motions.

The fact that motion study is to the advantage of the worker does not necessarily mean that he will like it. He may not view motion study or any other management device in the same way that the creators of the system look upon it. Even though management is convinced that the results of motion studies are sound, logical, and efficient, the worker may feel that a fixed set of motions is an annoyance and a restraint upon his freedom of movement.[10] To overcome such an objection, it is important that the right approach be made at the time the study is made and subsequently when workers are trained to use the new method.

[10] See F. J. Roethlisberger, *Management and Morale* (Cambridge, Mass.: Harvard University Press, 1941), p. 38.

Some persons contend that the methods of motion study are unsound because differences between workers are disregarded. They point out that workers differ from each other in their vision, manual dexterity, versatility, accident proneness, mental attitude, health, strength, and ingenuity. They differ also in natural capacities, training, and education. Psychological and manual dexterity tests show wide differences in people. To require all workers in a group to use the same set of motions may create nervous tensions and disorders similar to those caused by requiring a left-handed child to write with his right hand.[11] This may be a valid criticism in some cases; but it clearly would not apply to most phases of motion study, such as the elimination of stooping, bending, lifting, and other tiring motions.

Another phase of the motion-study technique to which objection is sometimes made is the combination of the motions made by two or more workers to form a single set of motions. If one worker has found a short cut at one phase of the operation and another worker at another phase, the motion-study man will combine the two short cuts to get a more efficient method than either worker had before. Psychologists point out that the new series of motions may be impossible to attain, and that the rate at which one muscular pattern functions in one person is not necessarily an indication of its possible speed in another. It is also pointed out that the rate of output is not always a safe basis for judging the effect upon fatigue, since the nervous system may be seriously affected by a rigidly enforced pattern of motions. The increase in production that follows the making of motion studies may be the result in part of the introduction of an incentive method of wage payment and other changes which usually accompany the study.

Because a synthesized and fixed set of motions may cause nervous strain and disorders, it has been suggested that the following principles be observed in the making of motion studies:

1. Motion studies should be undertaken in an effort to lessen fatigue rather than to increase production.
2. The first objective of a desirable set of motions is rhythm rather than speed. Motions should be those which are easiest for the worker.
3. Motion studies should suggest lines of improvement rather than attempt to standardize motions for all workers.

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[11] For criticisms of motion study, see E. Farmer, *Time and Motion Study,* Report No. 14 (London: Industrial Research Board, 1923), reprinted in Moore and Hartman, *op. cit.,* pp. 285–90; F. K. Berrien, *Practical Psychology* (New York: Macmillan Co., 1945), pp. 228–30; Herbert Moore, *Psychology for Business and Industry* (New York: McGraw-Hill Book Co., 1939), pp. 184–85, 190–91; Joseph Tiffin, *Industrial Psychology* (New York: Prentice-Hall, Inc., 1942), p. 17.

It is not to be assumed that these criticisms invalidate the results of motion study. There is too much evidence of the economies and savings which such studies have made possible. Such criticisms indicate only that care is required in making the studies, selecting the workers for their jobs, training them, and following up to assure that the motions are practical, feasible, and economical in their results.

QUESTIONS

1. Explain how the standards established by motion and time studies may be used for the following purposes:
   a) Determining the pay of the worker.
   b) Determining estimated costs of the product.
   c) Rating the performance of workers.
   d) Judging the efficiency of foremen.
   e) Scheduling work and planning completion dates for the product.
   f) Planning or revising plant layout.
2. Can motion studies be made without time studies? Can time studies be made without motion studies? Explain.
3. "A reduction in the time required for a task ultimately results in a saving of brick and mortar." Explain the meaning of this statement.
4. What is the attitude of workers toward delays in production? Do they welcome interruptions because they make the job last, or do they prefer that the job proceed in an orderly and efficient manner?
5. Where should the motion-study man begin in his attempt to improve the motions performed by the worker?
6. List the therbligs performed in each of the following simple operations. Indicate therbligs for both hands.
   a) Man shaving. He uses brush, shaving cream, and safety razor.
   b) Man starting from home to the office in wintertime. Indicate therbligs from putting on rubbers and overcoat to closing front door.
   c) Stenographer preparing to take dictation in a notebook.
7. What would you expect the attitude of the bricklayer to be toward the improvements made by Gilbreth? Could the worker expect to benefit by the improvement? How?
8. Can the easiest way to perform a task be determined by listing and studying the therbligs, or is observation with a stop watch necessary?
9. Contrast the short-run and the long-run effects of motion economies. With which is the worker most concerned?
10. As a result of economies effected in studying a job, a worker can produce a greater number of units of a product in a given time with less effort. Is he entitled to an increase in pay? Why?
11. Can several workers be taught to use a fixed set of motions regardless of individual differences?
12. When motion studies are made, what other changes are usually introduced?

13. Why is it difficult to determine the precise effect of motion study upon worker production, worker attitude, and fatigue?
14. Suggest efficient methods of performing the following tasks:
    a) Loading bricks in a truck and unloading in the yard at the destination.
    b) Moving bricks to the wall for laying them in the construction of a multistory building.
    c) Replacing light bulbs in high ceiling lights.

CASES

38. METHOD OF COLLECTING TRASH ON THE STREET

The manager of trash collection of a municipality has been investigating the following methods of collecting trash from the street:

1. Sweepers using wide brooms would collect the trash in small piles, with two or three piles in each city block. Trucks would follow sweepers, and workmen would scoop up the trash and throw it into the truck.

2. Each truck would be accompanied by three workmen. Two workmen would walk at a brisk pace along the street and push wide brooms in front of them. Each workman would walk ten steps and then manipulate the broom to make a small pile of trash. The other man would perform the same operation for the next ten steps while the first man would carry his broom across the space swept by the other. The truck would follow a short distance behind the men at a slow speed. A third man would stand on the running board of the truck with a wide but lightweight scoop; and he would pick up the trash at each pile and throw it over his shoulder into the truck. Since the piles would always be the same distance apart, he would be able to develop a rhythmic motion. Workers would alternate positions to reduce fatigue.

3. Workmen would push hand trucks along the street. Each workman would have a broom and a shovel which he would use to sweep trash and throw it into the truck. Hand trucks would be emptied into trash cans on the sidewalk. Trash cans would be emptied into a truck once a week.

4. A truck equipped with a vacuum device would be used to pick up trash by suction. The only labor would be that of the truck driver.

Questions:

1. How can the manager determine which is the best method?
2. Under what circumstances might each method be preferable?
3. What information not given in the case might be required for a decision?

39. METHOD OF COLLECTING LOOSE CORK

A manufacturer receives large shipments of cork for use in manufacturing linoleum, insulating materials, and related products. Cork is shipped in crates, which frequently are broken in transit. Loose pieces of cork have usually been collected by three workers. When cork is received in bulk, it is packed in bags for storing. In bagging the cork, one worker picks up an empty bag from the floor, opens it, and hands one side of the open bag to another worker. A third worker scoops up the cork with a large fork and drops it into the bag.

An improved method has been suggested by the motion-study man. He devised a hand truck on four wheels which can be pushed by one worker. The truck is equipped with an upright standard, to which is fastened a metal hoop. The burlap bag is looped around the hoop and fastened securely in position. One worker can push the truck along and pick up any loose pieces of cork without the assistance of anyone else.

The motion-study engineer figures that the cost of picking up one bag of cork by the present method is as follows: The cost of the bag is 45 cents, and each bag can be used three times before it is discarded. The cost of string and wire is 0.02 cent. The labor cost per bag is 45 cents. Tests of the proposed method indicate that the labor cost will be reduced by 40 per cent. Materials cost will be unchanged. The cost of the equipment for the new method will be $250. The management estimates that 7,000 bags of cork are handled annually.

Required:

1. Prepare a report showing the savings for the first year. The entire cost of the equipment will be considered an expense for the first year.
2. Indicate the savings for the second year.
3. How many months will be required for the company to recover the cost of making the change?

40. METHOD OF INSERTING PAPER IN TYPEWRITER

A typist is required to type a report in three copies. The following methods of inserting paper and carbons in the typewriter have been suggested:

1. Assemble on the desk three sheets of paper with two sheets of carbon between the sheets of paper. Make the edges of the sheets even by upending them on the desk. Insert in typewriter.

2. Use a method similar to the first method except that a small thin piece of paper is folded and placed over the edge of the sheets before insertion in the typewriter. This paper will prevent tearing of the edges of paper and carbons while the paper is being turned into position. The roller is turned far enough to permit the removal of the protective sheet of paper, and the roller is then turned back to return the paper to the proper position for typing.

3. First assemble three sheets of paper, and insert them in the typewriter. Turn the roller just far enough to engage the sheets and hold them in position. Then insert two sheets of carbon between the sheets of paper, and turn the roller to place the paper in position for typing. The edges of the carbons will extend beyond the edges of the paper.

Required:

1. Try the three methods to determine which is easiest. Time yourself for five minutes by each method to determine how many insertions you can make.
2. Prepare a motion chart of the left and right hands by the most effective method. Use the form shown on page 300.

CHAPTER XIX

TIME-STUDY TECHNIQUES AND PROCEDURES

TIME study, or the observation of the time taken to perform a task, is one of the most controversial techniques of management. To many persons, time study is the most important feature of the Taylor system; and Taylor himself regarded it as fundamental to scientific management. His incentive system of wage payment required that a standard time be fixed by time studies; and time studies, in turn, required production planning, standardization of materials and equipment, and other management techniques.

Organized labor opposed time study from the beginning. Congress passed a law in 1913 prohibiting the use of the stop watch in government arsenals, and this clause has been inserted in all appropriation acts since that time. The advocates of time study admit that, although time study is widely used throughout industry, its acceptance has been "grudging and tenuous" and has been "accompanied by much hostility."[1]

Beginning of Time Study. Although Taylor created the time-study technique, he was not the first to use the stop watch in timing jobs in manufacturing operations. M. Perronet, a Frenchman, in 1760 listed the operations necessary to make pins and timed the job for the purpose of ascertaining the detailed cost.[2] However, the studies seem to have been over-all studies and not studies of the elements or therbligs. The technique was not further developed, and Perronet's experiment seems to have been an isolated incident. Charles Babbage made similar studies

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[1] Ralph Presgrave, *The Dynamics of Time Study* (2d ed.; New York: McGraw-Hill Book Co., 1945), p. 1.

[2] V. S. Karabasz, "The Analytical Study of Production Jobs," *Annals of the American Academy of Political and Social Science*, Vol. CXIX (1925), pp. 80–84.

in England in 1830.[3] There is no other evidence of the use of the stop watch by anyone else for studying jobs until 1881, when Taylor used it at the Midvale Steel Company. The first book on the subject appeared in 1920 and was a reprint of a series of articles.[4]

Taylor got the idea of time study from a teacher of mathematics at Phillips Exeter Academy while he was a student. The teacher had established an average time for the solution of each problem. From this experience, Taylor thought it feasible to establish an average time or standard time for doing any task.

Uses of Time Study. Time studies may be used to set up a standard, regardless of how the worker is paid. Taylor's idea as to such a standard is expressed in the following statement: "The average individual accomplishes the most when he either gives himself, or someone else assigns him, a definite task, namely, a given amount of work which he must do within a given time; and the more elementary the mind and character of the individual the more necessary does it become that each task shall extend over a short period only."[5]

Time study is often thought of as a phase in the fixing of piece rates or the establishing of some other basis of incentive wages. Although this is one use of time-study data, it is not a part of the work of the time-study man. Money values introduce an entirely new problem with which time study in itself is not concerned. The standard money rate for a job depends upon such additional factors as bargaining with the union, the supply of labor, wage levels in the community, and the skill required of the worker who performs the task.[6]

The standards set by time study are used for many purposes in addition to providing data for setting wage rates. In controlling production and planning for the flow of work, the planning department uses the standards to estimate the time that will be required for work at each workplace. Work for each machine can be scheduled, and completion dates for various production orders can be estimated. Deliveries of finished goods to customers can be planned with the assurance that the schedules can be met.

Time standards supply information on machine capacity for purposes of machine replacement. As explained in Chapter X, the computation

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[3] Robert Lee Morrow, *Time Study and Motion Economy* (New York: Ronald Press Co., 1946), p. 73.

[4] Dwight V. Merrick, *Time Studies as a Basis for Rate Setting* (New York: Engineering Magazine Co., 1920).

[5] F. W. Taylor, *Shop Management* (New York: Harper & Bros., 1903), p. 69.

[6] See Presgrave, *op. cit.*, pp. 63–64.

of costs per unit of product by the use of the old machine in comparison with the estimated unit costs with the new machine is based upon data of the number of units that can be produced within a certain time. Production standards are useful in planning plant layout because one objective in layout is a proper balance between workplaces. Balance means that machines and workplaces produce approximately the same number of units per hour or per week. When converted into monetary costs, production standards are useful in making bids on sales contracts.

Other uses of production standards relate to the control of operations within a department. The efficiency of a worker is judged by his ability to meet the standard, and foremen are sometimes judged by the percentage of workers in a department who meet or fail to meet the standards. If workers are paid by the hour, the standard would indicate what the labor cost of the product would be if all workers produced the standard number of units per hour. If costs exceed this amount, management knows that the standards are not being met.

Production standards assist management in eliminating the differences between the requirements of various tasks. The standards should be set in such manner that a worker at one task can render a satisfactory performance as easily as any other worker at any other task. No work should be unusually easy or unusually difficult in comparison with other work.

The department that is responsible for the setting of standards by time study may also be responsible for related activities requiring the use of standards. In one company, for example, the standards department makes motion and time studies, revises the standards when necessary because of changes in methods of work, makes studies of new jobs and work done on new equipment, prepares the payroll, makes cost investigations for purposes of preparing bids on contracts, and prepares cost estimates for the use of management in establishing sales prices on new products.[7]

Relation of Motion Study to Time Study. Taylor never made time studies without first making improvements in the layout of the workplace, prescribing the machine tools, and making other such changes as were required.[8] Frank and Lillian Gilbreth, who perfected the techniques of motion study, believed that time studies were useless and misleading unless they were preceded by a thorough study of both

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[7] National Industrial Conference Board, *Wage Incentive Methods,* Studies in Personnel Policy, No. 68 (New York, 1945), p. 33.

[8] Taylor, "The Present State of the Art of Industrial Management," *Transactions of American Society of Industrial Engineers,* Vol. XXXIV (1912), pp. 1199–1200.

the conditions of work and the motion elements. Their method was to study and improve not only the workplace, equipment, working conditions, and arrangement of materials but also the motions made by the worker.[9] If the worker is to be guaranteed against a reduction in the standard time or in the piece rate, such studies are necessary. Otherwise, the worker may himself improve the motions and increase output to such an extent that the standard would be useless. Because motion study and methods improvement precede the taking of time studies, it is most important that the time-study man be skilled in manufacturing methods, machine tools, materials, and conditions of work as well as time-study techniques.

Time study may be made without motion study when an entire plant is changed to standards set by time study. This might occur when a force is changed from daywork to piecework or other incentive methods of wage payment, or from standards set by foremen or by past performance to studied standards. Time studies might also be made for an entire plant when a new factory is constructed. In any of these cases the number of studies to be made immediately would preclude complete motion studies for every job. Such study of the job as might be made would be less thorough and less elaborate than is implied by a motion study.

Time studies are sometimes made without motion studies when continuous changes in layout, equipment, product, or materials alter the requirements of a job. If a part of a department is already working under standards set by time study, the methods department is under pressure to complete studies of new jobs as rapidly as possible. Since the motion-study man cannot keep pace with the time-study man, and since some jobs do not justify the cost of a complete motion study, standards may be set in such jobs without motion study.

Time-study men realize the hazard of setting standards without motion studies, but they contend that the errors actually are negligible. The reasons are that abbreviated motion studies are made by time-study men; that operators follow fairly well-defined patterns of motions, even though no motion studies have been made; and that workers know that a loose standard will eventually be changed, regardless of earnings or subsequent performance.[10]

Because of the cost, time-study standards may not be set for all jobs in a department. In most productive departments the maximum of

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[9] Frank B. and Lillian M. Gilbreth, "Time Study and Motion Study," paper read before New York Section of Taylor Society, December 15, 1920.

[10] Presgrave, *op. cit.*, pp. 133, 140–43.

jobs which justify such standards is estimated to be 95 per cent.[11] Standards are sometimes set, with or without motion or time study, for a wide variety of tasks, such as emptying wastebaskets, trucking supplies from storage, cleaning and replacing cuspidors, cleaning the corners in the stair wells, and replenishing supplies in the washroom.[12]

Beginning the Time Study. If no time studies have been previously made, the first step is the selection of a department and a job for beginning the studies. Much depends upon the choice of the job for the first study, since the time-study man is sometimes regarded with suspicion by the workers. This suspicion may be shared by the foreman who is close to his men and is under pressure to get the work out. He may regard the entrance of the time-study man as an intrusion and a reflection upon his ability to manage his own department. The situation is one which calls for tact, sympathy, and understanding on the part of the time-study man.

Some of the considerations in selecting the job or the department for making motion studies were considered in the preceding chapter. These are the number of persons on the job, their rate of pay, the possibility of changes during the next year, and the relation to other jobs in the production line. Another factor is the type of workers and their attitude toward the studies. If the foreman has a close personal relationship to his men, and if he is convinced of the value and the desirability of the studies, the department might be a good place to begin. Another factor is the rapidity with which jobs can be studied. To convince workers and management of the economy and fairness of the studies, it may be desirable to begin to show results as soon as possible.

Another factor in the choice of a department to begin the studies is the possibility of raising the output and increasing the wages of workers. The results of the first studies are certain to be subjected to the greatest scrutiny by all concerned. The possibilities of savings to the company are also a factor. The time study must be justified in dollars and cents and not merely by percentage increases in output per worker per hour. Although sensational or stunt performances should be avoided, the first job to be studied should be one that can be improved through motion study; and the worker should benefit by an increase in pay

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[11] Phil Carroll, Jr., *Timestudy for Cost Control* (2d ed.; New York; McGraw-Hill Book Co., 1943), p. 10.

[12] R. W. Gibbs, "Wage Incentives Encourage Better Housekeeping," *Factory Management and Maintenance,* Vol. CIII, No. 12 (1945), pp. 136–40.

The person chosen for the study may be the best worker or an average worker on the job. The type of worker observed is supposed to make no difference in the standard which is finally set because allowance is made for the skill of the worker. Gilbreth never made a time study of any but the very best workers. In fact, his studies were based upon a synthesis of the motions of the best workers. He said that judgment supplants measurements when a mediocre worker is used and that no allowances can be made for inefficiency.[13] The willingness of the worker to co-operate is also important because no allowance can be made for indifference or false motions intentionally made. The achieving of worker co-operation requires tact, sincerity, and fairness on the part of the time-study man as well as the co-operation of supervisors. The understanding of union officials is also helpful.

In practice, time studies are usually made of the average worker instead of the very best. The justification for this procedure is that workers do not understand the method of making allowance for skill, and they are likely to think that the standard is to be set so high that it will be impossible for them to make it.[14] The study is usually made of a worker who is on the job, regardless of his skill. To ask an especially trained person to do the work while a study is being made would appear to the worker to be very unfair. As Carroll says, the practice of timing only the highly skilled sets up a mental hazard against the final standards, which should be avoided.[15] It is generally agreed, however, that time studies should not be made of a worker who is new on the job, a nervous worker, or a worker who is working with especially valuable material which he might spoil through poor workmanship caused by nervous strain or excitement.

The selection of the worker depends in part upon the workers themselves. When the studies are begun, a volunteer for the first study may be asked for. Each worker may hesitate for fear of losing the respect and the good will of his associates, and the personal friendship and influence of the foreman becomes important. If the standard is judged to be fair, and if the worker who is transferred to an incentive wage based upon the time study is able to increase his earnings, the others are more likely to be willing to have studies made. In no case should an attempt be made to take studies without the knowledge and co-operation of the worker.

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[13] Frank B. and Lillian M. Gilbreth, *op. cit.*

[14] Ralph M. Barnes, *Motion and Time Study* (New York: Wiley & Sons, Inc., 1937), p. 191.

[15] *Carroll, op. cit.*, p. 64. See also Presgrave, *op. cit.*, pp. 51–92.

FILE NO. 111-395

WM NO. 265-AH-44-A

OPERATION NO. 30

TIME STUDY RECORD

DIVISION

1

DESCRIPTION OF ELEMENTS (INCLUDING NAME AND NUMBER OF TOOLS, FIXTURES AND GAGES)	SPD.	FD.	LEN.	CUT	TIME IN DECIMAL MINUTES AND RATINGS 1	2	3	4	5	6	7	8	9	10	AVER. TIME	RTNG. FCTR.	ALLOW. AT 100%
1. Pick up piece from bench					.06	.06	.05	.05	.04	.07	.05	.06	.04	.05	.05	100	.05
2. Break edges on ends, round one (1) corner to 1/8" radius	#80 stone wheel				.60	.58	.62	.60	.59	.60	.60	.64	.60	.61	.60	100	.60
3. Break edges on sides	#80 stone Wheel				.32	.40	.32	.35	.38	.34	.40	.36	.37	.37	.36	90	.32
4. Burr edges on sides and ends	#80	Rag	Wheel		.25	.24	.27	.24	.30	.31	.28	.27	.32	.30	.28	90	.25
5. Set aside					.03	.03	.02	.02	.02	.01	.02	.03	.02	.02	.02	100	.02
															SUB-TOTAL		1.24

DEPARTMENT: 111	SPEEDS, FEEDS, CUTS, TOOLS, FIXTURES, GAGES, MACHINE AND METHOD APPROVED BY:	GEN. FOREMAN	FOREMAN	SET-UP MAN: Rooney	QUAL. CONTRL.	NET TIME PER 1 PCS. 1.24
WORK STATION	STARTING TIME: 1:40	STOPPING TIME: 1:56	ELAPSED TIME	PCS. COMPLETED: 1	MACHS. PER OPER.	18 % ALLOWANCE .22
DATE: 8-15-47	EMPLOYEES' NAME: Gloeckner	CLOCK NO.	CLASS	JOB EXPERIENCE	NO. OF HELPERS	TOTAL STD. TIME/ 1 pc. 1.46
STUDY BY: E. Fowler	MATERIAL: SAE X 1020 CRS	TYPE AND GRADE	DIMENSIONS: 7/16 x 1" x 1-7/16"	WEIGHT	SOURCE	SET-UP TIME/ 14.00
APPROVED BY: E. Hall	MACHINE, MAKE AND TYPE: Polish Jack			MACHINE NO.	SIZE	SECTION: 111 FILE No.: 395 SHEET No.: 1 of 1
OPER. SPEC. NO.	OPERATION NAME: Burr ends and sides and radius				LOT SIZE: 240	OPERATION NUMBER: 30
PART SPEC. NO: 10.00 1.00 E	PART NAME: Block				ORDER NO.: 42607	PART NUMBER: 265-AH-44-A

FIG. 39. Observation Sheet for Time Study

advantage of holding the watch in the hand is that the board may be put in the pocket or laid down, while the watch is protected in the hand. Some time-study men use two or more stop watches, which are fastened to the board. It is usually considered best to keep the equipment as simple as possible to lessen the suspicion and the mystery which are likely to surround the studies. In any case the nature

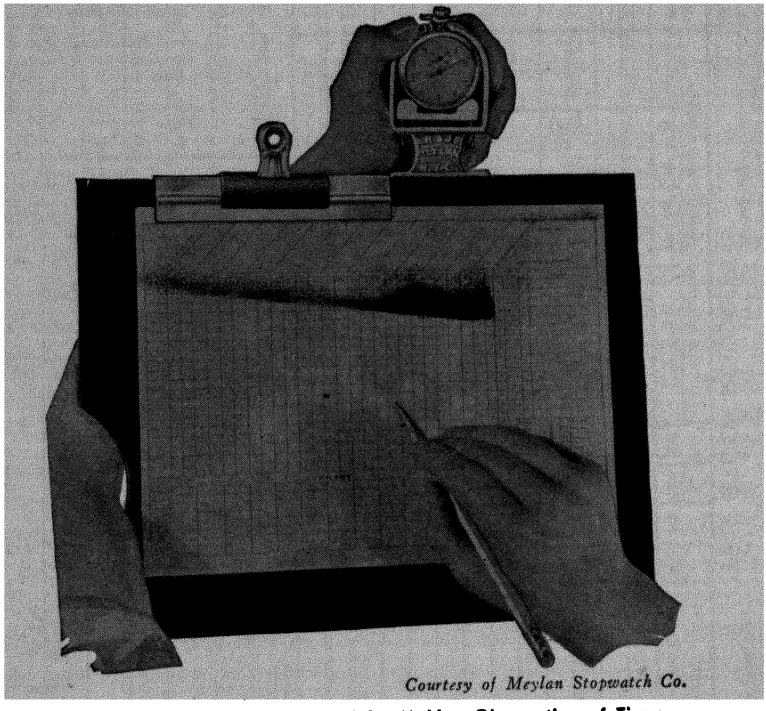

FIG. 40. Board Used for Making Observation of Times

of the equipment is secondary, for the important feature is the accuracy of the observations made. A board used to make observations is illustrated in Figure 40.

Recording the Element Times. In making the observations, the time-study man usually stands to the side of the worker because all suggestion of secrecy or underhandedness is thereby removed.[17] For similar reasons a position in front of the worker may be preferred to a position behind him. If the worker stands at the job, the observer should also stand. Throughout the study an effort should be made to remove the "social distance" which is likely to exist between worker and observer.

[17] Morrow, *op. cit.*, p. 98.

The observations are made of the time required for each element and not of the over-all time for a task. This is one of the phases of time study on which all time-study men are agreed.[18] To make a study, it is necessary to divide the task into its elements in a manner which was described in the preceding chapter. The smallest length of an element that can be successfully observed is usually considered to be 1/10 of a minute. If element times are very short, the errors of the observer in reading the watch and making the recordings are likely to be greater than the variations in the time required by the worker.

The observations may be made by the "snapback method." The snapback method means that the hand of the stop watch is returned to zero at the end of each element. When the worker completes an element, the observer reads the watch, presses the stem to return the hand to zero, starts the watch for timing the next element, and records the time for the element completed. The observation sheet shown in Figure 39 was prepared on the basis of timing by the snapback method. Some time-study men regard this method as highly unsatisfactory because of the possibility of error in making the readings and recording the times while also manipulating the watch. The Gilbreths rejected the entire procedure because of the probability of error. They contended that the errors of the observer in reading the watch might easily equal the elapsed time for the performance of the element under observation. Moreover, they contended that the errors could not be corrected by averaging the results of several studies because this procedure might have the effect of cumulating the error.

The advantage of the snapback method is that the observer can use his recordings as a guide as he continues with the timings. For example, if one reading of an element is much longer or much shorter than the other readings, the observer can see this at once. He can then investigate the cause, which might be an error on his part, stalling on the part of the worker, a sudden burst of speed, a failure of the worker to conform to a lax standard which he had set for himself, or any one of several other causes. Any isolated instances of improved methods of work should be studied to determine whether they can be duplicated and made habitual. Unless the observer knows the situation as he proceeds, he is said to be "flying blind."[19]

Another method frequently used is the "continuous-run method." When this method is used, the stop watch is permitted to run con-

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[18] Smyth and Murphy, *op. cit.*, p. 112.

[19] Presgrave, *op. cit.*, p. 42.

tinuously; and the observer records the reading of the watch at the end of each element. When one cycle of operations is completed, the watch is allowed to continue to run as the worker proceeds with the next cycle. This process is kept up until an entire series of observations has been made. The elapsed time for each motion element is computed by subtracting the reading of the watch at the end of an element from the reading at the beginning.

The advantage of the continuous-run method of timing is that the observer is required to account for all time, including delays and interruptions. He is also relieved of the necessity for starting and stopping the watch at any time during the observation. This method is the one most commonly used.[20]

If the element times are of short duration, a motion picture of the operation with an electric timing device in the picture will reduce or eliminate the possibility of error in making the studies. The clock should indicate time to a fraction of a second, and the motion-picture camera should be stepped up to take more frames per second. The picture is run on the screen after the observations have been completed. The projector can be stopped at any point, and the timing can be accurately observed. If any element time appears to be too long, the picture can be rerun; and the cause of the delay can be determined. Pictures of the worker performing the task are useful in training employees and in considering any subsequent complaint from workers about difficulties in meeting the standard as set for the task. The use of motion pictures for motion and time studies was first perfected by the Gilbreths. The method is now rather widely used. It is frequently referred to as "micromotion study."

In accumulative timing, two watches are used. The two watches are mounted on a board in such a manner that, by pressing a lever, the observer can stop one and start the other. He may then read the watch while the hands are stopped, and the reading may therefore be more accurate. Subtractions are unnecessary. The principal objection to this method is the complexity of the equipment, which tends to alienate the worker.

In the cycle method a record is made of the total time of the motion cycle, except for one element. The cycle method is suitable only for very short cycles of very few elements. To illustrate the method, assume four elements which are designated as W, X, Y, and Z. On the first observation, W might be omitted, on the next X, on the third Y,

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[20] Smyth and Murphy, *op. cit.*

and on the fourth Z. The time for each element would be figured in the following manner:

$$
\begin{array}{rrrrl}
 & X + & Y + & Z = 0.22 & \\
W & + & Y + & Z = 0.24 & \\
W + & X & + & Z = 0.20 & \\
W + & X + & Y & = 0.18 & \\
\hline
3W + & 3X + & 3Y + & 3Z = 0.84 & \\
W + & X + & Y + & Z = 0.28 & \\
 & X + & Y + & Z = 0.22 & \text{(first observation)} \\
W & & & = 0.06 &
\end{array}
$$

In the same manner the values of the other elements are computed: Z is 0.04, Y is 0.08, and Z is 0.10.

The cycle method was devised by Taylor,[21] but it has very limited application in practice. It requires too many observations to determine the time of one element. If several computations of the value of each element are made, a relatively large number of observations would be necessary.

Number of Observations. The number of observations to be made of a task depends upon such factors as the length of the cycle and the time required to make the observations, the number of elements in the cycle, the skill of the worker, the consistency or variations in the observations made, the number of people employed at the job, the study made of the workplace and the motions prior to the timing, and the use to be made of the standard time. If the motions of the worker and the time required at the task are partially controlled by machine time or an assembly line, the observations may be fewer in number.

Although consistency in results may be an indication that the worker is skilled and that the results are reliable, this is not necessarily the case. Presgrave warns that unusually high consistency is open to the suspicion that the worker has deliberately timed each element by counting to himself, observing a wrist watch, or pacing himself against a revolving part or a recurrent noise.[22] While the observer strives for the co-operation of the worker, he cannot always be sure that he has attained it.

If the observer makes an excessive number of observations, he is wasting his own time at unnecessary work; this is the thing he is seeking to avoid in the worker. Time-study work should be as efficiently conducted as the time-study man expects the other departments to be. If the observer makes an insufficient number of observations, his stand-

[21] Taylor, *Shop Management*, p. 173.
[22] Presgrave, *op. cit.*, p. 182.

ards may be too tight or too loose because they are based on inadequate samples. As a general rule, it is better to take too many observations than too few. Two short studies taken at different times are considered better than one long study.

QUESTIONS

1. Can a person who performs an ordinary task for himself improve his performance by checking his progress by the clock? Is clock watching by employees objectionable?
2. Can time study be used to fix the money rates for a task, or is its use limited to the determination of a standard time?
3. Why should the job be improved before a time study is made?
4. Is it feasible to set time-study standards for all jobs in a department? Why?
5. Can a telephone company establish time-study standards for such jobs as installing a new telephone, installing an extension telephone, and making miscellaneous repairs to equipment? Why are such standards especially desirable?
6. In a plant in which no time-study standards have been used, what principles should be observed in selecting a department and a job for study?
7. Why may a foreman prefer not to have time studies made in his department? How may his co-operation be secured?
8. Why should a worker object to having an especially skilled worker perform the task while a time study is being made? How can the objections be overcome?
9. A worker who does not understand the purpose of time studies fears that the studies may be used to cut piece rates and to reduce the number of workers on the job. When the time-study man starts to make a study of his job, he becomes nervous and is unable to co-operate. Consequently, no satisfactory study has been made. What should be done to establish a standard for his job?
10. Compare the snapback method with the continuous-run method of making time studies with respect to the following:
    a) Accuracy of the recordings.
    b) Ease of detecting significant varitions in the recordings as the studies are being made.
    c) Assurance that the total elapsed time has been included in the timing of the various elements.

CASE

41. TRAINING IN TIME-STUDY METHODS

At the Union Saw Company, standards are set for most jobs by means of time studies. When the time study was first used for setting standards, it was found that neither foremen nor shop stewards understood the method. In response to a complaint from a worker that he could not meet the standard, the

foreman would usually answer: "That is not my worry — you will have to see the time-study man." The shop steward was inclined to agree with the worker that the standard was too tight. The time-study man believed that the co-operation of the foreman and the understanding of the steward were necessary to the success of the program.

To correct the situation, the standards department obtained the approval of the plant superintendent and the vice-president in charge of manufacturing to give a course in time study for foremen and shop stewards. The two groups were included in the same course in order that they might hear the same explanations. In the shop, they were more likely to agree if each knew that the other had been through the same course. The instruction was given after hours at overtime pay.

Upon completion of the course, foremen were asked to check each study made and to initial as satisfactory the standard set. Approval of the standard meant that the foreman could no longer shift responsibility. If a shop steward could explain the standard to the worker, the explanation was more likely to be accepted.

Questions:

1. How is the program designed to reduce complaints about standards?
2. Who should give the course in time study for shop stewards?

CHAPTER XX

SETTING THE STANDARD TIME

THE standard time as determined by time study depends upon the skill of the worker who was observed. He might have been average, above average, or highly skilled. The procedure also varies with the objective, which might be a standard time for the entire operation or a standard time for each motion element. If a standard is to be set for the entire task, the procedure would be as follows:

1. Discard the observation times for each element which were exceptional because the times were unusually short or unusually long.
2. Take an average of the observation times for each element.
3. Add the element times to determine the total time that would be taken by the worker who was observed, provided he could work continuously without interruption.
4. Increase the time to determine the time that would be required by an average worker who is working at an average rate of speed.
5. Make allowance for various delays, such as personal needs, fatigue, and interruptions for various causes.

Each of these steps requires further explanation.

Exceptional Observations. Abnormally long or abnormally short times might be caused by errors of the observer in reading the watch or in ending a motion element at a precise point. Very long times might also be caused by awkward movements, intentional slowing down, interruptions and distractions, defective materials, necessary adjustment of the machine, and numerous other factors. Abnormally short times might be due to a sudden burst of speed on the part of the worker or by an unusually favorable work cycle. Workers often unconsciously speed up because they see a break in a run of work or possibly because they wish to make up for poor performance at an earlier stage.

If a worker takes material from a bin, his performance will vary slightly as he works from one end of the pile to another. Some of the therbligs may be abnormally short because of the ease of finding, selecting, and grasping materials that do not rest against other parts; but these therbligs may not be discarded. The observer decides which are so long or so short as to be unrepresentative.

Computing the Time for an Element. The time for an element may be computed by the use of the median, the arithmetic average, or the mode. The median is determined by ranging the recordings from shortest to longest and selecting the middle one. The arithmetic average is computed by adding all the recordings and dividing by the number of observations made. The mode is the figure which occurs most frequently. If the mode is used, the abnormally long and short recordings need not be discarded, since they will have no effect upon the final result. Exceptional observations will usually not affect the average if the median is used, since a very long or a very short recording merely counts as one observation more or one observation less than the middle figure.

The choice of the average depends in part upon the results of the observations and the pattern of the recordings. Suppose, for example, that the time-study man has made twenty-five observations and the times for the first motion element are as shown below:

0.08	11111	11111	11
0.09	11111	1111	
0.10	1111		

The motion element was performed in 0.08 of a minute 12 times; in 0.09, 9 times; and in 0.10, 4 times. The mode is 0.08, which seems to be a typical performance. The arithmetic average is 0.0868, but the average is clearly inaccurate beyond the second decimal place because the smallest time recorded by the watch was 0.01 of a minute. The median is 0.09.

The second element might assume a pattern like that shown below. The average is 0.12, regardless of whether the mode, the arithmetic average, or the median is used. A symmetrical distribution of this kind is not the usual result.

0.10	11		
0.11	11111		
0.12	11111	11111	11
0.13	11111		
0.14	11		

A more common distribution is shown in the third illustration below. The reason for this type of distribution is that the variations in time are due principally to mistakes, fumbles, and interruptions which serve to lengthen the time required, while the worker and the observer continually strive for perfection.

0.15	111	
0.16	11111	11111
0.17	11111	
0.18	111	
0.19	11	
0.20		
0.21	1	
0.22	1	

In this illustration the mode is 0.16, and the median the same. The arithmetic average is 0.17, if all of the timings are included. The median or the mode is probably the best average, unless the long performances were caused by poor materials or some other factor beyond the control of the worker. If the cause cannot be corrected, the arithmetic average should be used; or perhaps more observations should be made.

When an element time has been computed for each motion element, the times for the various elements are totaled to determine the total average time. However, this is not to be confused with the standard time for the task, which is yet to be determined.

Adjustment for Skill and Effort. The time required by a skilled worker at a fast pace should be increased to bring the time within the possibilities of accomplishment by the average worker working at an average speed. The determining of this adjustment in the time is probably the most difficult phase of the entire procedure of motion and time study because it depends largely upon the judgment of the time-study man. Some authorities state that it is the only adjustment that remains to be put on a scientific basis.[1]

The fact that people differ in their capacities may be observed in almost any type of activity, such as running, walking, jumping, lifting, or boxing. In a factory job the poorest have been eliminated by selective methods of employment and placement, discharges or transfers for incompetency, and resignations due to discouragement. Many of the workers whose performance was formerly below average have increased their skill through training. Nevertheless, a considerable

[1] Robert Lee Morrow, *Time Study and Motion Economy* (New York: Ronald Press Co., 1946), p. 141.

difference will be found in the capacities of different workers on the job. A survey of available data from various industries indicates that the ratio of the poorest worker to the best ranges from 1 to 1.4 at one end of the scale to 1 to 5.1 at the other.[2]. Experiments show that, on a given job, production may range from 79 per cent of the average to 135 per cent.[3] On simple jobs, such differences may be reduced by training, since good workers do not improve as much as poor workers. On complicated work requiring judgment and skill, training may not greatly affect the spread.

A common method of rating workers is a point system based upon an output of one hour. The amount of work that an average worker, thoroughly familiar with his job, could do is referred to as 60 points. A worker who could do 10 per cent more than the average would be assigned 66 points. If the worker who was observed and timed was rated 70, he is 10/60 better than the average. The total time, therefore would be increased by 10/60 to determine a fair time for the average worker.

Many other rating systems are in use. One well-known system rates workers as superskilled, excellent, good, average, fair, and poor, with percentages of production assigned to each grade.[4]. How accurate such rating systems are in practice has not been determined.

The time required for a task is affected not only by the worker's skill, but also by the effort he puts forth to perform the task. A skilled worker may move slowly, either by nature or by intent. The effort of the worker when he first begins the task and before he has completed his warming-up period or when he is tired is not the same as at other times. Two persons who walk down the street, run, or deal a deck of cards do not necessarily exert the same effort. Although Gilbreth believed that no corrections could be made for mediocre effort, which he called "soldiering," such corrections are often made. The justification is that this procedure enables the time-study man to make his studies at any time, regardless of the worker on the job. Readings are converted to normal by means of a percentage adjustment.

One method of rating is to grade the effort of the worker as excessive, excellent, good, average, fair, and poor. Another method classifies effort as killing, excellent, good, average, fair, and poor.

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[2] Morris S. Viteles, *Industrial Psychology* (New York: W. W. Norton & Co., 1932), p. 64.

[3] Joseph Tiffin, *Industrial Pychology* (New York: Prentice-Hall, Inc., 1942), p. 17.

[4] S. M. Lowry, H. B. Maynard, and G. J. Stegemerten, *Time and Motion Study* (New York: McGraw-Hill Book Co., 1940), p. 207.

The effort rating, sometimes referred to as the "correction factor," is usually combined with the rating for skill. A worker of average skill working with average effort is expected to produce 60 points of work in an hour. If the worker who is timed is rated 80, he is 20 points above the average. The time which an 80-point worker requires is increased by 20/60 to determine the time of the average worker.

The leveling and correction factors are here assumed to be applied to each task. However, they may be applied to each element in the task. This might be desirable in case the worker is more highly skilled on some parts of the task than others. The rating factor might also be applied to each element in case elements of different workers are combined to determine a rate on a new task without time study. A third variation is to select a specific timing for each element which represents the rating of the worker. For example, if his skill and effort are to be rated 10 per cent above average, a timing of each element is selected as the typical performance of the worker at that level. This selection is made when the observations are recorded on the time-study sheet.

The problem in rating is to maintain consistency from day to day and from one task to another. Errors in rating will result in gross inequities in the time assigned for different tasks. Because of its importance the rating is sometimes made by three persons — namely, the time-study man, the foreman, and an engineer.[5]. It is found that the ratings are usually in agreement if the effort is about 100 per cent of average. If the performance of a worker is much different from that figure, the ratings vary widely.

Allowances. The worker cannot be expected to continue at the task, day after day, at the speed which he maintained while the observations were being made. Numerous factors in the work situation will prevent such a continuous rate of production. The factors naturally vary from one job to another, and they are so numerous that separate allowances cannot be made for each one. Some factors for which allowance is frequently made are as follows:

1. Personal needs of the worker.
2. Adjusting the machine or changing tools.
3. Time to set up or adjust the machine for new work. The worker is sometimes paid for setup time as if it were a separate task; but if setup time is short, the time is included in the standard for the job.
4. Miscellaneous interruptions, such as accidents and conferences

[5] W. B. Wisecarver, "Setting Worker Normals for Time Study Purposes," *Factory Management and Maintenance*, Vol. CIV, No. 10 (1946), pp. 122–26.

with the supervisor. A worker's production is affected by accidents at nearby workplaces as well as those in which he himself is involved. The allowance should include time out for the treatment of minor cuts and scratches, even though the worker in question has never had an accident. Time required for oiling the machine and for keeping records is also included under this classification.

5. Multiple machine interference. If a worker supervises the operation of two or more machines, he may not be able to keep their operations completely synchronized. Both machines may be stopped at the same time, and one must remain unattended until the worker starts the other. A standard which assumed that only one machine would require attention at a time would sometimes be unfair.

6. Faulty materials or tools. Motion study and time study assume that materials, tools, and equipment are standard; but at times variations may be expected. This is especially true in periods of material shortages.

7. Fatigue. Fatigue varies with the length of the workday, the type of work, heating and other conditions of work, rest periods, and numerous other factors. The allowance is necessary, but the proper amount is uncertain. Time required for the worker to develop rhythm or to get into the swing of the task is included in the fatigue allowance.

8. Defective work. If the worker is required to rework defective products or is allowed no credit for the spoiled product, an allowance may be necessary for this factor in order that his production for the day may be satisfactory.

9. Delay. Delay may be caused by machine breakdown, lack of materials, interference with production at a preceding operation, lack of power, or failure of the foreman to assign the worker a job. These causes are usually the fault of management. Such an allowance results in the inclusion of the cost of delay in direct labor cost, and for that reason an allowance is objectionable. Another method is to list delay separately and to record the cost as indirect labor. The amount of delay should be known for purposes of management policy and for use in making the budget, determining standard costs, and making cost estimates. However, a time-study allowance is frequently made for unavoidable delays.

The allowance may be stated as a percentage or as an amount of time, such as 0.05 of a minute. It usually is a percentage of the average time taken. The amount of the allowance may vary from 10 per cent on office work to 35 per cent on some types of hot and dirty jobs. The percentage should be determined on the basis of observations and

studies of conditions in various types of work. For an illustration of the method of computing the total time, see the observation sheet for time study in Figure 39 (page 317).

Use of Standard Element Times. After many time studies have been made, standard times may be established for elements which are common to many tasks. When new work is to be run, the standard time is set by assembling the necessary elements and their standard times. For example, in operations performed on a lathe, standard element times may be established for such element times as the following: select rough casting, pick up casting, insert in chuck (holding device), tighten chuck, bring tool to position, and various other necessary elements. On a new job, standard data may be available for all of the element times; or a study may be necessary for some one element, such as the cutting time of the machine. Standard element times are used whenever they are available in order to maintain uniformity with other jobs as well as to save the cost of making a complete study. However, the time-study man must be sure that the standard elements are the same as those of the new job.

By the use of standard element times, the cost of a new product may be estimated prior to production. The product engineer would first design the parts which are necessary to the finished product. He would then list the operations necessary to make each part, such as cut a piece of the necessary length, drill holes, ream (enlarge or shape the holes by turning), finish or mill the edges, press, crimp, and solder. Standard element times are arranged for assembly as well as for fabrication. In this manner the standard labor cost is estimated. Overhead cost is estimated on the basis of the standard time, together with data for manufacturing expenses. Material cost is estimated from market prices or bids from vendors.

Using standard element data to build up the cost of operations, parts, subassemblies, assemblies, and the completed product has been compared with using the letters of the alphabet to build up words, sentences, paragraphs, and the complete essay or book. Once the elements are known, a new product may be completed by a rearrangement of the elements.[6] The method of standard element times originated with Frederick W. Taylor, and it is now in quite general use.[7]

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[6] H. K. Hathaway, "On the Technique of Manufacturing," *Annals of the American Academy of Political and Social Science,* Vol. LXXXV (1919), pp. 231, 246.

[7] Frank B. Copley, *Frederick W. Taylor* (New York: Harper & Bros., 1923), Vol. I, p. 227; J. E. Black, "We Set 76% of Our Rates from Master Studies," *Factory Management and Maintenance,* Vol. XCIV, No. 5 (1936), pp. 177–78. See also Phil Carroll, Jr., *Timestudy for Cost Control* (2d ed.; New York: McGraw-Hill Book Co., 1943).

Another use of standard element data is the determination of piece rates in advance of production. When the design of the product is changed each season, and when the seasons are relatively short, the fixing of piece rates before the work is put into production is especially desirable. For example, a manufacturer of knit goods, such as mittens, scarves, and stockings, had 250 designs of colored embroidery work, which were changed each year. To permit the piece rates to be used as soon as production was started, the time-study man conducted a series of experiments on various designs and types of work. He found that the basic motions used to make the various designs were the same and that the length of the stitch made no difference. The time required to make a design varied with the number of stitches, the placement or positioning of the stitches, differences in the weight of the fabric, and the simplicity or complexity of the design. Standard times and piece rates were set by multiplying the number of stitches in a design by the standard element times and adding or subtracting a percentage to allow for variations in fabrics and in complexity of design. Time for threading needles was computed by the use of other standard element times. This procedure not only resulted in advance determination of piece rates but also in a reduction in the number of complaints of unfairness in the rates.[8]

Standard element times have other advantages. They result in fairer standards for different tasks. The standards are set more quickly. Time-study men can use their time to better advantage by making careful studies of elements that are common to many kinds of work. After the basic studies have been completed, only occasional studies need be made of new motion elements in other types of work.

Methods-Time Measurement. An adaptation or extension of the use of standard element times is a technique which is called methods-time measurement. Using this technique, the time-study man analyzes each manual operation or task into the basic motions required to do the work and assigns to each motion a predetermined time standard. The time standards vary with the nature of the motion and the conditions under which it is made. Once the standard has been determined, it can be used in any industry or company, provided that the basic motion and the conditions of work are the same as those under which the standard was fixed.[9]

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[8] Ralph P. Kreuter, "Standard Times for Handicraft Jobs," *Factory Management and Maintenance,* Vol. CIX, No. 11 (1951), pp. 94–97.

[9] H. B. Maynard, G. J. Stegemerten, and J. L. Schwab, *Methods-Time Measurement* (New York: McGraw-Hill Book Co., 1948), p. 12.

Methods-time measurement is distinguished by the extreme care of the methods engineer in analyzing motions and standard times. For each motion element, a different standard is set for each of the varying conditions under which the motion is made; and in using the standards, the engineer studies each job to determine the proper time. For example, the conditions under which a worker might reach for an object are as follows:

Reach to object in fixed location.
Reach to single object in location that may vary slightly from cycle to cycle.
Reach to object in a group.
Reach to very small object or where accurate grasp is required.
Reach to indefinite location to get hand in position for body balance, or next motion, or to get it out of the way.

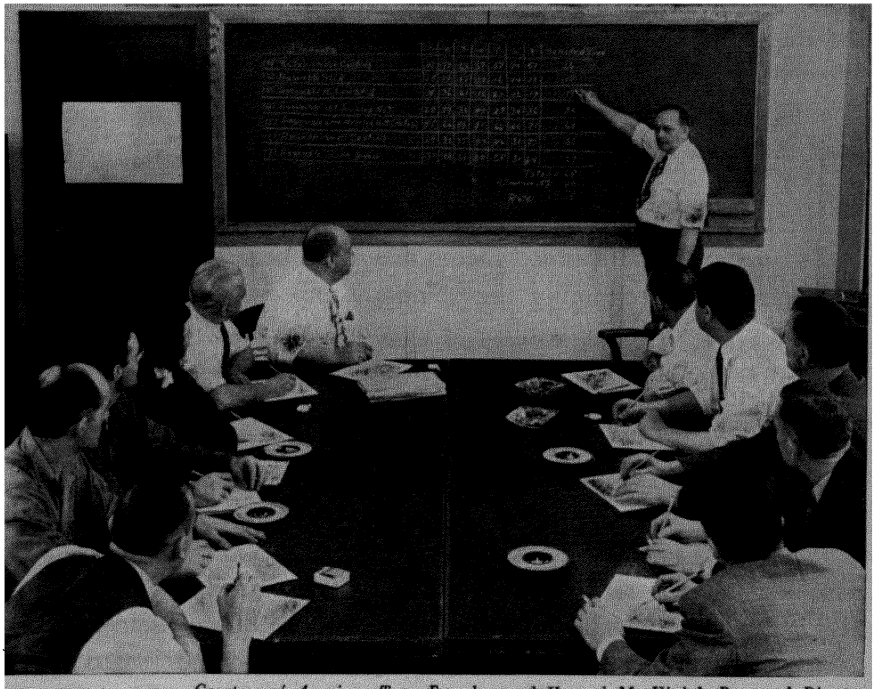
Similar tables of data for basic motions performed under varying conditions have been compiled for move, turn (including turning motions requiring the application of pressure), grasp, position, disengage, and release. The tables are believed to cover all motions made in any situation in any company.

Setting standards by methods-time measurement requires a thorough understanding of the procedure and of the motions performed by the worker. Successful application of the standards to new jobs requires a close study of the motions and the conditions under which a job is done. When the procedure is properly applied, the standards for various jobs are fair and equitable in relation to each other.

Inaccurate Standards. If the worker is unable to make the standard, a study should be made of the task over a period of a day or more. Inability to meet the standard might be due to such causes as slow setup of the machine, too much time taken for personal needs, delay in receiving materials, or materials lacking in uniformity. In some cases the worker might not have been properly trained; or for other reasons, he might not be following the best methods. The machine might be out of adjustment, or the worker may be stopping the machine too frequently to make adjustments. The standard might be too tight because the leveling and correction factors were too low, or allowances may be too small. Appropriate steps should be taken by the standards department to correct any difficulty, regardless of whether the trouble can be traced to the time-study man, the worker, or some member of a line or staff department.

Gantt pointed out that management could not afford to investigate every failure, if any small mistake would cause the worker to use more time than the standard allowed. Hence, he said, the standard time

should be liberal enough to enable a good workman to exceed it by a fair margin.[10] This does not mean a loose standard, for Gantt would make the task severe enough to require continuous and undivided attention.



Courtesy of American Type Founders and Howard M. Hinkel, Personnel Director

FIG. 41. Class of Shop Stewards Discussing Time Study

The complaint of the worker who believes a standard to be unfair is frequently made through the office of the union steward. If neither the worker nor the steward are familiar with the methods of time study, they may be unable to understand the basis for a standard which is fair and reasonable. A solution which some companies have found successful is to give a short course for shop stewards. Such a course is designed to impart an understanding of the method rather than to develop trained time-study men. Stewards who have completed a short course of this kind may arrive at an intelligent decision on the merits of a rate which has been challenged. Many labor unions also provide courses of training in time study for their shop stewards and other union representatives. A class of shop stewards for the discussion of the technique of time study is shown in Figure 41.

[10] Henry L. Gantt, *Industrial Leadership* (New Haven: Yale University Press, 1916), p. 80.

The Loose Standard. In order to obtain the co-operation of the worker, the management should agree not to reduce the standard time if experience on the job shows that the task can be done in a shorter time. Without such a guarantee, the worker will refuse to put forth his best effort and will be sure that he does not do the task in less than the standard time. This attitude would defeat the purposes of management, which is interested in having the work done in the minimum time in order to conserve the time of the machine and to save the overhead costs connected with the maintenance of the workplace. Management also wants all standards to be fair.

There are many reasons why the worker may do the work in much less than the standard time. Errors may have been made by the time-study man in determining the standard time. The worker may be following a pace which will result in cumulative and injurious fatigue. He may have improved the job by using better tools or more effective methods than were used when the studies were made. He may use faster motions than the average, just as one runner or swimmer may move faster than another. He may be able to resist fatigue, with the result that he is not required to rest or slow down at certain intervals.

If a worker is able to make high earnings on a job, it should not be assumed that the rate is too high. He may possess superior skill. If this is the case, the standard and the production rate may both be correct. The fact may be learned by inquiring into the record of the worker on other jobs or by transferring him to another job where the standard is known to be average or tight.

Management should not reduce the rate as long as the work remains unchanged. It should not create a pretext for changing the rate by making a minor change. This practice would destroy all confidence in the time-study program and would end all co-operation from the worker. The only solution to this problem is to keep mistakes in the setting of standards at a minimum.[11]

Criticisms of Time Study. Objections to time study relate to the method of fixing the standard time. Some of the severest criticisms have come from psychologists. The objections made to time study are not to be regarded as invalidating the technique, for time study has unquestionably proved its value to management.

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[11] For discussion of the difficulties of correcting a loose standard, see William F. Whyte, "Economic Incentives and Human Relations," *Harvard Business Review,* Vol. XXX (March, 1952), pp. 73–80.

One objection is that allowance is not easily made for differences in day-to-day production. Such differences are due to sleep or lack of sleep, exercise, fatigue, digestion, and possibly a "psychological periodicity." Production also varies according to the hour of the day. Furthermore, allowance is not easily made for differences in the capacities of workers. Many variables are not measured but estimated — for example, the degree of effort, degree of skill, working conditions, and fatigue. The number of observations to be made is left to the judgment of the time-study man. Another uncertainty is that the line between a normal time value and an abnormal time value is indefinite.

The criticisms of time study may be summed up in the statement that the time-study man must rely upon his judgment rather than scientific measurement in the fixing of the final time. However, this criticism can be made of many other management methods. Judgment is required in valuing inventories, determining depreciation allowances, interviewing and rating applicants for employment, and evaluating jobs. The criticisms of time study indicate only that much skill, training, and experience are required of the man who makes the studies.

QUESTIONS

1. What might cause some element times to be unusually long? What might cause some to be unusually short? What might cause a wide distribution of the element times? Justify the practice of disregarding very long or very short element times.
2. What conditions influence the amount of allowance which must be made for the skill of the worker? Why does it vary with the worker and the job?
3. The amount of work which the average worker can do in an hour is considered to be 60, and this figure is used as a base. Determine the allowance for the leveling factor in the following cases:

Worker No.	Time Required as Determined by Observations	Skill Rating
1	20 minutes	65
2	12 minutes	75
3	18 minutes	55
4	24 minutes	50

4. Does the time of day or day of the week affect the time required to perform a task? When would the worker be expected to do his best? When would his performance be likely to be poor?
5. Under what conditions would the leveling and the correction factors be applied to each element rather than to the total time for the task?

6. For what types of interruptions may allowances be made? Should separate allowances be made for each cause of interruption?
7. Under what conditions would an allowance be made for setting up the work, and when might setup time constitute a separate task?
8. Explain and illustrate multiple machine interference.
9. How do specifications, tolerances, and the closeness of inspection affect the time allowance?
10. Explain the relation of the following persons to the establishment and maintenance of time-study standards:
    a) Foreman.
    b) Equipment engineer.
    c) Tool supervisor.
    d) Quality control man.
    e) Production planning and scheduling man.
11. What are the reasons a standard may be "loose" or "fat"?
12. Why should the union steward be trained in time-study methods? Should the training be given by the company or the union?
13. Is it a fair criticism of time study to say that some time-study men are unable to perform a task within the time set by them as standard?
14. What parts of the time-study procedure depend upon the opinion of the time-study man?
15. Should labor unions oppose the setting of standards by time study, or would they gain more by co-operating in its use and in demanding that the benefits be passed on to workers as higher wages?

CASES

42. USE OF STANDARD DATA FOR PRODUCTION STANDARDS

The Reem Corporation developed a set of standard element times which enabled the standards department to set a production standard and a piece rate for new work by combining element times as established on other work. As a result of the use of this technique, the company was eventually able to set standards without the necessity for any studies on the production floor. When a rate for a new operation was set in this way for work to be done by Thomas McFadden, he suspected that the standard was too tight. He protested to the foreman, alleging that the standards department must be guessing at the proper rate. When the foreman relayed the complaint to the standards department, a time-study man was sent to make a time study of the work. The results of his studies agreed closely with the standard time as established by the use of standard element times. McFadden registered no further complaint.

Question:

Was the company right in making a stop-watch observation to confirm the standard, or should the foreman have explained to the worker the method employed in setting standards?

43. CORRECTION OF LOOSE PRODUCTION STANDARD

In the plant of the Sleepwell Mattress Company, the bottleneck operation was the job of sewing reinforcement bindings in the mattress. In the making of a mattress the cotton batting and the wire coil unit were inserted in one end of a mattress cover, and the open end of the cover was then closed by a sewing operation. To hold the entire unit in position, reinforcement bindings were sewed at various places in the mattress. The machine at which this work was done was manually operated. The worker placed the mattress on a metal platform which constituted a part of the machine. When the mattress was in proper position, the worker moved a lever; and the machine ran a strong cord through the mattress from top to bottom, pulled it tightly to hold the parts firmly, and tied and cut the cord. To prevent the cord from cutting the mattress cover, the machine placed a leather tufting under the string on each side of the mattress. This operation was repeated for as many reinforcements as were required.

The piece rate at the reinforcement machine had been set after a study of the task had been made by the time-study man, who had observed a skilled worker making average effort to do the work. The rate was fixed at an amount that would enable a skilled worker to earn $8.00 per day at the job. The first man who was placed at the job was unable to keep up with the flow of work from preceding operations, although his piece-rate earnings averaged about $7.50 per day. He was transferred, and William Compton was given the reinforcement job. Compton proved to be very fast at the work, and within a short time the work was moving so that mattresses no longer piled up at the workplace. Compton's earnings averaged about $14.00 per day. The time-study man, who regularly inspected the earnings of workers on jobs for which he had set standards, re-timed the job and found that the adjustment for skill and effort had been too large. He therefore recommended that the piece rate be reduced in order that Compton should earn no more than $8.00 per day. When Compton complained, the foreman showed him the following statement in the company manual:

"No rate setter is perfect. The mistakes which he makes are made on the up side as well as the down side. No employee thinks it is wrong to adjust a rate upward when a mistake on the down side has been made. There should be just as fair recognition of the necessity and the right to make a downward adjustment in the rate as an upward adjustment."

Questions:

1. Should the rate be adjusted? Give reasons for your answer.
2. Would the worker readily accept the explanations given in the manual. Why?
3. May rates be adjusted downward as readily as they may be adjusted upward? Why?

PART VI

Wages and Incentives

CHAPTER XXI

THE PROBLEM OF WAGES

WAGE determination is one of the vital problems of management. It is of great significance to the workers and their families because their standard of living and their social status depend upon the wages paid. The status of the worker within the factory and the standing of his family in the community depend in part upon his wages in relation to the earnings of others. Both the amount of earnings and the method of payment are important. Social significance is attached to such distinctions as being paid by the month and being on the office payroll.

To the employer the problem of wages is important not only because wages are a part of the cost of the product but also because an equitable and satisfactory settlement of the wage question is a factor in the establishment of proper industrial relations. Controversies over wages are not the sole cause of industrial strife, although they are a frequent cause. Industrial strife is costly to the employer and should be prevented, if possible.

Some of the questions relating to wages are as follows:

1. What determines the general level of wages? Are wages fixed by economic law?
2. How does the employer determine the amount of wages?
3. What can workers and management do to increase the amount of wages paid?
4. What are the relative merits of payment on an hourly basis, by piece rates, or by some type of bonus system?
5. How are the wages in various jobs or trades determined?
6. What factors influence the amount paid to one worker in comparison with another?

These and other questions of similar nature will be considered in this chapter and the following chapters.

The Economics of Wages. The question "what determines the level of wages" has long been discussed by economists, and several theories have been advanced. The best-known wage theories are the marginal productivity theory, the commodity theory, the functional theory, and the theory of relative bargaining strength.

The Marginal Productivity Theory. The marginal productivity theory of wages is usually explained by reference to agriculture. If a farmer with a given amount of farm equipment and livestock has been producing a stated amount of grain or other crops, he may more than double the output of the land by employing an additional worker. As he employs additional workers to cultivate the same land, the product per worker will ultimately begin to decline. The farmer may profitably employ additional workers as long as the wages paid are less than the proceeds derived from the sale of the increased product. Ultimately, the increase in the product resulting from the employment of an additional worker will just suffice to pay the wages of the worker. The last worker employed is the marginal worker. The amount of increased production attributed to him is the marginal productivity of labor. His wages tend to equal the value of the product attributed to him. His wages would also determine the wages of all other workers because all persons on the farm are doing similar work.

The marginal idea is sometimes applied to the workers themselves. The marginal laborer may be thought of as the least efficient or least effective worker in the group. The employer pays the least efficient no more than he is worth — that is, no more than the value of his services as a contribution to the product. If all the workers in a group receive the same wage, their wages would be limited by the earnings of the least efficient worker, who is also the marginal worker.[1]

The marginal productivity theory is a good explanation of wages in an agricultural economy. In industry the application might imply that a manufacturer could add one or more additional workers and that he would continue to expand his plant, if wages were so low as to afford a probability of profit from an increase in output. The manufacturer might also use more workers by operating his plant for more hours of the day. His difficulty would arise in the marketing of the additional output or perhaps in the purchasing of raw materials. However, if manufacturers and farmers generally were able to employ more workers, the product could be sold to other workers, who would have increased purchasing power and would in turn produce more

[1] Lionel D. Edie, *Economics: Principles and Problems* (2d ed.; New York: Thomas Y. Crowell Co., 1932), p. 258.

materials and goods for sale to others. Thus, demand and supply would tend to be equalized.

The marginal productivity theory assumes competition between workers for jobs and between employers for workers. It assumes that, because of this competition, the worker will be paid all he is worth to the employer. A perfect operation of the theory would also require some practical method of measuring the contribution of the marginal worker. This theory has had wide acceptance among economists.

The Commodity Theory. The commodity theory of wages regards labor as an article whose price is fixed in the market in the same way that the price of any article of merchandise is fixed. When the supply of labor is increased in relation to demand, wages decline. When the supply is decreased in relation to demand, wages increase. A change in demand, in comparison with the supply of labor, will affect wages in a similar manner.

Many employers accept the commodity theory, and they contend that any attempted control of wages by either unions or government is an interference with economic laws. The employer might be expected to pay as low wages as possible, just as he attempts to buy materials at low prices. Labor unions reject the theory, and they succeeded in having a clause inserted in the Clayton Act of 1914 which declared that labor is not a commodity.

Labor differs in many respects from such a commodity as coal or lumber. Labor cannot be separated from the personality of the worker. The employer cannot purchase the skill and brawn of the worker without taking into his plant a human being with all of his emotions, prejuduces, antagonisms, and other attributes. Furthermore, the value of the services of an individual depends in part upon what is paid in wages, for it has been demonstrated many times that an increase in wages may result in better service and lower unit costs. Labor is immobile in that the worker has his personal and family ties to a community. He does not readily move from one job or one factory to another merely because of the lure of slightly higher wages. On the other hand, he may change jobs on provocations which appear to the employer to be unjustifiable. Labor is perishable, and services not sold each day are forever lost. Labor also differs from a commodity in that it constitutes both supply and demand. An employed worker sells his services; and he must have food, clothing, and shelter in order that he may live. The wages paid him are spent for the products of other workers in other industries. The commodity theory is therefore not an adequate explanation of the factors which determine wages.

The Functional Theory. The word "function" as used in the name of this theory means a magnitude or trait that is closely related to another magnitude and that varies with it. The functional theory holds that wages depend upon the pecuniary, industrial, and economic factors of the industry.[2] The amount paid workers in an industry depends upon two factors: (1) the efficiency of the industry and its methods of production, and (2) the ability of wage earners to discover and to appropriate income in competition with other groups. In other words, the amount which an employer can afford to pay depends upon the state of the industrial arts and the general level of industrial efficiency; but the workers may not receive their share unless they know how much the employer can afford to pay and unless they make their demands for their share.

The efficiency of industry is affected by the development of the technique and the science of management, the extent to which machinery and laborsaving devices have been perfected and utilized, and the manner in which the plant is organized. The amount of wages which the industry can pay is also affected by the costs of raw materials, the salaries paid to managers, and the prices for which the products of the industry can be sold.

The functional theory of wages is very realistic. Instead of the hopeless outlook for raising wages which is presented by the other wage theories, the functional theory makes possible a constructive program. To raise wages, labor unions should do two things: First, they should co-operate with management in increasing production, eliminating waste, and introducing the most economical methods. Second, they should demand their share of the product by pressing for higher wages. This program would result in the increase in the wages of all workers rather than in increased wages for one group at the expense of another.

The Theory of Relative Bargaining Strength. According to some economists, the level of wages in a trade, an area of the country, or an industry depends in part upon the extent to which employers are organized and by express or tacit agreement refrain from bidding competitively for labor, or the extent to which they actively compete for the services of labor. Labor itself may or may not be effectively organized to press its demands for higher wages.

If one large employer dominates the labor market in a town or industrial area, the level of wages established by him may by tacit or

[2] This theory was first advanced by Walton H. Hamilton and Stacy May, *The Control of Wages* (New York: George H. Doran Co., 1923).

expressed agreement be observed by other employers in the area. Other employers may pay somewhat higher or lower wages as the occasion seems to them to require, just as one company may decide to sell its product for a little more or a little less than the prices of its largest competitor. In that case the large employer occupies a position comparable to that of a monopolist. He fixes the price and lets the supply of labor be what it will. If more labor is required, he can draw more workers into the labor market by increasing wages. This policy would cause more persons to move into the area. It would prevent young persons from leaving; and it would cause wives, daughters, and others who previously were unemployed to seek employment. The employer pays what is necessary to obtain the help he needs.

If labor is well organized and the employers are not organized, the situation is reversed. The union may demand a high wage and thus fix the price of labor. The employer is then required to adjust his business to the wage level. If he is unable or unwilling to employ all potential workers at the wage established by the union, some workers remain idle for the time being. The union will seek to control the situation by various restrictions upon admission to the trade and upon union membership and by stretching out the work to make more jobs. Thus the union fixes the price of labor and possibly the amount of work done in a day, and it permits the volume of employment to find its own level.

If both employers and workers are well organized and each achieves a monopolistic position, the situation resolves itself into a contest of strength between the two forces. In such a contest, there is an upper limit beyond which the wage level cannot go without threatening workers with the loss of their jobs. Within certain limits the level of wages is fixed by bargaining.

Wage Criteria for the Individual Employer. The individual employer does not gain much assistance from the economic theories of wages. His difficulty arises from the fact that he cannot measure the contribution to the product which is made by any one employee. For example, if fifty-five separate operations are required in the manufacture of a pair of trousers, the garment is not complete without all operations. The sales price of the finished product must be divided among a great many persons, including, in addition to the fifty-five workers in the trousers factory, the sales manager and his assistants; the employees in the accounting office; the maintenance men; the employees in the power plant; the stockholders; the creditors; and many others, such as workers in textile mills, on the farm, on railroads, and in

other places. The employer lacks a definite economic rule to guide him in the allocation of the proceeds of the sale, and he must use some practical criteria which approximate fairness and justice. Possible criteria are as follows:

What is necessary to get workers.
The cost of living.
The ability of the employer to pay.
Working conditions in the plant.
Nature of the job.
Skill and personal qualities of the worker.

What Is Necessary to Get Workers. Each employer may have established his wage rates by bargaining with workers individually or collectively over a period of several months or years. In that case, he pays what he is compelled or induced to pay. Such rates have no relation to the contribution of the worker to the manufacture of the product and no relation to sales prices. If the employer finds that he is unable to retain workers after they have been employed, he might attempt to correct the situation by wage increases.

When the employer pays what he considers necessary to recruit and maintain his work force, he usually measures his wage rates against the wages paid by other firms employing workers of similar capacities in jobs which are comparable in their mental and physical requirements and in their agreeable and disagreeable factors. He might attempt to pay a little more than a neighboring employer if jobs in his plant are more disagreeable or more tiring.

Wages are known to vary somewhat between plants within an area and between plants in different sections of the country. Variations in wage rates between plants within an area are certain to cause dissatisfaction, unless the differentials are offset by regularity of employment or some other factor. Variations between wage rates in different sections of the country are generally interpreted by labor leaders as proof that wages in one area are too low. However, the difference might be offset by other advantages to workers in the low-wage area, such as paid vacations, retirement allowances, sick benefits, and stabilized employment. If the total compensation of workers actually differs, several explanations are possible. The training and efficiency of workers may not be comparable, the employers may be too inefficient to pay high wages, or the supply of workers may be excessive as compared with the opportunities for employment. An excessive supply of workers would ultimately be corrected by a movement of industry into the area to take advantage of the low wage rates or by a migration of workers

out of the area. It might be unwise to attempt to remove such geographical wage differentials by legislation because they serve a desirable economic purpose.

Cost of Living. If wages are based upon the cost of living, a minimum standard is assumed for food, clothing, shelter, medical care and other items. Some minimum budgets estimate the living costs on the basis of facilities which a public welfare agency might consider necessary to the maintenance of comfort and decency. In the preparation of a minimum budget, it is usually assumed that the wage earner must support a family of four. According to the census data, however, the number of employed persons is greater than the number of families in the United States. In many families, two or more persons are gainfully employed; and in other families, no one is gainfully employed. Many wage earners are not members of families because they are servants or because they reside in hotels, boarding houses, or institutions.

Other assumptions in estimating the wage rate necessary for a minimum budget relate to the regularity of employment, the amount of overtime work, the type of living quarters, the ages of the children, the nature of the transportation facilities, and other such considerations. Such budgets can be used only as general criteria. They do not apply to individual situations.

If the employer is engaged in interstate commerce, he is required to pay the minimum wage prescribed by the federal Fair Labor Standards Act, except that apprentices and learners are subject to special requirements. The minimum wage is presumably based upon a minimum budget. In the hiring of workers, the employer must decide whether the applicant is worth the minimum wage. This provision may result in the exclusion of some persons from the ranks of the employable.

Wage differentials between city and country and between various sections of the country are usually justified by differences in the cost of living. The practice of increasing the salary of an employee when he marries or when a child is born into the family rests largely upon the justification that the cost of living has increased, although a raise may be justified on the ground that persons with dependents are more likely to be stable and reliable and less likely to be floaters. The cost of living is also recognized in wage policies in the practice of giving preference to persons with dependents in layoffs, rehiring, and perhaps promotions.

Labor leaders have usually opposed the basing of wages solely upon the cost of living.[3] The objective of labor is to gain for workers a larger percentage of the output of industry.[4] Its leaders argue that, as industrial production increases, the real (not money) wages of workers should be increased to enable the larger volume of goods to find a market. The objective is a constantly rising standard of living for labor. William Green has said that the goal of the American Federation of Labor has consistently been higher wages which should not be tied to either prices or living costs.[5]

In recent years, money wages in many industries have been adjusted to changes in the cost of living. During periods of rising prices, unions support their wage demands by data on increases in living costs. They point out that rising prices reduce real wages unless money wages are increased accordingly. A formula for wage increases in proportion to increases in the cost of living was adopted by the National War Labor Board during World War II and by other government agencies since that time. A provision of this kind was included in the contract between General Motors Corporation and the United Automobile Workers, C.I.O., in 1948.[6] Similar provisions have been included in contracts between unions and managements in the railway transportation and other industries.

The proposal to allow increases in wages in proportion to changes in the cost of living raises a number of general problems for industry as a whole. An increase in wages which is made to compensate for rising prices would probably have the effect of further increasing the demand and causing further increases in prices. The effect upon prices would not be proportionate to the increase in wages because some workers and some other consumers would not share in the increase. However, the increase may become general as competition for workers by various employers forces each company to meet the level of wages paid by others. If all incomes of all groups of persons in the country are raised to compensate for changes in the cost of living, and if the output of goods is not increased accordingly, the only effect would

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[3] For discussion of the use of cost-of-living data in wage negotiations, see Sumner H. Slichter, *Basic Criteria Used in Wage Negotiations* (Chicago: Chicago Association of Commerce and Industry, 1947), pp. 10–18.

[4] Clinton S. Golden and Harold J. Ruttenberg, *The Dynamics of Industrial Democracy* (New York: Harper & Bros., 1942), p. 153.

[5] William Green, "The American Federation of Labor's Wage Policy," *Annals of the American Academy of Political and Social Science,* Vol. CCXLVIII (1946), p. 3.

[6] For discussion of the plan and opinions of labor leaders and executives, see "GM.'s Pay Plan," *Factory Management and Maintenance,* Vol. CVI, No. 7 (1948), pp. 108–12.

be the distribution of the same supply of goods to the same persons in the same proportions. In practice, some persons will not receive cost-of-living increases. Such persons include many salaried workers, annuitants, pensioners, and persons whose income is subject to price control, such as landlords. The usual effect is therefore a gain for some groups at the expense of others. The problem becomes most acute during periods of monetary inflation when rapid advances occur in the sales prices of the products of the company, the cost of living, and all other items included in the price level. During such periods, wage increases are necessary and desirable, even though the incomes of some groups lag behind the general increase. Individual employers can only minimize the effects of inflation when the difficulty is due to causes in the national and international fields. The remedies can be provided only by the government through a control of banking policies, credit, borrowing, and spending.

Closely related to the question of the cost of living is the demand of unions that "take-home pay" of workers be maintained after overtime work has been eliminated. The demand for an increase in hourly wages to compensate for the loss of overtime pay is supported by the argument that such an increase is necessary to prevent a decrease in living standards. This argument overlooks the fact that workers expect an increase in pay when hours of work are increased. In considering a demand for maintaining take-home pay, the employer must consider the rates of wages paid by competitors, the effect of the elimination of overtime work upon productivity, and the existing level of wages.

Ability of the Employer to Pay. One of the arguments made by labor unions for wage increases during periods of prosperity is that wages should be increased because employers can afford to pay more. The increase in wages, it is contended, can be paid from profits without the necessity for price increases. According to this argument, which requires "a look at the books," those employers who are making sufficient profits should increase wages. If an employer is not making profits, he will be relieved of the demand for a wage increase and will be permitted to pay lower wages than other employers.

The argument that wages should vary with profits can hardly be sustained. An employer whose business is well managed cannot be expected to pay higher wages than his competitors. If he did so, he would have no incentive for introducing laborsaving methods because the gain would accrue to labor. Moreover, every employer would have a different scale of wages for the same job. All workers would seek employment where wages were highest, and they would refuse to work

where the wages were low. Neither the union nor the individual workers would approve a low wage scale for an inefficient employer.

In an economic system based upon the profit motive, the profits of efficient employers can be expected to exceed the profits of the less efficient. Profits provide the incentive for good management. They are the compensation for producing goods at a cost below the prices that consumers are willing to pay. If workers are to receive as wages all or a part of the profits in excess of a stated percentage, some standard of a fair rate of profit must first be agreed upon. This procedure would place all industries in a category similar to that of a public utility. The method is subject to both theoretical objections and practical difficulties.

Profits are the most fluctuating factor in the national income. They increase sharply during periods of prosperity, and they decline during periods of depression. Wage rates normally fluctuate over a much narrower range. Workers cannot expect their wages to increase during periods of prosperity by a percentage that is comparable to the increase in profits because wages do not decrease by comparable percentages during periods of depression.

Over a period of years the ability of industry generally to pay higher wages is increased by technological changes and better management methods. The benefits of the greater productivity and decreased costs may be shared by the management, the stockholders or owners, and the workers. Consumers of the product may ultimately enjoy a part of the benefits through lower prices. A large part of the higher standards of living of workers from year to year is explained by the greater productivity. A definite provision for annual increases in wages was included in the contract between General Motors Corporation and the United Automobile Workers in 1950. The promise of an annual increase of 3 cents per hour for all employees is called the *annual improvement factor.* The willingness of the employer to guarantee such an annual increase in wages is predicated upon his belief that he can continue to lower costs through technological improvements and better management. He makes a substantial gain in productivity through the existence of the agreement itself because the union agrees not to call a strike for a period of years. The employer can regularize production without fear of interruptions due to labor trouble.

Effect of Work Conditions. One employer may reasonably expect to hire workers at lower wage rates than another if he offers them better working conditions. It is impossible to give a complete list of the conditions of work, but the following are suggestive:

Safety of work and the accident prevention program.
Regard for the personal feeling of the worker in employment and supervision.
Noise.
Monotony or variety of the work.
Type of building and general attractiveness of the workplace.
Lighting and air conditioning.
Retirement plan.
Opportunity to invest savings in a credit union.
Guarantee of daily or perhaps annual wages.
Stabilization of employment.
Policy concerning technological unemployment.
Provision for warm, inexpensive lunches.
Rest periods.
Opportunity for social activities.
Hours of work, such as odd shifts.
Opportunity for advancement.

The various conditions of work have been discussed elsewhere. They are mentioned here to call attention to the fact that the worker is interested in many phases of the job besides the rate of wages.

Nature of the Job. In any plant there is not one wage rate, but there are many wage rates. Some jobs require greater skill and more training, education, and experience than others. Some jobs subject the worker to heat, cold, moisture, accident hazards, or other unfavorable conditions. Some require heavy lifting or muscular exertion; and others require care in the handling of materials, tools, or equipment. Some jobs cause the worker to soil or possibly to ruin his clothing, while others permit him to wear clean clothing.

The technique of evaluating the various factors in a job for the purposes of fixing wage rates and also for purposes of employing workers is called "job evaluation." It is based upon the principle that wage rates should vary with the requirements of the task.

The Ability of the Worker. Workers who are employed at similar jobs are not necessarily worth the same to the employer. They will differ in their productivity, regularity of attendance, accident record, spoilage of materials, ability to shift to other types of work as occasion requires, ability to help train new workers, and many other respects. The employer is therefore compelled to rate his workers as well as his jobs if he is to pay his employees in accordance with their value to him. The rating of workers is called "merit rating."

Several devices are used to vary the wages paid to workers on various jobs. A piece-rate or bonus method of wage payment is one

such device. Payment by the piece requires that standards be set to indicate the amount of work which represents a fair day's work in a job. Payment by the piece also requires that individual production records be kept. Employee records are kept to indicate absences, tardiness, spoilage, and other significant facts, both favorable and unfavorable. All factors in the record of the employee should ultimately be reflected in the monetary or other rewards.

QUESTIONS

1. Are wages fixed by economic law or by collective bargaining? To what extent is each a factor?
2. If higher wages paid to all workers in industry cause higher commodity prices, can the causal relationship be traced to higher costs for all manufacturers, who are thereby compelled to raise prices? Would it be more correct to say that higher money wages cause a greater demand for commodities in the market and thus permit or cause higher prices?
3. What income or services to the worker make up his income in addition to the money wages paid to him?
4. A manufacturer establishes a production line with 55 operations and 55 workers. Each workplace must be manned in order that the product may be kept moving along the line. Does the marginal productivity theory of wages help to explain the amount paid to each worker in the line? How can the contribution of any one worker to the product be measured?
5. Indicate the manner in which each of the following affects the wage level in a country or a section of the country:
   a) Amount of farm land and its productivity.
   b) Ambition of workers and families to advance their economic position.
   c) Natural resources.
   d) Managerial efficiency.
   e) Extent to which scientific principles have been applied to methods of production.
   f) Size of corporate establishments.
6. Do living standards of workers determine the level of wages, or do wages determine living standards?
7. Can the efficient employer be expected to pay higher wages than the inefficient employer in the same labor market area?
8. How does the nature of the job affect the rate of pay? Is the nature of the job related to the contribution which the worker makes to the value of the product?
9. What causes differences in the level of wage rates in various sections of the country? Do such differences serve any economic or social purpose? Should they be eliminated by legislation?
10. Why is labor not willing to make all changes in wage rates dependent upon changes in the cost of living?

11. Indicate whether the worker is entitled to an increase in wages under each of the following conditions:
   a) Getting married.
   b) Birth of a child.
   c) Completion of a course of training to improve performance on the job.
   d) Improvement in health, permitting better attendance and less tardiness.
   e) Change in attitude toward the company and the development of willingness to co-operate with management.

CASES

44. TERRITORIAL DIFFERENTIALS IN WAGES

In a recent pronouncement the Communication Workers of America, C.I.O., commented on wage differentials as follows:

"Geographical wage differentials are far too great in the telephone industry. Phone workers do the same job whether they are employed in the north or in the south, in the east or in the west. Yet craft workers are subject to wage differentials as great as $22 a week and telephone operators as high as $16 a week.

"This scheme was foisted on telephone workers before the days of the union in order to hold down overall wage levels. CWA is striving to narrow geographical wage differentials.

"Figures of the Bureau of Labor Statistics show that these differentials have no bearing on realities of living costs in the various areas of the country and have no relationship, generally speaking, to any factor other than company caprice."

Questions:

1. How does the company gain from territorial wage differentials?
2. Can a large company force wage differentials that are unfair and unrealistic?
3. May social and economic forces compel an employer to observe wage differentials?

45. SHARE-OF-PRODUCTION PLAN OF WAGE PAYMENT

The Union Paper Company uses a plan of rewarding its employees which is known as the "share-of-production" plan. The plan provides that employees are entitled to 31 per cent of the difference between the cost of materials and supplies used in production and the income from sales. The figure of 31 per cent was determined from the experience of the company for a period of years before the installation of the plan.

Every four weeks the company determines its sales and computes the 31 per cent to which employees are entitled. The amounts paid to hourly workers are deducted from this amount. The difference is allocated as follows: 25 per cent is placed in reserve to be held for semiannual adjustments of payments; 37½ per cent is paid in cash immediately; and 37½ per cent is paid into a retirement fund.

If the wages in any period exceed 31 per cent of the difference between sales and the cost of materials and supplies, the excess is deducted from the reserve. Every six months the balance of the reserve is paid to employees in cash. These payments are made on June 15 and December 15.

Questions:

1. What is the merit of the "share-of-production" plan?
2. How would payments be affected by seasonal fluctuations in production and sales?

CHAPTER XXII

WAGE SYSTEMS

A LARGE number of methods of wage payments have been devised. Some methods emphasize the amount of time spent on the job, and other methods provide for payment largely on the basis of production. Some methods vary the payment on the basis of time, quantity, and quality of work. Many companies use more than one method of wage payment because the requirements of various jobs differ.

Wage systems may be classified on the basis of the amount of bonus paid for increased production above a predetermined standard. From this point of view, wage systems may be classified into five groups, which are as follows:

1. No increase in wages for increased production. The systems of payment falling under this classification reward the worker for time on the job rather than the amount produced. The retention, transfer, or promotion of the worker may depend upon his production rate; but his pay from one day to another does not vary with his production. Three wage systems fall under this classification — namely, the day or hour wage, the measured day wage, and the annual wage.

2. A slight bonus for production in excess of the standard but less than a proportionate increase. For example, a production of 5 per cent above the standard is rewarded by less than 5 per cent increase in pay. Examples are the Halsey plan and the Rowan plan.

3. An increase in pay in proportion to the increase in production. Examples are piece rates, the 100 per cent savings or premium plan, and the Bedaux plan.

4. An increase in pay which is larger than the percentage of increase in production. Some plans which may properly be classed under this heading do not grant the higher rates for all levels of achievement but only at certain fixed points. For example, the worker may receive

a sharp increase in pay when his rate of production exactly equals the standard with no more than a prorata increase in pay for additional output. Examples of systems of wage payment which liberally reward the worker for equaling or bettering the standard are the Taylor, Merrick, and Gantt systems. The Emerson plan also awards substantial bonuses and is therefore discussed under this heading. Under this plan the bonuses increase most sharply just before production reaches the standard rather than at the time it reaches the standard.

5. Profit-sharing and bonus plans, which provide for additional payments to workers not related directly to either time or production.

Wage systems may be classified on other bases. For example, they may be divided into two classes according to whether the worker is guaranteed a minimum daily or hourly wage. They may also be classified into two groups on the basis of whether the standard is set by time study or by past experience. The systems which liberally reward the worker require that standards be fixed by time study. Systems which grant small rewards may be used with standards that are fixed by past experience.

SYSTEMS WHICH GRANT NO BONUS

Wage systems that fall under this classification reward the worker for the amount of time which he spends on the job rather than the amount of his production. His daily or hourly rate may be adjusted from time to time as the quantity and quality of his production increase or decrease. Nevertheless, on any one day, the pay is for time spent rather than quantity produced.

Advantages of the Day Rate. Both individual workers and labor unions have been inclined to favor the day rate, although not all of them have done so. One reason is that payment by the day gives the worker some feeling of security. He knows how much he will earn each day and each week or month, so long as he continues to be employed. He can therefore plan with some measure of assurance what he should be able to pay for rent, clothes, food, and other necessities. To the extent that he can budget his expenses, he has security and is relieved of fear and worry. This is obviously an advantage to the employer as well as to the worker. The day rate permits the worker to emphasize quality of work. In any event, quality must be such that the product will pass inspection; but a worker on daywork can emphasize quality, whereas the worker on piece rates will think first of quantity.

The day wage tends to develop a solidarity of interest among the workers. Workers at similar jobs may be paid the same rates, and they can raise their rates by gaining a general wage increase. Workers on piece rates may increase their daily earnings by increasing production. Differences in daily or weekly earnings tend to destroy group solidarity because highly paid workers are less inclined to press for higher wages for workers whose production rate is low.

From the point of view of management, the day rate has other advantages. It requires a minimum of payroll work. To determine the amount due the worker, it is necessary to know only the rate per day or hour and the amount of time worked. The worker can readily figure his own pay when this system is used, and this is an added advantage to both the worker and the management. Many systems which are theoretically desirable on other grounds have been discontinued because they were confusing to the worker and required excessive payroll costs. Another advantage is that the day rate can be used in any type of work. If the worker does a variety of jobs, such as repairs and maintenance, the day rate may be the most logical method to use. Even if the worker is engaged in repetitive work, such as assembly line work, the day rate may be satisfactory because the production rate may be controlled by regulating the speed of the line.

Disadvantages of the Day Rate. From the point of view of the employee, a disadvantage is that superior workers are not encouraged to do their best. The day rate offers no inducement to the good workers to excel in production. The better workers may be inclined to follow a pace which enables them to avoid being criticized and which also protects slower workers. In fact, good workers sometimes permit others to take credit for some of their production. Workers or their unions often set informal production standards which are quite generally observed.

Daily earnings may be lower when payment is by the day or hour. It is not possible to prove precisely what is the effect of the method of wage payment upon daily or weekly earnings, since all wages are fixed in relation to earnings on other jobs or in other plants. However, if the day rate fails to encourage the better workers to do what is for them a fair amount of work, the result is lower productivity. According to the functional theory of wages, lower productivity results in lower wages.

From the point of view of management, the day rate has additional disadvantages. Good workers may feel that the day rate is unjust to them. When all workers on the same type of work receive the same

pay regardless of their efficiency or their production rate, the better workers are inclined to feel that the rate is unfair. The employer is required to assume the greater part of responsibility for maintaining production. The worker has little incentive to produce more than is necessary for holding his job. Labor cost on contracts cannot be accurately estimated. Standard costs are unreliable because the rate per piece is not fixed.

The Measured Day Rate. In the measured daywork plan the worker is paid a guaranteed daily rate plus a bonus which is determined by his individual performance. The guaranteed daily rate is the same for all workers on the same type of job. The bonus varies with the efficiency of the worker. The plan is usually so designed that approximately 75 per cent of the total pay is base rate and 25 per cent is bonus.

The bonus to be paid under the measured day rate is determined by rating each worker. Ratings may be based solely on productivity, or two or more factors may be used. Factors used in the rating may be productivity, quality of work, dependability of the worker, and versatility of the worker or his ability to do various kinds of work.[1] The factors are weighted according to the requirements of each job. For example, productivity may be weighted 50 or 60 per cent, with the remaining percentages assigned in varying amounts.

The essential feature of the measured day rate is that the performance of employees is measured over a fairly long period, usually one to three months. The record of an employee in one period determines his rating during the ensuing period. His rate of pay during any period is determined solely by his performance during the preceding period and is not affected by his production during the current period. The plan protects the worker against loss of earnings due to breakdowns, poor scheduling, shortage of materials, and lack of customer demand. The worker has an incentive to increase production, improve quality, work regularly, and shift to other jobs in emergencies, because a good record will increase his rate and his earnings during the next period. It assures the worker a certain weekly income while offering an incentive for good work.

The measured daywork system differs from merit rating of employees in that productivity is heavily weighted and employees are rated at definite intervals. The rating is immediately reflected in the wage rate, and the change may be either an increase or a decrease. Merit-rating

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[1] Archibald Williams, "Measured Day Work or Wage Incentives," *Bulletin of National Association of Cost Accountants*, Vol. XX, No. 1 (1938), pp. 12–24.

plans usually provide that pay rates may be increased as a result of the rating, but they usually are not decreased.

Annual Wage. Although payment on an annual basis has usually been limited to executives, a few companies have experimented with the plan of paying employees by the year. Interest in the subject of annual wages was increased after the close of World War II when the Congress of Industrial Organizations began to advocate the plan in an active manner.[2]

Annual wage plans assume many forms. They may be classified into three groups, which are as follows:

1. The employer may guarantee a certain number of weeks' employment each year at unspecified job assignments or wages. A variation of the plan is a guarantee of a certain number of weekly or monthly pay checks of a stated amount. Payments are made even though the employer has no work for the employee to do. If the employer wishes to do so, he may transfer a worker to another task; or he may continue the payments without receiving any services in return. In this case the guaranteed annual wage is the equivalent of unemployment compensation for the duration of the guarantee.

2. The employer may guarantee to maintain the income payments from week to week at a rate which fluctuates less than the hours of employment. The overtime of some periods is balanced against the hours of underemployment. If the peak season precedes the slack period, full payments may be made in the weeks of overtime work without provision for future deficits. Other plans provide for deductions from the pay in the overtime weeks to be held by the employer for credits against payments not earned by the worker during slack seasons. If wage advances in dull seasons exceed the amounts earned by overtime work in subsequent weeks, the indebtedness is canceled at the end of the year.

3. The employer may provide for some type of grant or aid during periods of low earnings. The plans include loans from the employer, funds for the benefit of unemployed workers which are established by the investment of a part of the profits, and mutual benefit programs. For example, the employer may retain the employees' share of the profits under a profit-sharing plan and use the money to supply make-up pay for unemployed workers. The fund may be increased by a contribution from the employer. A different provision is that employees with a specified number of years of service may be entitled to cash

[2] Congress of Industrial Organizations, *Guaranteed Wages the Year Round* (1945).

advances in layoff periods up to 60 per cent of their standard wage for 40 hours per week. The money for such payments may be contributed by the employer, or it may be deducted from the earnings of other workers who are provided with work of more than a stated number of hours of work per week.[3]

The annual wage plans have been developed by employers rather than by labor unions. Many unions have not endorsed the program. One reason is that the annual wage would weaken the position of craft unions because the employer reserves the right to transfer workers to new jobs where they may be kept busy. The seniority rights of workers may be lost by interdepartmental transfers, unless seniority is made plantwide. Many craft unions prefer that seniority be limited to the job or the trade. Another objection is that the weekly wage may be decreased as a result of the guarantee of yearly employment. Furthermore, the annual wage is not extended to all workers. The result of the plan may be an increased number of casual workers.

An advantage of a guaranteed annual wage, from the point of view of the employer, is that the greater security offered the worker relieves him of worry and thus makes him a better worker. Workers have a greater loyalty to the company. Increased loyalty reduces labor turnover and results in a higher level of efficiency. The plan eliminates one distinction between the office workers and the factory workers. It raises the social status of factory workers. Moreover, workers are less inclined to oppose technological changes. Although the employer is free to reduce his working force at the beginning of the next contract period, the situation may be corrected by the normal labor turnover or business expansion. Investment in plant and equipment is decreased, provided that the employer is able to utilize his productive equipment at a more nearly uniform rate the year round.

In the institution of a plan for a guaranteed annual wage, the principal question for the employer is whether he can eliminate seasonal and cyclical variations in production to the extent necessary to finance such a guarantee. In some industries, such as the processing of oysters or the canning or freezing of fruits and vegetables, production cannot be stabilized because the supply of raw materials is subject to seasonal variations. In other industries the stabilization of production might be effected by inducing customers to spread their orders evenly over the

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[3] For description of various plans, see U.S. Department of Labor, "Guaranteed Wage or Employment Plans," *U.S. Department of Labor Bulletin 906* (Washington, D.C.: U.S. Government Printing Office, 1947).

year, by producing and storing the product in anticipation of demand, or by dovetailing the production of two or more commodities which have different seasonal peaks. To stabilize the demand in an industry such as the steel industry would require that customers stabilize their production. The principal customers of the steel industry are automobile companies, construction companies, railroads, the electrical industry, and oil companies. Stabilization for these companies is difficult, and the development of a substitute material which might be produced by a steel mill in the dull season is impractical.

Storing the product in anticipation of an increased demand at a later season or year would cause increased expenses for storage space, interest on idle capital, record keeping, handling costs, and possible deterioration and obsolescence. A further difficulty is the anticipation of the probable demand for various sizes, colors, grades, shapes, and finishes of product. While some employers have been able to stabilize their production, many of them have found it cheaper to permit plants to be operated at less than capacity for a part of the time than to attempt to produce goods in anticipation of the busy season.

Since most employers have considered it unprofitable to stabilize their labor force, it may be assumed that their costs would be increased by such a plan. The feasibility of the guaranteed annual wage, therefore, depends upon the answers to such questions as the following:

1. Can employers find ways to reduce operating expenses to offset the increase in labor costs?
2. Can prices be increased to cover the increased costs?
3. Is the margin of profit great enough to absorb the increased costs without forcing firms into bankruptcy?

The answers to the above questions would obviously not be the same for all industries. The annual wage is practical for some companies and in some industries but not in all of them.

SYSTEMS WHICH PAY A SMALL BONUS

A few systems of wage payment grant the worker a small bonus for production above a designated standard, but the bonus is less than the percentage increase in production. For example, an increase of 10 per cent above the amount set by the standard would be rewarded by something less than a 10 per cent increase in pay. Two well-known systems of this kind are the Halsey premium plan and the Rowan plan. This method of wage payment is generous with the time allowed but not with the premium paid. With both systems the standard time for

a task is established on the basis of past performance and not by time study.

The Halsey Plan. Under this plan of wage payment, the worker is paid a guaranteed hourly wage plus a percentage of the wages for the time saved. If he completes a task in less than the standard time, he is paid the wages for the time taken plus from one quarter to one half of the wages for the time saved. Since the worker is free to begin another task as soon as he finishes any one task, he is enabled to increase his hourly rate. He is paid by the hour on those tasks where he requires more than the standard time.

To illustrate the method of the Halsey plan, assume that the standard time for a task is 10 hours and the worker is paid $1.00 per hour. If he takes 10 hours to finish the task, he is paid $10.00. If he takes 9 hours, he is paid $9.00 plus a premium of, say, one third of the wages for the time saved, or a total of $9.33 for the task. See Table 6.[4]

TABLE 6
THE HALSEY PLAN
(Standard Time 10 Hours)

Time Consumed (Hours)	Wages on an Hourly Basis	Premium	Total Cost of Work	Worker's Earnings per Hour
10	$10.00	None	$10.00	$1.00
9½	9.50	$0.17	9.67	1.018
9	9.00	0.33	9.33	1.036
8½	8.50	0.50	9.00	1.058
8	8.00	0.67	8.67	1.084
7½	7.50	0.83	8.33	1.111

The reason for the small increase in the earnings per hour is that the standard is based on past performance. It is, therefore, not difficult for the worker to do most jobs in less than the time set. The scanty bonus makes for permanence in the standard. Earnings on the various jobs are not seriously out of proportion, even though the standards are inaccurate. The unfairness in the standards is not carried over into earnings per day or per hour. This feature of the plan permits it to be used as a temporary basis of bonus payment prior to the completion of time studies. If some jobs have been placed on a bonus plan and workers in other departments would also like to earn a bonus, they may

[4] This table follows the form of one prepared by F. A. Halsey in his article, "The Premium Plan of Paying Labor," *Publications of American Economic Association*, Vol. I, No. 2 (1896), pp. 75–88, 82. The article appeared first in *Transactions of American Society of Mechanical Engineers*, Vol. XII (1891), p. 759.

be paid by the Halsey premium plan without subjecting the entire program to the risk of failure.

The Halsey plan, in effect, amounts to a reduction in the piece rate as the performance of the worker improves. This is apparent from an examination of the total cost of the work, as shown in Table 6. However, the plan is not stated as a series of decreasing piece rates, since that would probably raise objections. The method of statement presents the plan in a much better light.

Objections to the Halsey Plan. The objections to the Halsey plan are:

1. It permits the continuance of standards which are inequitable and unfair. It makes possible a policy of drift on the part of management. It does not require that management set its standards carefully.
2. The plan does not offer sufficient incentive to the worker. Of the total pay, too much is base pay, and not enough is bonus. Experience indicates that, if a bonus plan is to encourage the worker to put forth his best efforts, incentive earnings should be from 25 to 30 per cent higher than daywork earnings.[5] In the Halsey plan the base rate is too near the maximum earnings possibility.
3. The plan is unfair. If the saving in time is the result of worker efforts, the worker should be paid the entire amount. If the saving is due to an inaccurate standard, the fault is that of management, and the worker should not be penalized.
4. The worker can shift from the day rate to the bonus rate and back again when he wishes to do so. The day rate is so near the bonus rate that the worker is not greatly penalized when he fails to make the standard.

The Rowan Plan. The Rowan plan, like the Halsey plan, fixes the standard by past production rather than by job study; and it provides for a small bonus for better than standard performance. It provides that the wages for the time taken will be increased by the same percentage that the time set for the job has been reduced. For example, if the worker completes the task in 10 per cent less than the standard time, he is paid for the time required on the job plus a bonus of 10 per cent of his wages for the time taken. The pay for a 10-hour task completed in 9 hours by a worker whose rate is $1.00 per hour would be $9.00 plus 10 per cent of $9.00, or $9.90. As in the Halsey

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[5] Ralph Presgrave, *The Dynamics of Time Study* (2d ed.; New York: McGraw-Hill Book Co., 1945), p. 124.

plan, the rate for the task has been reduced. However, the reduction is less under the Rowan plan than it is under the Halsey plan. Stated as a formula, the Rowan plan provides for payment of wages as follows:

$$\text{Wages for the task} = \text{Wages for the time taken} + \left(\frac{\text{Time saved}}{\text{Standard time}} \times \text{Wages for the time taken} \right)$$

The justification of the Rowan plan is embodied in the statement that the bonus bears the same relation to the base pay for the task as the time saved bears to the standard time. The Rowan plan is somewhat more liberal with the worker than the Halsey plan because the bonus is larger for performance slightly better than the standard. For deductions in the standard time of 50 per cent or more, the Halsey plan is more liberal; but the worker cannot be expected to reduce the standard time to that extent. Under the Rowan plan a worker can never double his base pay because the bonus is a percentage of the wages for the time taken. This plan has most of the advantages of the Halsey plan and is subject to the same limitations.

QUESTIONS

1. What are the advantages of the day or hour rate, as compared with the piece rate, from the point of view of the employer? What are the advantages from the point of view of the worker?
2. Why do unions usually favor the day or hour rate?
3. Compare the measured day rate with the usual day rate and the piece rate, with regard to:
   a) Effectiveness in securing application to the job.
   b) Fairness to the worker.
   c) Amount of clerical work to determine the pay of the worker.
4. May the guaranteed annual wage require the employer to pay for labor which he does not need and would not require without the plan? How can he afford to make such payments?
5. Would it be possible for all employers to guarantee year-round wages or steady employment to all workers? Would this plan create a continuous and steady demand for all goods by stabilizing purchasing power? Discuss with reference to such industries as steel, railroad construction, and shipbuilding.
6. Why have some labor unions not endorsed the annual wage plan?
7. What explanation might be given to workers of the manner in which premiums are determined under the Halsey and the Rowan plans?
8. The effect of both the Halsey and the Rowan plans is to reduce the total pay for the job as the worker reduces the time required. How can the reduction be justified?

CASES

46. PREMIUM PAYMENTS UNDER HALSEY AND ROWAN PLANS

The standard time for a task is 4 hours. The hourly rate of the worker is 90 cents. In doing the work on different days, the worker performed the task in various times as follows:

Day	*Hours Taken*
1	4.5
2	4.0
3	3.8
4	3.5
5	3.0

Required:

1. Compute the pay under the Halsey plan. The premium is 33⅓ per cent.
2. Compute the pay under the Rowan plan.

47. GUARANTEED EMPLOYMENT

In October, 1951, the Drury Hoe and Rake Company informed the union that the hours of work would be reduced from 40 per week to 32 because of a lack of orders. The union officers advised that the company plan would be ineffective because the men would stretch out the work and thereby force the company to return to a 40-hour week. The management then suggested to the union that it would guarantee 40 hours of work per week provided that the union would give the company a free hand in shifting men to maintenance, yard work, or any other work available. This proposal was presented to the workers at a meeting of the union, and they accepted it.

After the new agreement was put into effect, productivity increased 10 per cent. The management believed that the increase in production was due to a realization on the part of workers that they would not work themselves out of a job and also to a belief that the profit position of the company was not good. The management increased its efforts to sell the larger volume and to avoid paying employees for maintenance and other work not immediately productive. The result was that the employees were kept busy at regular productive work for the remainder of the year, and no transfers of employees were necessary.

Questions:

1. Was the company right in accepting the suggestion of the union, or should production policies be determined without consultation with union officers?
2. How might the increase in production be explained? Did it indicate that employees had previously been loafing on the job?

CHAPTER XXIII

WAGE SYSTEMS — CONTINUED

IN THE preceding chapter, two general classes of wage systems have been considered. These were, first, systems which provide for no increase in pay with increased output and, second, systems which provide for a small increase or small bonus. In this chapter the third and fourth classes of wage systems will be considered.

SYSTEMS WHICH PROVIDE FOR PAYMENT IN PROPORTION TO OUTPUT

When this type of wage payment is used, any worker who increases his output is rewarded by an increase in pay of the same percentage as the percentage increase in production. Wage systems of this type include piece rates, the 100 per cent premium plan, the Bedaux system, and group piece rates. When any one of these methods is used, management is required under the federal Wage and Hour Law to guarantee a stipulated minimum wage per hour.

Piece-Rate Plans. The piece-rate plan of wage payment provides for an established rate per unit of output. Separate rates are set for each operation, but no day rate is guaranteed.

The 100 per cent premium plan is a form of piece rate with a guaranteed hourly wage. The worker is paid for the time required for a task and is also paid a bonus of 100 per cent of the time saved. For example, a worker who is paid $1.00 per hour may be assigned to a job on which the standard time is 30 minutes. If he does the task in 25 minutes, he is paid for the 25 minutes taken and also for the 5 minutes saved. The effect of this plan is, therefore, to fix a rate of 50 cents for the job with a guaranteed wage of $1.00 per hour.

Bedaux Plan. This plan is also a modified piece-rate system with a guaranteed hourly wage. It differs from the straight piece-rate system in that each job is standardized by being assigned a number of

"B's" (for Bedaux) according to the number of minutes required to complete it. A "B" is defined as follows: A fraction of a minute of effort plus a fraction of a minute of relaxation to overcome fatigue, the total being equal to one minute of effort.

Thus a task which requires 15 minutes of work, including time necessary for relaxation, is said to be worth 15 "B's," and a task which requires 20 minutes is worth 20 "B's." During any payroll period the total minutes spent at work are compared with the total "B's" completed. The worker is paid for the "B's" completed if he is above standard. Otherwise, he is paid at the hourly rate.

Some variations of the Bedaux plan provide that the foreman may share in the bonus paid for the "B's" earned above the standard. To illustrate, assume that the worker is employed 40 hours during the week. His standard of work would be 60 "B's" in each hour, or a total of 2,400 "B's." If he has completed 2,460 "B's," he is entitled to a bonus of 60 "B's," or one hour of pay. He may receive three fourths of the bonus and the foreman one fourth, on the theory that the foreman has helped the worker to make the standard. This system is usually opposed by the workers because it encourages the foreman to put pressure on the men.

An advantage of the Bedaux plan is that it can be used in any department and in any type of work, and it can be used for a worker who shifts from one type of work to another. The reason for its adaptability is that all types of work are converted to a common denominator through the device of the "B" and the unit of work.

Group Piece Rates. A group of workers may be paid for their total production on a piece-rate basis, provided that the work of one is dependent upon the work of another, as in line fabrication or assembly work. If the workers are guaranteed an hourly rate and the hourly rates vary, the amount to be paid each worker may be determined as follows:

1. Total production of the group multiplied by the piece rate equals the total amount to be paid to all workers.
2. Total amount to be paid minus hourly earnings equals bonus.
3. Bonus divided by total hourly earnings equals the bonus percentage.
4. Earnings of each worker multiplied by the bonus percentage equals the amount of the bonus in dollars.

To illustrate the group bonus plan, assume that workers are paid hourly wages and are permitted to work for a bonus on the basis of 2

cents per piece. During a stated payroll period the group produced 100,000 pieces. Their wages on an hourly basis totaled $1,600. The pay of a worker who earned $120 on an hourly basis would be determined as follows:

Total amount due all workers, 100,000 × 2 cents	$2,000
Deduct wages on an hourly basis	1,600
Bonus above hourly wage	$400
Bonus percentage, $400 ÷ $1,600	25%
Pay of the worker on an hourly basis, $120 × 25%	30
Add earnings on an hourly basis	120
Total pay	$150

When this system is used, an increase in the hourly wage of all workers does not affect the total earnings of the group. It affects only the distribution as between the hourly wages and the bonus. If some workers receive an increase in their hourly wage rates while others do not, the effect is a redistribution of the total earnings of the group, since the amount of the bonus and the percentages are changed.

A variation of the group piece rate provides for the payment of an hourly wage to each worker and an additional bonus for each unit produced. At the end of the year the bonus is distributed on the basis of the number of hours worked by each employee during the year. To be eligible to share in the bonus fund or "kitty," the employee must have a record of 90 per cent "presenteeism"; and he must not have participated in any unauthorized strike or other work stoppage. Employees who have not been on the payroll for ninety days or more are usually ineligible to participate.

Attitude of Labor Unions. Many labor unions oppose piece rates.[1] They fear that the piece rates on different jobs may be inequitable. Piece rates are an indirect recognition of the prevailing wage rate, in that the employer fixes the rate at that figure which he thinks will enable the employee to earn a fair wage for a day's work. The time set is therefore subject to all the limitations of time study. In industries that are subject to frequent changes in style or product design, it is not easy to keep changes in rates abreast of changes in the job. If designs change from year to year, a wage scale must be scrapped for a new scale when new designs are put into production.

When piece rates are used, unions cannot easily compare wage rates in different plants because jobs are not precisely the same throughout the industry. Piece rates permit the workers in one shop to work for

[1] A full discussion of the objections of unions to piece rates may be found in S. H. Slichter, *Union Policies and Industrial Management* (Washington, D.C.: Brookings Institution, 1941), pp. 296–310.

lower wages on jobs slightly different from those in other plants, without this fact being apparent. The employers who pay lower wage rates can undersell employers who pay higher rates and thus force a general reduction in wage rates throughout the industry.

The earnings of workers on piece rates are decreased by the inability of management to stabilize production, to maintain a steady flow of work, or to keep machines in repair. This problem is especially acute in industries which bring a series of models into production or which are unable to stabilize production because of fluctuating demand. Piece rates are also unfair to workers when the production run varies greatly. If the worker can produce five hundred units without having to change jobs, he can make better earnings than he would make on a run of one hundred units on each of five different jobs of the same standard time.

Piece rates often lead to speeding up on the job. In a seasonal industry where the amount of work to be done is definitely limited, such as in certain branches of the clothing industry, each worker is likely to rush through his work to produce as large a number of pieces as possible before being laid off. In such an industry, speeding by workers on piecework can be prevented only by a plan for allocating the work.

Piecework makes it more difficult for the workers to present a united front to the management. The better workers who earn a satisfactory wage may be unwilling to strike for more money or to risk an interruption of work by making demands upon the employer. The foreman can discriminate against the workers he dislikes by putting them on jobs where the standards are tight and by putting his favorites on jobs where the standards are loose.

Workers fear that the piece rate will be cut if they increase production. If some workers demonstrate to management that an increase in production is possible, management may cut the piece rates in order to keep down daily earnings. Workers believe this to be true even though no rate reduction has occurred in the plant; but it is true, however, that cuts in piece rates have sometimes followed increases in output.[2]

Unions seek various forms of protection for workers on piece rates. They may take an active interest in management methods to prevent interruptions in the flow of work and to see that the worker has an opportunity to earn a satisfactory daily wage. The result has been in

[2] F. W. Taylor was compelled by the directors of Midvale Steel Company to cut piece rates under such circumstances. See N. I. Stone, "Wages, Hours and Individual Output," *Annals of the American Academy of Political and Social Science*, Vol. LXXXV (1919), pp. 120, 131.

many cases that the unions insisted that outside consultants be asked to recommend changes in policies or that the management itself make certain improvements. Unions have concerned themselves with difficulties which prevented workers from making fair piece-rate earnings in such industries as coal mining, textile manufacture, clothing, window glass, foundry work, and carpets. The conditions with which the unions have been concerned include the following:

Inadequate, obsolete, or poorly maintained equipment.
Unsatisfactory working conditions.
Insufficient or unsatisfactory material.
Faulty methods of doing work.
Avoidable delays.
Obstructions caused by other workmen.[3]

Some unions prefer piecework to daywork. The preference of certain unions for piecework is based upon a number of factors. Some unions, as in coal mining, recognize that supervision of individual workmen by the employer is not practical. Since each worker is placed upon his own responsibility, piecework is the only feasible method of payment. However, the worker may be paid on an hourly basis for travel time or for odd jobs, such as timbering.

Piecework relieves the employee of pressure from the foreman to get out production. When the worker is paid by the day, management uses various devices to assure itself that production is up to standard in both quality and quantity. Consequently, the worker may be gradually speeded up until he is turning out a much greater production for the same pay. Under piece rates a worker has a chance to follow his own pace. If, by general understanding among the workers, the pace is a leisurely one, the employer may not make serious objections.

Many unions recognize that competition from other shops, particularly nonunion shops, is so keen that the employer cannot grant general increases in daily or hourly wage rates. The piece rate permits the employee to increase his earnings with no increase in labor cost. Where work is uniform from one plant to another, as in certain branches of the clothing industry, the piece rate enables the union to eliminate discrimination in the rates paid by various employers. Day rates do not permit the same uniformity, unless the union can fix the amount of the daily production as well as the daily wage.

Workers tend to benefit by numerous small improvements in the job which enable them to increase output. Many such improvements are not of sufficient importance to justify a cut in rate by the employer. In

[3] For discussion, see Slichter, *op. cit.*, pp. 315–28.

the aggregate, improvements may result in substantial increases in earnings. Some job improvements result from changes made by the employer, and some result from short cuts developed by the employee or taught him by fellow workers.

The employer is more likely to retain older workers if he pays them by the piece. The loss to the employer when he keeps the older man is limited to machine time, although in some cases one slow worker may cause a slowing-down of others. Workers who take off a few minutes from work in the middle of the day are also less likely to be criticized by the foreman, even though the practice is a violation of the rules, because labor costs cease when the worker stops work.

INCENTIVE WAGE SYSTEMS

While the piece rate rewards the worker by paying him an increase in wages in proportion to his increase in production, some plans allow the efficient worker an even higher percentage increase. Usually, the increase in pay comes just at the point where the worker measures up to the established standard. If a worker does a task within the standard time, he gets a very large increase in his pay. Under most plans the bonus is not regularly distributed for small increases in efficiency but is granted for any performance within the standard time. Although the plans of wage payment that liberally reward the worker for increasing production are not the only systems that provide incentives, these plans are commonly referred to as "incentive systems." All the plans are based upon the following principles:

1. The task is large and clearly defined. This means that the standard time is fixed by time study rather than by past performance. Taylor believed that the standard should be so high that it could be met only by workers who were better than average. While practice varies somewhat in this respect, it is generally true that close attention and unusual skill are required of any worker who completes the task in the standard time.

2. Standard conditions of work are maintained by the management. Standard materials are issued, tools are kept in repair, and the machine is in good operating condition at all times. In addition, the management sees that a steady and continuous supply of materials is moved to the workplace. Failure to meet the standard cannot, therefore, be ascribed to management. Performance becomes a matter of worker efficiency and application to the job.

3. The pay for worker success is high. Since the task is large and clearly defined, an inefficient worker cannot make the standard as he

might do under the Halsey or Rowan plans. The management can afford to be generous with the pay because it is not generous with the time allowance. A further reason for the high rate of pay is that, if the worker can perform the task within the standard time, he uses the machine or the workplace for a relatively short time. The machine becomes available for another task, with the result that cost per unit is decreased. The more expensive the machine is to operate, the more generous management can afford to be with the bonus.

4. The penalty for failure to meet the standard is severe. Under most incentive plans the worker is ultimately expected to reach the standard, but the penalty for failure varies. Although some plans guarantee a daily wage, the difference between the guaranteed wage and the earnings for the worker who is standard or above is so great that workers make every effort to make the standard. Some incentive plans do not guarantee a daily wage and thus make no provision for the learner. Under all incentive plans the worker who does not ultimately meet the standard is expected to change to some other job.

The best-known incentive plans are the Taylor differential wage, the Merrick multiple wage, the Gantt task and bonus plan, and the Emerson efficiency wage.

The Taylor Differential Wage. Under the Taylor plan the standard worker receives a high piece rate and the substandard worker a lower piece rate. The difference between the two rates is substantial. In an illustration given by Taylor, the man who completed the task within the standard time was paid 15 cents per piece; and the man who required more time than the standard was paid 12 cents. If a standard requires the production of 40 units in 8 hours, the man who produces 40 units in 7½ hours would be paid $6.00. His average pay per hour would be 80 cents. The worker who takes 10 hours to do the same amount of work would be paid $4.80, or 48 cents per hour. If machine time costs 80 cents per hour, the total labor and processing cost would be as follows:

Cost for standard worker who does the task in 7½ hours:	
Labor: 40 units at 15 cents	$6.00
Machine time: 7½ hours at 80 cents per hour	6.00
Total labor and machine cost	$12.00
Cost per piece	0.30
Cost for worker who does the task in 10 hours:	
Labor: 40 units at 12 cents	$ 4.80
Machine time: 10 hours at 80 cents per hour	8.00
Total labor and machine cost	$12.80
Cost per piece	0.32

Taylor lists the following advantages for his plan:

It lowers the cost of production.

It eliminates the motive for soldiering because the rate is fixed on the basis of accurate knowledge.

The men are treated with uniformity and justice.

Men and management are given a motive to co-operation.

The system results in the attainment of maximum productivity within a short time.

It selects and attracts the best men for each class of work. It discourages and sifts out the lazy and inferior workers.

It promotes a friendly feeling between the management and the workers.[4]

The Taylor system is not widely used because it does not make provision for the beginner and is too severe on the worker who is just below standard. It subjects the skilled worker to a continuous strain because he must do every task within the time set. Much depends upon the fairness of the standard time.

The Merrick Multiple Wage. The Merrick plan was devised by Dwight V. Merrick, an associate of Taylor. He changed the Taylor plan by adding a piece rate for the average worker. He followed Taylor's idea in allowing the excellent worker the highest rate and the slow worker the lowest rate. The Merrick plan softens the penalty for the worker who barely fails to make the standard because he is paid a medium rate instead of a very low rate. However, it is subject to many of the criticisms made of the Taylor plan.

The Gantt Task and Bonus Plan. According to the Gantt plan, the worker who does the task within the standard time is paid for the standard time (not the time taken) plus a bonus of 25 per cent or more of the wages for the standard time. To illustrate, assume that the task time is 1 hour and the worker is guaranteed 80 cents an hour plus a bonus of 30 per cent. A worker who completes the task in 60 minutes is paid 80 cents plus a bonus of 30 per cent, or a total of $1.04. A worker who does the same task in 55 minutes is paid the same amount, namely $1.04. Thus the plan provides a piece rate for standard workers and an hourly rate for substandard workers. Like the Taylor plan, Gantt made a sharp distinction between the worker who did the task in a little less than the standard time and the one who required a little more time. Under both plans the standard was so high that a worker could not expect to do the task in much less than the time set.

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[4] Frederick W. Taylor, "A Piece Rate System," *Publications of American Economic Association*, Vol. I, No. 2 (1896), pp. 91–92.

The Emerson Efficiency Wage. The Emerson plan was designed by Harrington Emerson, whose work was referred to in Chapter I (see p. 21). This plan guarantees the worker a daily wage and a bonus according to a graduated scale. The percentage of bonus increases as performance nears the standard. The efficiency of the worker is not computed on the basis of daily performance but is averaged over a payroll period of a week, two weeks, or a month. The efficiency is determined by the ratio of total standard time on all tasks completed to the total time taken by the worker. For example, a worker who required 90 hours to complete tasks with a total standard time of 80 hours would have an efficiency rating of 80/90, or 88.89 per cent.

The scale of bonuses permits a small premium to be paid to the worker who is 66⅔ per cent efficient, but the bonus rate increases sharply as the performance of the worker nears standard. Above 100 per cent efficiency the bonus increases by 1 per cent for each 1 per cent increase in efficiency.

The Emerson plan has the advantage of relieving the worker of the fear that on any one task he may barely fail to make the standard. It offers encouragement to the learner because the bonus begins at a low level of performance. However, the worker has a strong incentive to continue his improvement because of the sharp increase in the rate as he nears 100 per cent efficiency.

The principal disadvantage of the Emerson plan is its complexity. The worker has difficulty in computing his pay under this plan, and a considerable amount of work is required by the payroll department. It does not offer the same incentive for sustained effort as the Taylor or Gantt plans because the efficiency rate is an average for the period. This objection may be minimized by posting each day the efficiency rate of each worker for the preceding day.

Requirements of an Incentive Plan. From the point of view of the management as well as of the worker, it is essential that the wage plan meet the workers' standards of fairness and justice. No incentive plan can succeed unless employees believe that the standards have been accurately set, that wages will be computed honestly, and that the rate or the standard time will not be changed except as a result of a bona fide change in standards and conditions of work. The plan should be understood and freely accepted by the workers. Worker acceptance usually requires that the increase in pay be at least proportionate to the increase in production. A plan which is understandable to the employee and which permits easy calculation of pay by the worker himself is most likely to be acceptable. It is also desirable that employees

should be rewarded promptly, first, by being informed of the amount of bonus earned and, second, by an early payment of wages due. The more directly the bonus can be related to individual effort, the more effective is the incentive. A group bonus stimulates effort only when the size of the group can be definitely limited. The incentive plan should provide for an increase in pay regardless of the amount of the earnings by the hourly rate prior to the adoption of the plan. No maximum rate of earnings should be set. Foremen or workers should not be criticized for past performance regardless of the increase in output under the incentive plan.

Incentive plans presuppose good working conditions. Worker criticism is inevitable if failure to make the bonus is due to faulty shop conditions. The following are especially important:

1. Production schedules should be well established. The worker should not be afraid of working himself out of a job because of poor production planning.
2. The purchasing program should assure a supply of materials.
3. Methods of work should be established by motion and time studies.
4. A competent technical staff should be available for setting standard times and pay rates.
5. Management should have reliable methods of selecting, training, and inducting workers. If workers are poorly selected or inadequately trained, they will oppose any plan which will expose their own limitations.
6. Pay rates should be equitable between various jobs.
7. Arrangements should be made for quality inspection and for determining quantities produced.[5]

Maintenance of the Plan. A wage incentive plan that is satisfactory at the time of its adoption will in time become unsatisfactory unless it is properly maintained. Maintenance requires attention to such conditions as regularity in the flow of work, type of material being processed, lighting and heating, and equipment. If the task is changed the effect on the standard time or the rate of output should be determined. Some authorities contend that any change in the task requires a change in the standard because of a series of small changes may in time result in gross inequities in the pay rates.[6] Other authorities

[5] See John W. Riegel, "Essentials in Incentive Compensation," in *Developments in Wage Payment Techniques* (New York: American Management Association, 1944).

[6] Phil Carrol, Jr., *Timestudy for Cost Control* (2d ed.; New York: McGraw-Hill Book Co., 1943), p. 36.

state that the task should be retimed only when the change is perceptible, say 5 per cent.[7] If workers object to their inability to earn a bonus, their protests should be investigated without prejudice. All complaints should be regarded as legitimate questions to be settled on their merits. A worker who complains that his bonus has been incorrectly computed should be given an explanation of the method of calculating his pay. Workers who are unable to make a bonus should be helped to make the standard by proper training or by whatever action may be necessary.

Evaluation of Incentive Plans. There is much experience to indicate that incentive plans result in increased production, higher wages, and lower unit costs. Reports to the War Labor Board during World War II showed that on the average the introduction of an incentive plan was followed during the next 90 days by an increase in production per man-hour of 40 per cent.[8] A survey of a number of firms by the American Management Association showed that, where a company had changed from an hourly rate to an incentive plan, production was increased 20 to 50 per cent. Many other reports indicate similar increases in production. Much depends upon the rate of the bonus, the circumstances under which the change in methods of wage payment is made, and possibly other factors.

For reasons previously suggested, most labor unions prefer the hourly wage to an incentive plan. One objection is that the wage incentive plan is superimposed upon a wage structure that is not scientific. For this reason the incentive plan alone will not correct inequities in the wage structure. The rates or bonuses are not scientifically determined because the base rate is usually the result of tradition or bargaining methods. It is also said that the bonus does not compensate the worker for his increased effort and that the speed may injure his health. Although not really a serious objection, it is said that the wage standards are set by engineers who could not make a bonus if they were assigned to the job under their own standards. Furthermore, wage incentive plans disregard variances between the capacities of workers, since all are expected to reach a high standard. The plans also do not allow for variations in output from day to day and from one hour in the day to another. Another objection is that wage incentive plans result in a continuous simplification in the methods of work, with a resultant

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[7] Riegel, *op. cit.*

[8] Edward T. Cheyfitz, *Constructive Collective Bargaining* (New York: McGraw-Hill Book Co., 1947), p. 70.

decrease in the need for craftsmanship on the part of the worker. It is a part of a larger movement for making jobs routine and repetitive.

Use of Various Wage Plans. The method of wage payment which is most commonly used is the day or hour wage. Piece-rate plans are also widely used. During World War II, when labor was fully employed and the need for goods was urgent, many companies adopted some form of wage incentive plan. After the war, some companies returned to the daily or hourly wage, while others continued their incentive wage plans. A survey of 96 plants in 1948 disclosed that 145 plans were being used, as follows:[9]

Plan	*Plants*
Straight daywork	67
Piecework	26
Standard hour, 100% premium	23
Bonus, based on total production or profits	12
Measured daywork	7
Standard hour, less than 100% premium	6
Point or unit	4

PROFIT-SHARING AND BONUS PLANS

Profit sharing is not a complete system of wage payment because it assumes that the initial wage payments to workers are determined by hourly or day rates, piece rates, or some other plan. The worker gets a share of the profit as an additional lump-sum payment at the end of the month, half-year, or year. Monthly payments have the advantage of promptness, but the accounting difficulties of figuring monthly profits cast serious doubts upon the advisability of such a plan.[10] The share of profits due to each worker may be paid in cash or stock of the company or may be credited to an employee retirement fund. Payment may be partly in cash, partly in stock, and partly in retirement benefits. Usually, an employee must have been with the company six months or longer to participate in the distribution. The termination of employment during the year, whether voluntary or otherwise, usually cancels all participation rights. Layoffs or leaves of absence are not considered termination of employment.

Several plans for the sharing of profits may be distinguished. The following are typical:

1. The labor dividend is a stipulated percentage of the profits before taxes or dividends are deducted. The amount paid to any em-

[9] "Wage Incentive Practices in 96 Plants," *Factory Management and Maintenance,* Vol. CVI, No. 10 (1948), pp. 88–90.

[10] For a discussion of a plan of monthly distribution of profits, see John Chamberlain, "Every Man a Capitalist," *Life,* Vol. XXI, No. 26 (1946), pp. 93–103.

ployee may be determined by his wages or salary or by the total unit credits in accordance with a plan such as the following.[11]

For each $100 of annual compensation	1 unit
For each year of continuous service	1 unit
For each 6-month term on the junior board of directors during the current year	5 units
For supervisor	5 units
For assistant department manager	15 units
For specialized personnel	Various

2. Payments to employees may be made after a stipulated dividend has been paid on the capital stock. The amount paid to workers may be from 25 to 100 per cent of the profits after the dividends. Before the distribution is made, the total payment is apportioned to various groups of workers and salaried personnel on the basis of their rates of pay. Payment to workers is usually in cash, but payment to salaried employees may be partly or entirely in stock.[12]

3. Payments of profits to employees may be made in proportion to the dividend paid on the stock. Employees may be paid a dividend on their annual earnings equal to the percentage earned or paid on the common stock of the company. This method would usually pay the employees about 25 per cent of the profits.

The advantage to the employer of a profit-sharing plan is that it encourages a moderate degree of co-operation. In small companies, it has tended to break down the distinctions between crafts and to encourage workers to assist in any job that needs to be done. It makes workers interested in the elimination of idle time of men and machines and in the reduction of spoilage and waste. It results in a reduction of labor turnover. To the employee, profit sharing probably has the advantage of increasing the annual wages.

Disadvantages of Profit Sharing. Several objections are made to profit sharing from the point of view of management. One objection is that the profits are not directly dependent upon the efforts of any one employee. A worker cannot increase his personal share of profits by application to the job because earnings are distributed among so many persons. Moreover, profits may be made or lost by many factors not under the control of workers as a group, such as sales policies, expansion into new territories, the development of new products, budgeting of sales and expenses, production planning, and business depression. Good and poor workers are rewarded in the same manner without

[11] E. J. Stickland, "How Eric Johnston Plans to Share Profits," *Factory Management and Maintenance*, Vol. CIV, No. 5 (1946), pp. 34–95.

[12] *Report on Profit Sharing* (New York: National Industrial Conference Board, 1937).

distinction or discrimination. The inefficient worker receives the same share as the efficient, provided that his hourly or daily wage rate is the same.

Workers share in the profits but not in the losses. Some attempt has been made to secure an agreement from workers that in case of emergencies or failure of the corporation to make profits, employees will accept reduced compensation or fewer hours of work or will make other sacrifices until the emergency is past. [13] However, substantial sacrifices cannot be expected of workers during lean periods; and they are likely to find other jobs if company losses are deducted from their pay. The fact that the company shares the profits but bears all of the losses is not a serious objection to profit sharing. The plan can accomplish its purpose of giving the workers an incentive to increase production or reduce cost without an accompanying loss-sharing plan.

The reward is too uncertain and too long postponed to be effective. A possible payment which may be made at the end of the year does not stimulate the worker to much greater effort throughout the year. Payments are sometimes made at more frequent intervals, but monthly payments are usually considered impractical because of the uncertainties of accounting methods. Monthly computations of profits are especially difficult in an industry which is subject to marked seasonal fluctuations.

Workers eventually look upon a year-end distribution as a matter of right. If payments are not made, workers may consider that somehow they have not been fairly paid for their labor.

The accounting practices used by management in determining profits are likely to be misunderstood by the workers. Many accounting practices are a matter of opinion, and any one of several methods may be acceptable to accountants and to management. This is true, for example, of depreciation expense, maintenance and repair charges, and inventory valuation. Workers usually cannot see why the profit and loss statement should include such expenditures as those for research, public relations, long-range planning, and budgeting.[14] A profit-sharing plan has often proved to be a source of friction rather than a means to better industrial relations.[15]

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[13] Roy C. McKenna, "Profit Sharing for a Balanced Economy," *Factory Management and Maintenance*, Vol. CIV, No. 3 (1946), pp. 302–6.

[14] Morris L. Cooke and Philip Murray, *Organized Labor and Production* (New York: Harper & Bros., 1940), p. 121.

[15] For discussion of the reasons for failure of profit sharing, see "The Pitfalls of Profit Sharing," *Fortune*, Vol. XLIV, No. 2 (1951), pp. 104 ff.

Christmas Bonuses. Many companies that do not have a profit-sharing agreement regularly pay a bonus to their employees near the end of the year. The bonus is a gratuity, but the amount may be based upon annual wages or salaries. Employees are usually classified into groups according to the number of years of service, with the oldest employees receiving the largest bonuses. If the bonus is paid near the end of the calendar year, it is called a Christmas bonus.

Bonuses are designed to develop the loyalty of employees and to decrease labor turnover. Since the amount varies from year to year, employees cannot rely upon it as a means of meeting their Christmas bills or of paying other obligations. If payments are made regularly, employees may regard the bonus as part of their wages.

QUESTIONS

1. Distinguish between the 100 per cent premium plan and the piece-rate plan. What is the advantage of the 100 per cent premium plan?
2. Indicate the base pay, the premium, and the total pay for the task under the conditions stated below. The worker is paid 90 cents per hour with a 100 per cent premium. The standard time is 48 minutes, or 0.8 hour.

Task No.	*Time (Hours)*
1	0.9
2	0.8
3	0.6
4	0.5

3. Assume the same conditions as stated in the preceding question except that the worker is paid by the Bedaux plan. The task is assigned 48 "B's." Indicate the base pay and the premium in "B's" and the total pay for the task. All of the "B's" saved are paid to the worker.
4. Determine the pay of worker Joseph Ring under the following conditions. He is a member of a group of workers who are paid on the group piece-rate plan with a guaranteed base rate for each worker. The piece rate is 8 cents, and Ring's base wage is $5.00 per day. Over a 10-day period the production is 6,000 pieces. The base pay of all workers in the group during that period is $400.
5. "Piece rates increase the responsibility of the management for providing standard conditions of work." Explain why this is true.
6. The foreman has been described as "the man who is caught in the middle" by the piece-rate system because he feels pressure from both the workers and his own boss in case worker earnings are unsatisfactory. Why should this be the case?
7. Should the union concern itself with the inefficiencies of management which prevent workers from making satisfactory earnings at piece rates? Do wages depend upon the efficiency of management?

8. Should management change the piece rate when minor changes in the work enable the worker to increase output? For example, would it be good policy to reduce the rate from 9 cents per piece to 8.8 cents in order that daily earnings may remain the same as before?
9. What are the principles underlying all incentive methods of wage payment?
10. A worker who is paid according to the Gantt plan with a 25 per cent bonus is guaranteed a $1.00 hourly wage. Determine his pay for a 4-hour task completed in the following time periods: 4.5 hours, 4 hours, 3.8 hours, and 3.7 hours.
11. Why are good management conditions more essential to the success of efficiency wage plans than for such plans as the Halsey and the Rowan?
12. Does scientific management require greater concentration and sustained effort on the part of the worker, or is the increase in production the result of motion study and improved working conditions?
13. How is the total amount for distribution to all employees determined under a profit-sharing plan? How is the amount to be paid any one employee determined?
14. What is the advantage of making profit-sharing payments on a monthly basis? What is the disadvantage of this plan?
15. A chain of ready-to-wear stores is formulating a profit-sharing plan. Should the payments to employees be a share of the profits of the entire company or a share of the profits of the store where each worker is employed? Why?
16. What is the advantage to the employer of paying a Christmas bonus? Do workers like gratuities, or would they prefer a higher daily wage?

CASES

48. EFFICIENCY PAYMENT BY THE EMERSON PLAN

The hourly rates, the hours worked, and the standard time on tasks completed by four workers were as follows:

Name	Hourly Rate	Hours Worked	Standard Time on Tasks Completed
Frank Rice	$1.00	80	70
Howard Gammon	0.90	75	60
John Smith	1.10	75	80
Walter Ringo	1.00	60	40

Selected bonus percentages are as follows:

Percentage Efficiency	*Bonus Percentage*	*Percentage Efficiency*	*Bonus Percentage*
67	0.01	81	3.78
75	1.31	87	7.54
80	3.27	100	20.00

For each 1 per cent increase in efficiency above 100, increase the bonus percentage by 1.

Required:

1. Compute the efficiency of the four workers to the nearest whole percentage.
2. Compute the base pay and the bonus of each worker.

49. PROFIT SHARING BY FORMULA

The profit-sharing agreement of the Daisy Manufacturing Company provides that 30 per cent of the net profits before taxes will be paid to a trust company for the benefit of employees. The trust company distributes one half of the payment to employees and holds the remainder in a retirement fund for their benefit. Distributions of profits are made annually.

The amount paid to any employee is determined by the number of hours worked. To share in the distribution, the employee must be on the payroll at the end of the year. The total amount to be distributed is divided by the number of hours worked by all employees entitled to share in the distribution to determine the profit distribution per hour. Hours worked by any employee multiplied by the profit distribution per hour equals the payment to be made to him. An amount equal to the cash distribution is credited to each employee as his equity in the retirement fund. Retirement fund equities cannot be withdrawn by the employee but must be used for the purchase of an annuity. In case of death the equity of the employee is payable to beneficiaries.

Questions

1. What is the merit of the plan of the Daisy Manufacturing Company?
2. What are the limitations of the plan from the point of view of the company?

50. PROFIT SHARING WITHOUT FORMULA

The Ramsay Corporation shares its profits with its employees each year but has no formula for determining the amount. Each year the board of directors pays dividends to the stockholders and also a "dividend on wages" at such rates as seem fair to the directors. If dividends to the stockholders are reduced or passed in any year, the stockholders are considered to be entitled to extra dividends in the next year before profit distributions are made to employees. If the money of stockholders has been used for risky ventures in any year, they may receive extra dividends as compensation in case the ventures are successful. If the board of directors believes that earnings have been increased because of plant operating efficiency, profit distributions to employees may be increased without any increase in dividends paid to stockholders.

Each year the company holds a meeting of jobholders just as it holds a meeting of stockholders. At the annual meetings, as well as in the communications during the year, the plan and the profit position of the company are explained. The company considers that the plan is a success and that employees believe the management to be fair with them.

Questions:

1. What is the merit of the plan of the Ramsay Corporation?
2. What are the limitations of the plan?

CHAPTER XXIV

JOB EVALUATION

JOB EVALUATION is a significant management technique in the field of industrial relations. Its essential purpose is to reduce or eliminate differentials in pay which are not due to differences in the job. Its basic principle is that an employee who works at a difficult, hazardous, dirty, or lifting task should be paid more than an employee who works at an easy job in safe, pleasant surroundings and that the pay should be determined by the various requirements of the job.

The pay for any job is high or low only by comparison with the pay of other jobs or in comparison with some factor in the work situation. Consequently, when a worker says that he is not paid enough, he may mean that the correct differential has not been maintained between his wages and the pay of other employees in the company or between his pay and that of persons doing similar work in another plant in the community. A system of wage payment which aids in the establishing of fair differentials between jobs should avoid underpayment for some jobs and overpayment for others. It should grant increases in the wages for advancement to jobs that have been given a higher rating under the plan. It should also provide an incentive for employees to prepare themselves for more difficult jobs because a logical wage scale has been established. Because it reduces complaints of discrimination in wages, employee satisfaction should be increased; and labor turnover may be decreased. The plan should reduce the opportunities for favoritism on the part of foremen in recommending wage increases.

Information Concerning Jobs. Before the jobs are evaluated, much detailed information should be compiled. The first step should be a definition of a job. A job may be defined as a group of positions which are identical with respect to their major or significant tasks. This definition permits the inclusion of positions with minor difference under

the same job title and reduces the number of jobs to be evaluated. The tasks of workers at various workplaces may be regarded as a single job even though their work is not exactly the same. For example, several workers on an assembly line may be regarded as assemblers even though they occupy different positions on the line. In one company, 1,800 workers were employed on one evaluated job.[1] The usual number would be much less.

The collecting of information relating to a job would include the following:

Job Analysis. This is the process of studying operations, duties, and organizational aspects of jobs.

Job Description. This is a detailed statement of the work done, including all tasks which are done and the conditions under which they are done. It usually follows a prescribed form in order that all essential information may be included. It shows for each job such information as the following:

The title of the job.
The department in which the work is done.
A complete statement of the various duties performed, and the percentage of the time of the employee devoted to each type of work.
The number of men supervised by the worker and the extent of the supervision.
The amount of the supervision received and the nature of the supervision.
Equipment used on the job and its value.
The relation of the job to subsequent operations.
The material used and its value.
Reports and records prepared by the worker.
The promotion opportunities of the job.
Initiative and ingenuity required, variety of situations encountered on the job.
Personal qualifications of worker, such as sex, age, or other qualifications.
Effort, such as stooping, standing, pulling, lifting, pushing, or sitting.
Mental requirements, such as ability to read and write, add and subtract, read blueprints, or use a slide rule.
Physical requirements, such as hearing, sight, strength, and right-handedness.
Length of time required to learn the job.
Experience needed.
Accident hazards which might result in injury to self or fellow workers.

The job description should be prepared in specific rather than general terms and should indicate precisely what is done, how it is done, why it is done, and under what conditions it is done.

[1] R. C. Smith and M. J. Murphy, *Job Evaluation and Employee Rating* (New York: McGraw-Hill Book Co., 1946), p. 73.

Job Specifications. This is a written description of the job in relation to the worker. It shows the abilities and the qualifications that a person should possess in order to hold the job. Job specification has been called a "man specification" because it relates the occupant to the job.

The compiling of job information should precede job evaluation because the persons evaluating the jobs should first agree on the requirements and conditions of work. Unless job descriptions are prepared, various members of the committee will have varying concepts of the meaning of such terms as toolmaker, crib tender, or lacquer sprayer.

Four methods of job evaluation may be distinguished. They are job ranking, job classification, factor comparison, and the point system. The point system is the method most commonly used.

Job Ranking. Job evaluation by the ranking method means, as the name indicates, the arranging of the various jobs in the order of their difficulty, responsibility, and other requirements. Each member of the job-evaluation committee independently ranks the jobs from the highest to the lowest. The usual procedure is to begin by identifying the highest and the lowest jobs and gradually to work toward the jobs in the middle. The ranks assigned by different members of the committee are compared, possibly revised, and averaged to determine the final rank of each job. A partial job ranking might be as follows:

1. Toolmaker, first class.
2. Toolmaker, second class.
3. Electrician, first class.
4. Machinist, first class.
5. Plumber and steam fitter, first class.
6. Lathe operator, first class, intricate.
7. Milling machine operator, first class, complicated.
8. Milling machine operator, ordinary
9. Bench assembler, first class.
10. Bench assembler, second class.
11. Watchman.
12. Gateman.
13. Inside laborer.
14. Sweeper.

Although the job-ranking method is the simplest of the methods of job evaluation, it is subject to several serious objections. Because each rater must be familiar with all of the jobs to be rated, it is difficult to find qualified raters. Since the method does not provide a definite basis for the ratings, the rankings are likely to be made on the basis

of prevailing wage rates for the various jobs. The assignments of rankings are difficult to justify in case workers or union officials challenge the pay rate for any job. The rankings do not indicate the differences or the amount of spread between the pay of the various jobs. For these reasons the job-ranking method is usually regarded as unsatisfactory.

Job Classification. This method consists, first, of setting up various classes of jobs according to the duties, responsibilities, and experience required by the work and, second, of assigning each job to a class. The method has had more general use in the evaluation of clerical and office jobs than of factory jobs. A well-known plan provides for six classes of jobs, as follows.

CLASS	DESCRIPTION
1	Work of office- or messenger-boy character.
2	Simple operations. Use of few definite rules. Routine operations performed under close supervision.
3	Requires recognized clerical ability.
4	Requires complete and intensive knowledge of a restricted field.
5	Requires knowledge of general policies and principles of management. May require long experience with the company.
6	Work of a highly technical or confidential nature or of semiexecutive supervisory character.[2]

After the classes have been established, the committee which is responsible for job evaluation will assign each job to a class. If a more definite differentiation between jobs is desired, the jobs within each class may be ranked. This procedure is an improvement over either the ranking or the classification method used independently, but it is subject to most of the limitations of the job-ranking method.

Factor Comparison. This method evaluates all jobs in terms of a rating scale based upon fifteen to twenty-five key jobs. The relative rank of the various jobs is determined in relation to a monetary scale. The procedure includes the following five steps:

1. The factors to be used in the rating plan are determined, such as mental requirements, physical requirements and skill.

2. The key jobs are selected. Key jobs are jobs whose pay is believed to be fair in relation to the requirements of each job.

3. The key jobs are ranked under each of the factors. For example, the job which has the greatest mental requirements is ranked No. 1

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[2] Adapted from War Manpower Commission, *Industrial Job Evaluation* (Washington D.C.: U.S. Government Printing Office, 1943), p. 23.

under that factor. The same job might rank as No. 7 under physical requirements, with other rankings under each of the other factors.

4. The total payment for any job at existing rates is apportioned to the various factors in accordance with the ranking of each job under that factor. To illustrate, if a patternmaker is paid $1.38 an hour, a painter 90 cents and hour, and a drill press operator 75 cents an hour, the payment might be attributed to the job factors in the manner illustrated:[3]

Factor	Patternmaker	Painter	Drill Press Operator
Mental requirements	$0.40	$0.15	$0.13
Physical requirements	0.15	0.16	0.12
Skill	0.50	0.28	0.21
Responsibility	0.24	0.16	0.17
Working conditions	0.09	0.15	0.12
Total pay, present rates	$1.38	$0.90	$0.75

If a key job is found to be improperly paid for any factor or for total requirements in relation to other jobs, it is dropped from the list of key jobs, and another job is substituted.

5. Other jobs are evaluated in relation to the key jobs. The job of machinist, first class, for example, would have mental requirements only slightly below that of patternmaker and might be assigned 35 cents for that factor. Physical requirements might be somewhat greater and might justify pay of 18 cents. Skill required of the machinist might be less and might justify payment of 48 cents for that factor. This process is continued until the total hourly wage of each job is determined. Each factor for each job is compared with the same factor and the pay for all other jobs, but the total pay for each job is computed for that job. Although the total pay for key jobs agrees with existing wage rates for the key jobs, it does not necessarily agree in the case of other jobs.

While the factor-comparison method results in more equitable rates for various jobs than ordinary methods of rate setting do, it is subject to some objections. It begins with the assumption that selected key jobs are properly paid in relation to each other. The fact that the rating is stated in monetary terms is objectionable because of a change in the prevailing level of wages requires a change in all the rating tables. However, the method has been successfully used by many companies.

[3] *Ibid.*, p. 27.

Point System. In the point system a number of factors which are common to all jobs are used as a basis for evaluation. The factors are weighted according to their importance. The number of factors used in any plan varies from 4 to 40. The usual number is 10 to 12.[4] The factors most frequently used are experience, education, skill, physical effort, working conditions, responsibilities for material and equipment, and hazards of the job. The weights assigned to all factors may total 1,000 points, or the total may be as low as 100. The total points should be a large number if many jobs are to be evaluated, but it is not necessary that the total be a round number, such as 500 or 1,000.

Each factor is divided into degrees or grades. The meaning of the factor and also of each degree is carefully defined. For example, educational requirements might be divided into five degrees, with requirements as follows: lowest degree, ability to read and write; second degree, grade-school education; third degree, technical-school education; fourth degree, high-school education; and fifth degree, college or special.

If educational requirements are weighted 50 points, the various degrees would be evaluated with a spread of 10 points from one degree to the next. Intermediate degrees of value are recognized in the evaluation. The number of degrees in various plans ranges from four to seven. Some authorities recommend an even number to avoid the tendency of some raters to assign the middle rating when they are not thoroughly familiar with a job or are unable to form a definite opinion. The number of factors, the weights assigned, and the number of degrees vary with the company and the requirements of the jobs.

Figure 42 shows a job-evaluation plan with six factors and five degrees for each factor. The differences between the degrees and the points assigned are indicated in the table. An instruction manual for use by raters should be prepared to give a detailed description of the plan, the factors, and the degrees. The maximum points in the illustration total 400. However, it is not to be expected that any job would receive the maximum evaluation on all six factors.

Before the evaluation plan is considered complete, a few jobs should be evaluated by a rating committee composed of experienced executives of the company. The original plan may be revised as a result of experience in rating the first jobs. After the point values of the first jobs have been determined, the title of each job evaluated should be entered in the rating manual as an illustration of the degree

[4] Smyth and Murphy, *op. cit.*, *p.* 33.

FACTORS	1	2	3	4	5
EDUCATION REQUIRED	READ AND WRITE 10	GRADE SCHOOL 20	TECHNICAL SCHOOL 30	HIGH SCHOOL 40	COLLEGE OR SPECIAL 50
EXPERIENCE REQUIRED	0 TO 3 MONTHS 15	3 TO 6 MONTHS 30	6 TO 9 MONTHS 45	9 TO 12 MONTHS 60	OVER 12 MONTHS 75
MENTAL EFFORT	SLIGHT 10	BELOW AVERAGE 20	AVERAGE 30	HIGH 40	VERY HIGH 50
PHYSICAL EFFORT	VERY LIGHT 20	MODERATE 40	AVERAGE 60	ACTIVE 80	STRENUOUS 100
WORKING CONDITIONS	NO UNDESIRABLE CONDITIONS 10	SOMETIMES UNDESIRABLE 20	ONE OR MORE UNDESIRABLE CONDITIONS 30	CONTINUOUS EXPOSURE 40	CONTINUOUS AND EXTENSIVE EXPOSURE 50
RESPONSIBILITY FOR MATERIALS AND EQUIPMENT	LESS THAN $1,000 15	$1,000 TO $10,000 30	$10,000 TO $25,000 45	$25,000 TO $50,000 60	OVER $50,000 75

FIG. 42. Job Evaluation by the Point System

requirement. For example, if the job of tool setup man is rated as fifth degree under the factor of experience required for the job, the title of that job should be used as an illustration for the guidance of subsequent raters.

The evaluation of six representative jobs is illustrated in the chart shown in Figure 43. The factors used in the evaluation and the weights assigned to each factor are indicated in the scale of values at the right in the illustration. The total value of all factors is 1,000 points, and the highest rated job is assigned 645 points. The high evaluation of the job of tool setup man is due principally to the mental development, skill, accuracy, experience, and mental effort required.

The evaluation will usually result in a wide range of point values for the various jobs. To avoid the confusion which would result from having a different pay scale for each point value, a limited number of labor grades should be established. The method is similar to the system of grading used in many schools where all students making numerical marks within a certain range are given a letter grade of A, B, C, D, or F. For example, 10 labor grades might be established with definite point values within each grade. Grade 10 might include all jobs with point values of 175 or less. Grade 9 might include jobs with

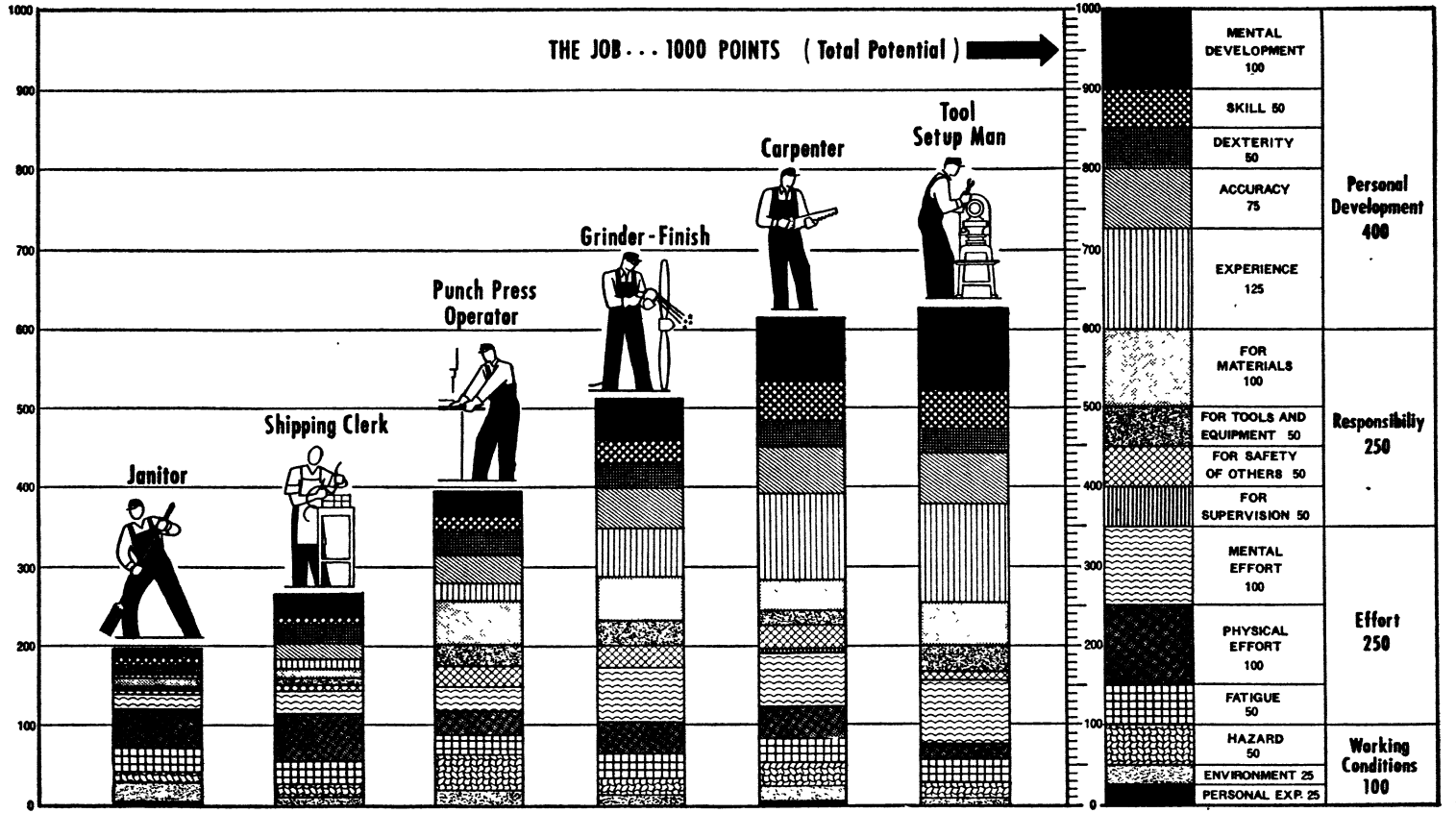


FIG. 43. Illustrative Job Evaluations

point values from 176 to 185.[5] The number of points included within a grade usually increases with the higher grades. The limits depend upon the jobs to be graded.

In the discussion of the point system up to this time, the question of pay for the job has not been considered. Because of the fact that wage rates have often been a haphazard process, the pay for many jobs will be found to be out of line with the points assigned under the job-evaluation program. This fact can be graphically demonstrated by the preparation of a chart which shows the existing pay rate for various jobs and the points assigned to each job. Such a chart is shown in Figure 44.

Usually, the pay rates for the various classes of jobs are determined after a survey has been made of comparable jobs in the same industrial area. In making the survey, the job-evaluation committee submits job descriptions for a limited number of jobs to selected companies and requests information as to wages paid for similar jobs by the other employers. A visit is made to the plant of each company to which such an inquiry is sent to determine the requirements of the jobs and to establish the fact that the job requirements are similar. The committee must inquire into any supplementary pay for each job, such as bonuses, overtime pay, paid vacation, paid group insurance, pension or retirement plans, and other financial aids.[6] Because an increasing number of companies are interested in labor market surveys,

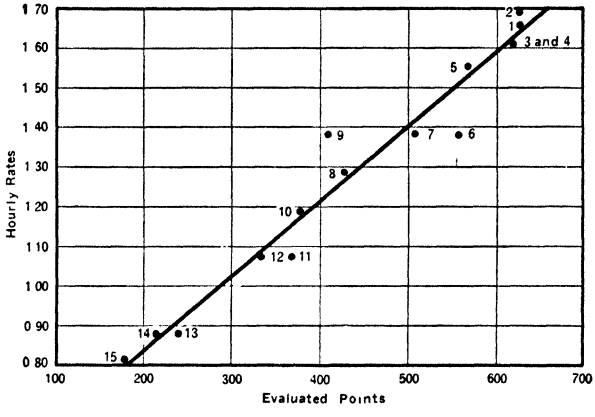


FIG. 44. Method of Showing Relation of Prevailing Wage Rates and Job-Evaluation Points

From this chart, management can easily see which jobs are out of line. Key: 1—machinist, first class; 2—tool setup man; 3—welder; 4—carpenter; 5—engine lathe operator; 6—assembler, gang leader; 7—grinder, finish; 8—drill press operator; 9—truck driver; 10—milling machine operator; 11—punch press operator; 12—turret lathe operator; 13—shipping clerk; 14—unskilled labor; 15—janitor.

[5] For example, see Edward Lender, "Rating Maintenance Jobs," *Factory Management and Maintenance*, Vol. CIII, No. 5 (1945), pp. 137–41.

[6] See Samuel L. H. Burk, *Translating Ratings into Rates in Putting Job Rating to Work* (New York: American Management Association, 1941).

the information is sometimes tabulated and made available to the co-operating companies. The rates established for the various grades, which are based upon the results of the survey, may be at, below, or above the rates paid by other companies. For example, an employer who guarantees a yearly wage or who guarantees a stated number of weeks of work each year might pay rates which are somewhat below the community level.

Another problem which must be decided in establishing rates of pay for the labor grades is whether to establish one or several rates of pay for each grade. One of three policies may be followed:

1. A single rate may be established for each grade. All jobs within the grade are paid the same rate regardless of their point values or the rating of the employees on the jobs.

2. A maximum and a minimum rate may be established for each grade. The minimum rate is the starting rate. The pay of an employee is established by periodical rating of the qualifications and accomplishments of each employee.

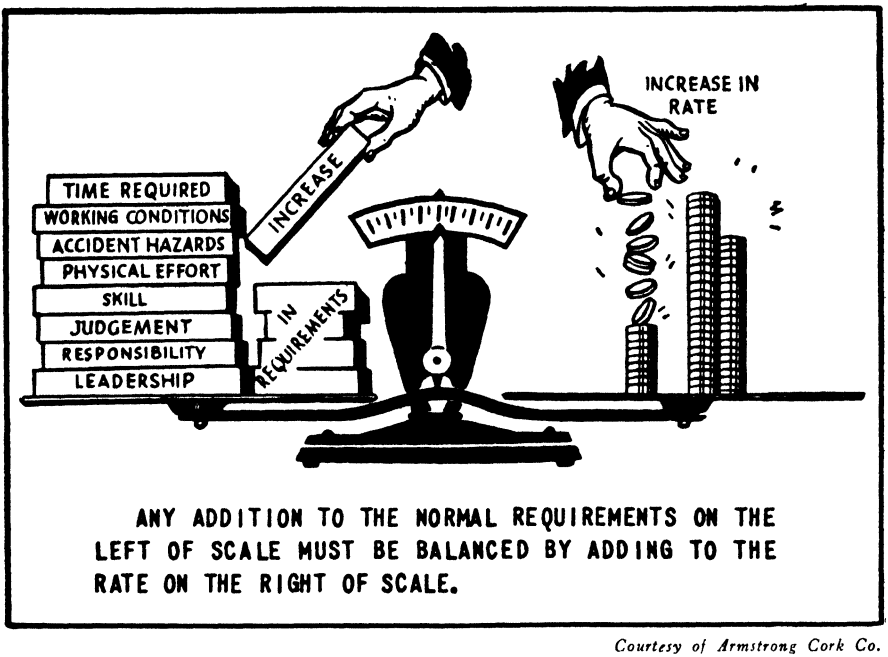
3. A maximum and a minimum rate may be established. The pay of an employee on the job is advanced to the mid-point of the scale by reason of seniority, with advances at predetermined intervals. Advances beyond the mid-point are based upon merit.

When the evaluation of a job indicates a wage rate which is higher than the existing rate, the wages should be advanced in accordance with the evaluation. If the existing rate is higher than the rate called for by the plan, the problem is more difficult because it is usually unwise to reduce the pay of an employee as a result of the evaluation of his job. One solution is to train the employee for a higher rated job and to transfer him to it without loss of pay. The job made vacant by the transfer is filled by transferring a worker from a job with a lower rating. Another way out of the difficulty is to pay present employees the existing rates and, as vacancies occur, to employ persons at the lower rates.

The part which the labor union plays in the job-evaluation plan varies with the company and the union. In some cases a union representative participates in the making of the job descriptions and also in the evaluation. Many unions prefer not to participate because they wish to be free to criticize and to ask for revisions in case the plan works inequities. A union official who has participated in the program and has agreed to the evaluation of a job cannot easily take the part of a member who claims discrimination. Instead, the union official may be required to take the side of the company and to defend the evalua-

tion. In any event, the union should be informed when the program is initiated and should be consulted as the plans are formulated.

Disseminating Information as to the Plan. If the union has participated in the formulation of the job-evaluation plan, the task of informing employees of its purpose and its application is made much easier than would otherwise be the case. Employees may be informed through the plant periodical, the local newspapers, group meetings, the bulletin board, and booklets or leaflets. Appeal is made to the



Courtesy of Armstrong Cork Co.

FIG. 45. Drawing Used to Explain Job-Evaluation Plan

This drawing was used in a pamphlet on the job-evaluation plan which was prepared for distribution to employees.

sense of fairness of employees, who will readily agree that rates of pay should not be the same for all jobs. While the factors and the weights assigned may be subject to differences of opinion, the policy of increasing the pay as job requirements increase will usually be accepted without question. An illustration of the method of explaining the job-evaluation plan is shown in Figure 45.

When the evaluation plan is explained to employees, they should be told not to expect that the plan will cure all the ills in the rate structure. They should also be told that, while no one will receive a pay cut, some will not receive pay raises. Attention should be centered upon the fact that the plan is designed to fix compensation by a uni-

form measurement of jobs rather than by individual bargaining and secret dealing.

To obtain the support of foremen, several advantages of job evaluation may be pointed out. The plan should reduce the amount of dissension and criticism. False accusations of discrimination can no longer be made. The program does not strip foremen of their authority but helps them to evaluate and measure jobs.[7]

Maintaining the Plan. The job evaluations will ultimately become obsolete unless they are revised. New jobs will be added, and existing jobs will be changed. Points assigned to a job may be challenged by the union and by workers. Such jobs must be restudied and reclassified, if necessary. Requests for re-evaluation of a job may come from foremen, time-study men, or other persons.

Limitations of Job Evaluation. While the technique of job evaluation is vastly better than haphazard opinion, it is not to be inferred that it is perfect. Job evaluation is not scientific in the sense that it is exact. Opinion enters into the selection of factors, the assignment of weights, and other phases of the program. As one observer comments:

> The interpretation of the judgments is likely to be that they are "right" in so far as they conform to the sentiments of persons making the judgment, and "wrong" in so far as they fail to do so. There is no conceivable procedure for determining the share of any individual or group of individuals in the total value of the product or services produced by a company, without sooner or later resorting to nonscientific judgments of differential worth or merit.[8]

This criticism is not to be taken as invalidating or weakening the advantages of the technique of job evaluation. It indicates that too much should not be claimed for it.

QUESTIONS

1. What might a worker mean when he says that he is not paid enough? How does job evaluation attempt to deal with such complaints?
2. What is the weakness of the job-ranking method of job evaluation? Under what conditions is it a practical plan?
3. What is the advantage of the job-classification method?
4. A widely used job-evaluation plan by the point method lists 11 factors, with total points of 500. Three of the factors, namely, education, experience, and initiative and ingenuity required, are weighted a total of 250.

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[7] P. W. Jones, "Salesmanship in Job Evaluation," in *Development in Wage Payment Techniques* (New York: American Management Association, 1944).

[8] Wilbert E. Moore, *Industrial Relations and the Social Order* (New York: Macmillan Co., 1946), p. 186.

How can such a preponderance of points for the 3 factors relating to skill be justified, since very low point values are assigned such factors as working conditions, unavoidable hazards, and physical demands of the job?

5. A job-evaluation plan lists seven factors and describes the degrees of each factor as follows: highest, high, average, low, and very low. Is this description of factors satisfactory?
6. Who should compose the committee for job evaluation? May the membership of the committee be changed for rating the jobs in various departments?
7. Should the plan for job evaluation be discussed with representatives of the union or unions? Should a union representative assist in evaluating the jobs? Why?
8. Why are labor grades desirable? Would it be desirable to establish a different rate of pay for every evaluated job with a different point valuation?
9. Why is a community survey desirable in the establishment of the pay scales? What difficulties may be encountered in making such a survey?
10. What incidental pay to the worker, in addition to the base pay for the job, should be investigated as a part of the community survey?
11. Are the rates paid for similar jobs by other employers, as disclosed by the community survey, invariably to be used in setting rates? May average community rates be illogical and inequitable, as a result of pressures, favoritism, secret dealings with employees, and other such causes?
12. Does the employer have a free hand in correcting injustices and inequities in his wage structure, or is he required to fix wages for various jobs by bargaining with unions?
13. What can an employer do about jobs found to be paid a higher rate than the job evaluation justifies?
14. Does job evaluation result in an exact measurement of the job factors? In what respect is the money rate fixed by job evaluation a fair rate?

CASE

51. LAUNCHING A JOB-EVALUATION PLAN

The Brinkley Spring and Wire Company has had considerable difficulty over requests of employees for wage increases. An argument frequently made by employees was that their wages were not sufficiently higher than wages paid certain other employees whose jobs required less skill and experience, permitted them to work in more pleasant and desirable working conditions, or made less physical and mental demands. The plant superintendent, the foreman, and the personnel director, in conference with the worker and the shop steward, frequently found themselves unable to explain differentials in pay. After dealing with a number of such cases, they decided that wage differentials were largely the result of bargaining with employees and union officers and that a general revision was needed. The president authorized that a job-evaluation program be undertaken for the jobs of the 750 employees. The plan selected was a widely used point system which had been especially developed for the metal trades.

As the personnel manager did not feel qualified to supervise the program, the company employed a job analyst who had recently organized the program of another company. Since the job analyst was not familiar with jobs in the Brinkley Spring and Wire Company, he requested that two men be selected from the plant to work with him. They would be able to continue the program after the job analyst had completed his work if the management found this arrangement to be desirable. One of the men selected to assist the analyst was a former time-study man and the other was a cost estimator. These men were selected on recommendation of their supervisors, who rated them high on analytical ability, ability to express themselves, ability to handle people, and enthusiasm for their work.

The plant superintendent informed the foremen and other people in management of the nature and purpose of the program. After the analyst was employed, he attended the regular meetings of the supervisors and explained to them what the plan would be and how they would be affected by it. He emphasized the fact that they would be able to discuss intelligently with employees any complaints concerning wages. No wages would be reduced as long as an employee now holding a job remained on it. Ultimately, the hope was that a rational wage structure could be achieved. The program was also explained to union officers and employees.

Before undertaking to evaluate any job, the analyst spent two days with his assistants discussing the theory of job evaluation and the procedure to be followed. The assistants were then asked to write descriptions of jobs with which they were familiar. They were told to include all data that would be used in assigning points to jobs in the evaluation plan. The writing of the descriptions and the discussion of the jobs by the analyst and his assistants extended over two days more.

The next step was the making of a job evaluation by the analyst with the aid of the foreman of the department. For the first study the analyst chose the job of drill press operator, with which he was thoroughly familiar. The assistants observed the methods. On the next job the analyst and the assistants made the ratings, and the three evaluations were then compared. This method was continued for two days, during which time five jobs were rated. Then the analyst watched while the assistants made evaluations of other jobs. The training of the assistants extended over a total of fifteen days.

The work of evaluating the various jobs continued under the supervision of the analyst, who checked the job descriptions, the degrees of each factor, and the points assigned. The assistants obtained their information concerning each job from the foreman, the worker, and their own personal observation. They discussed each rating and the point values with the foreman and explained the reason for the ratings assigned. Foremen were given the opportunity to object to any rating. Workers were not told what the point values of their jobs were because no wage rates were assigned and no wage scale had yet been made.

The study of the jobs by the analyst and his two assistants continued over a period of five months. At the end of that time the management agreed upon a wage scale in money to be assigned to the jobs. This wage scale required a few wage increases. The new scale was explained in a general meeting of employees, and a booklet describing the plan and its results was distributed. Each foreman

was given information concerning the results of the evaluation of all jobs in his department. He personally explained to each employee how his job had been evaluated and how his job fitted into the new wage scale. In accordance with the original plan the company granted a wage increase where the point value of the job indicated that the worker was entitled to an increase. No wages were decreased.

After the analyst left the company, one of the assistants continued the program by investigating requests for the revision of point values assigned to jobs and studying new jobs as they were created. His work gradually decreased as the number of complaints became less. However, the management believed that he should be retained indefinitely in the personnel department.

Questions:

1. Why did the company find a program of job evaluation necessary?
2. What might it hope to gain by such a program?
3. How would the average wages paid be affected?
4. Do you approve of the procedure followed?

CHAPTER XXV

MERIT RATING

MERIT rating, or employee rating, is a management technique for estimating the worth of an individual to the organization of which he is a member. It is a plan for forming comparable judgments of the various capacities of different individuals who contribute to the success of an enterprise. It is designed to focus the attention of both the foreman and the worker upon specific traits which are significant in the work situation and to eliminate the irrelevant traits and qualities. Most merit-rating programs result in the statement of employee qualities in statistical quantities for present use and as a permanent record.

Merit rating is designed to replace haphazard and unsystematic estimates of the worth of an employee by a consistent and systematic method. An employer who does not have a formal plan for reviewing the efficiency and the progress of his employees does in fact rate them when he gives one person a wage or salary increase or a promotion instead of another or changes their relative standing in any other manner. Merit rating is a method of following a definite and consistent plan in making all such changes and of informing all interested persons in advance of the method by which the plan operates.

Purposes of Merit Rating. The purposes of merit rating vary with the company, the nature of the work, and the method of wage payment. The usual purposes are as follows:

Granting Wage Increases. When employees are paid by the hour, the wage depends largely upon the evaluation of the job and the rating of the employee. The job-evaluation program may establish a minimum and a maximum wage for the job, and the rate of advancement within the range for the job may depend upon the worth of the employee as established by periodical rating. This plan is especially desirable when the quantity or quality of work is not easily determined. Many staff and office positions are of this kind.

Merit rating may be used in granting wage increases when employees are on piece rates or bonus methods of wage payment, but its value in such wage determinations is limited. Merit rating of employees on piece rates usually has some other purpose.

Guidance of Employees. Merit rating sets up definite traits or qualities by which employees are to be judged. Each person who is rated can see for himself the traits which are considered important, the traits on which he is deficient, and the respects in which his work can be improved. Counselors and the foreman know better how to advise employees who are willing to work for advancement. Counseling which is based upon merit ratings is effective because it is constructive rather than critical. The counselor may begin by pointing out the traits on which the employee has improved or has received a satisfactory rating. When this procedure is followed, the criticism is likely to be accepted in the right spirit.

Promoting Employees. The merit-rating plan directs attention to the qualities of an employee which may indicate that a promotion is merited. The employees who are best qualified for promotion are more likely to be selected if foremen have given specific and periodic attention to various phases of employee performance. However, the number of qualities on which an employee is rated is usually limited; and promotion is not based solely upon the assigned ratings. Other factors in promotion are education, prior experience, physical condition, and executive ability.

Transferring Employees. The rating of employees on merit will disclose that some of them possess qualities which are not fully utilized in their present positions. Such employees may be transferred to other departments where their capacities are needed and the opportunities are greater. Some employees who receive low ratings may be able to improve if transferred to another job or department.

Training Employees. The rating plan may reveal areas where training is needed, such as job knowledge, observance of safety regulations, and attitude toward the company.

Improvement in Job Performance. The qualities which are rated are those which are regarded by the company as important and are usually directly related to production. The effort by employees to improve their rating should be reflected in an increase in the rate of production.

Many types of rating plans have been developed. They may be grouped into four classes: man-to-man rating, factor rating, graphic rating, and point systems.

Man-to-Man Rating Plans. The rating of persons in comparison with other members of the group was used in the United States Army during World War I for the rating of officers at each army camp and for the rating of candidates for commissions. Each person was rated on five qualities. These qualities, with the weights assigned, were as follows.

1. Physical qualities	15
2. Intelligence	15
3. Leadership	15
4. Personal qualities	15
5. General value to the service	40
Total	100

The instructions to the rating officer described each trait or quality. As to the method of rating, the instructions for rating on physical qualities, in part, were:

> Arrange the names on slips of paper in order from highest to lowest on the basis of physical qualities of the men. Select that officer who surpasses all others in this qualification and enter his name on the line marked Highest under physical qualities. Then select the one who most conspicuously lacks these qualities and enter his name on the line marked Lowest. Select the officer who seems about halfway between the two previously selected and who represents about the general average in physical qualities; enter his name on the line marked Middle. Select the officer who is halfway between middle and lowest; enter his name on the line marked Low.

A similar procedure was followed in selecting a person at each level of the scale for each other trait. Other officers were then graded by comparison with those whose names had been listed as the standard. Point values were assigned for the first four qualities in this manner: Highest, 15; High, 12; Middle, 9; Low, 6; and Lowest, 3. Point values for "General Value to the Service" were: Highest, 40; High, 32; Middle, 24; Low, 16; and Lowest, 8.

A man-to-man rating sheet for industrial employees is shown in Figure 46. Six traits are used. The traits and the weights are:

1. Quality of work	20
2. Quantity of work	30
3. Job knowledge	20
4. Dependability	10
5. Adaptability	10
6. Attitude toward company	10
Total	100

The instructions accompanying the rating sheet should describe the traits and the method of rating the employees.

The man-to-man rating sheet has several weaknesses. In practice, raters often attempt a short cut by rating each man directly without first selecting a typical man at each level for purposes of comparison. Even though such a master scale is first set up, it is difficult to compare the individuals to be rated with the persons who set the standard.

Employee _____ Clock No._____

Foreman _____ Dept._____ Date._____

Trait	Lowest	Low	Middle	High	Highest
1 Quality of Work	4	8	12	16	20
2 Quantity	6	12	18	24	30
3 Job Knowledge	4	8	12	16	20
4 Dependability	2	4	6	8	10
5 Adaptability	2	4	6	8	10
6 Attitude Toward Company	2	4	6	8	10

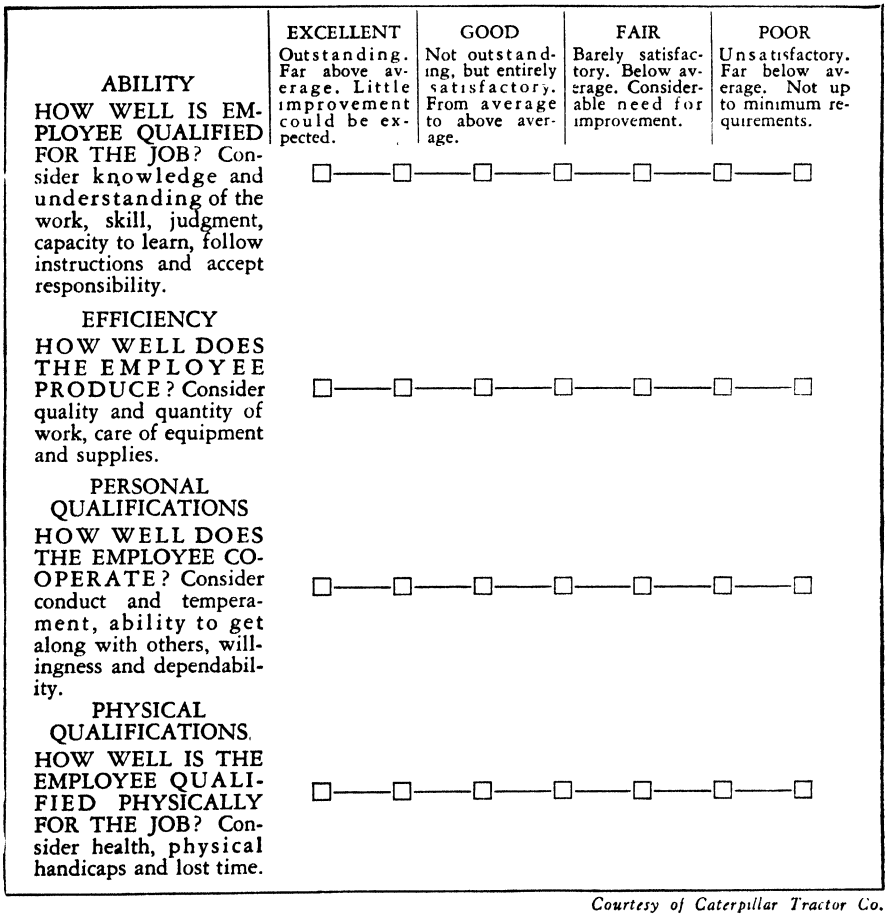
FIG. 46. Man-to-Man Rating Sheet

A further difficulty is that man-to-man comparisons are affected by the amount of preselection. In an organization in which the employment procedures are good, for example, the person ranked lowest would not be comparable with a person receiving a similar rank in an organization where the employees were not screened in the same manner. The result of a training program would not be reflected in the merit ratings if the level of performance of an entire group was raised. It would be reflected in the ratings only in case it reached a limited number of persons.

Plans Which Rate Individual Factors. Each employee may be rated on separate traits without reference to the rating of other persons. Weights are not assigned to the traits, and no total rating is made. A rating sheet of this kind is shown in Figure 47. Four traits are included in the plan, and four degrees of each trait are recognized. The traits and also the degrees are carefully defined. Seven ratings for

each trait are provided because of the recognition of positions midway between the degrees.

This rating scale has the advantage of simplicity, since it includes few traits and no arbitrary weighting is attempted. The traits do not include quantity of production, quality of work, accidents, regularity



Courtesy of Caterpillar Tractor Co.

FIG. 47. Rating of Separate Factors

of attendance, and other factors which can be measured statistically. Information of this type would be used to supplement the rating scale.

Graphic Rating Scale. The graphic rating plan permits as many evaluations for each trait as there are points on the scale. Each trait is represented by a line, and the rater puts a check mark ($\surd$) at the point which indicates the proper rating of the individual on that trait. The method is illustrated in Figure 48. It will be observed that this rating plan provides a sentence describing the work of the person

being rated at each degree of the trait. As to quality of work, for example, the statements are:

His work is carelessly done.	His work is usually good.
His work is passable.	His work is excellent.

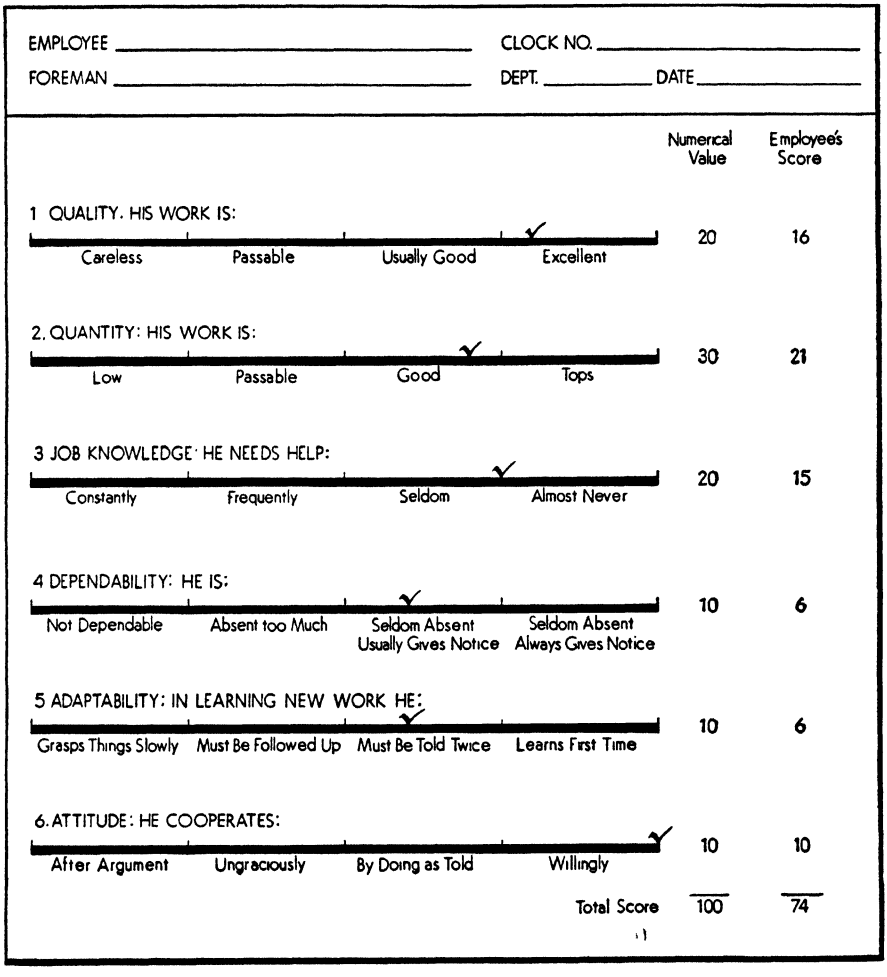


FIG. 48. Graphic Rating Sheet

The assignment of weights is not essential to the graphic rating plan, but that feature may be included. Weights are usually assigned if a totaling rating is desired for purposes of wage increases or promotion. In Figure 48, weights are assigned. Although only four degrees are marked on the scale, the check mark may be placed at any point, and any evalution is thereby made possible.

Point Systems. A well-developed plan of merit rating is illustrated

by the rating sheet for supervisors, which is shown in Figure 49. The sheet provides for the rating of each supervisor on 10 traits. As each quality is weighted 10 points, the total maximum value for all traits is 100. The characteristics are described but not named. This feature requires the rater to read the description of the trait and to give more attention to its meaning. For the same reason the degrees of each trait are described. The sheet permits a wide dispersion of the values for each characteristic because the space provided for each may be checked at any point. The highest values are shown on the left, and the lowest values are indicated on the right. A person who is accustomed to the reverse order of listing will be required to give the rating sheet more careful study. Possibly a further advantage might have been achieved by putting the highest values alternately on the right and the left.

Formulating the Rating Plan. The first step in the formulation of a plan is to determine the objectives or the uses to be made of the ratings. The form of the rating sheet depends upon whether the ratings will be used as a basis for promotion, selection of employees for advanced training, advances in wages or salary, or for other purposes. The next step is to determine the employees to be rated. The group may be limited to junior executives, clerical employees, shopworkers, salespeople, foremen, or others; and it may include employees from several ranks.

The next step is to select the traits on which employees are to be rated. The selection of the traits depends upon the decisions made at the two preceding steps. For example, if the plan is limited to workers in relatively safe positions, the safety practices of the employee may not be weighted heavily or may not be included. For some groups of workers, personal habits, leadership qualities, or supervisory ability would be more heavily weighted than for other groups. If the ratings are to be used as a basis for salary or wage increases, the traits should be those for which the company is willing to pay.

For shopworkers, the traits most frequently included and most heavily weighted are quantity of work, quality of work, co-operativeness, dependability, knowledge of work, initiative, and judgment. However, many other traits are sometimes included, such as safety, health, personality, adaptability, ability to learn, and work attitude. Some plans even include citizenship, marital status, registration as a voter, number of dependents, and cost-planning ability.[1] These characteristics, when included, are usually given a low point value.

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[1] R. C. Smyth and M. J. Murphy, *Job Evaluation and Employee Rating* (New York: McGraw-Hill Book Co., 1946), p. 212.

RATING SHEET FOR SUPERVISORS

NAME: _____ DATE: _____ DEPT.: _____ %

(Each quality is weighted 10 points.)

1. Consider employee's interest in his job and company	Enthusiastic; interest is contagious	Generally a booster; interested	Satisfied; not disloyal	Usually dissatisfied	Antagonistic; lacks interest	
2. Consider his ability on job relations; his handling of personnel problems and grievances	Expert; handles problems with tact and diplomacy	Usually handles problems with tact and diplomacy	Occasionally needs to be guided in handling problems	Frequently makes decisions without sufficient evidence	Seriously lacking in judgment and tact	
3. Consider his ability and interest in instructing those under him in job knowledge and good safety habits	Active interest; conscientious, thorough, follows up	Normal interest; well informed and effective	Interested but not very convincing or effective	Little interested in training or safety	Altogether indifferent	
4. Consider his knowledge of his job	Expert on his job; knows related jobs	Well informed; good experience	Has a fair working knowledge of his job	Needs coaching	Altogether inadequate	
5. Consider his success in going ahead with jobs assigned; his ability to make job improvements	Very resourceful; has initiative and ability; improves standards	Resourceful and efficient; plans work	Usually meets standards	Needs urging	Unsatisfactory	
6. Consider his judgment in scheduling work and meeting his deadlines	Unusually mature judgment	Good judgment	Fair amount of common sense	Makes immature decisions	Seriously lacking in judgment	
7. Consider his industry on the job	Does more than is assigned	Does all that is assigned	Generally meets requirements	Rarely meets requirements	Lazy; never meets requirements	
8. Consider his reliability in meeting his responsibilities	Dependable; conscientious	Needs little supervision	Needs normal supervision	Needs close supervision	Distinctly unreliable	
9. Consider his ability for leadership	Excellent; natural leader	Takes lead most of the time	Takes lead if pushed	Dodges opportunity to lead	Shows no qualities for leadership	
10. Consider his ability to co-operate with other departments and supervisors	Highly co-operative	Co-operative	Co-operative if urged	Not helpful	Prevents progress	
			Total Rating			

FIG. 49. Rating Sheet for Supervisors

Used by permission of the editor of *Factory Management and Maintenance* and Mr. H. I. Newsome, the author of the rating sheet.

The traits should be stated as objective qualities which can be determined by observing the conduct and performance of the employee rather than as subjective characteristics which can be judged only by personal opinion. The difference is illustrated by the following comparison:

Subjective Trait	*Objective Trait*
Studiousness	Amount of time spent in study
Morality	Moral conduct
Extrovert	Interest in other people, talkativeness
Egotism	Boasting of own accomplishment

After the traits have been selected, the next step is to determine the number of degrees for each trait and the weights to be assigned. These are, to some extent, a matter of opinion, although the qualities which are the most important for success on the job should be most heavily weighted. The degrees for each trait should not be so numerous as to confuse the raters or so few as to prevent proper refinements in rating. The degrees should be designated by descriptive phrases rather than by such words as "very high" or "above average."

Making the Ratings. The ratings are usually made by more than one person. Shop employees may be rated by a committee composed of the foreman, the personnel director, and the division chief. In order that ratings in different departments may be consistent and fair, the raters should be trained in the methods and the purposes of the plan. If raters are not trained, foremen will not rate their employees on the same basis.

A merit-rating system is no better than the raters make it, for it is a method whereby one person or a few people rate other people. Certain pitfalls should be pointed out to the raters in order that they may be avoided. One of the dangers is the *halo effect,* which means the tendency to give a person a high rating on all traits because he has received a high rating on some qualities. One way to minimize the halo effect is to rate all employees on one trait before proceeding to the next.

Central tendency is the practice of giving of an employee the middle rating regardless of his merits. A possible reason for this is that the rater fears criticism from the employee or from his own supervisor. The central tendency may be minimized by using an even number of degrees for a trait, such as four or six.

Another possible danger is *leniency.* A rater who knows the personal difficulties of an employee may assign a high rating because of sympathy. The use of a rating committee of two or three persons is

designed to correct this tendency. The construction of the rating scale may also discourage the tendency toward leniency. This is accomplished by reversing the scale for each successive trait. On the first trait, for example, the highest rating may be indicated at the extreme right; and on the second, the highest rating may be indicated at the left. This arrangement of the scale also minimizes the halo effect.

The possibilities of *racial or other bias* should also be recognized. There is also the possibility that, in an effort to be fair, the rater may be unnecessarily harsh with his friends and lenient with persons against whom he might be biased. These dangers can be minimized by the training of raters.

New employees may be rated at the end of sixty days of service. Other employees may be rated once every three months, once every six months, or once a year. Some companies rate at irregular intervals. Ratings are subject to review by the plant superintendent or other executive in case they are challenged by the worker or the union.

Uses of Ratings. Because the technique of merit rating does not afford precise evaluations of employees, the scores are often grouped into classes. For example, if the total points in the plan are 100, classes might be established in this manner:

Excellent	91–100
Good	81– 90
Average	71– 80
Poor	61– 70
Very poor	60 or below

An employee may be informed of the class in which he is rated, but it is usually considered unwise to inform him of his numerical score. An employee who is told that his rating is 86, for example, might get the erroneous idea that the system is very exact; but he is more likely to think that it is a farce. Moreover, if he should be rated 84 at the end of the next six months, he might get discouraged and think that he is not doing well. Actually, a lower rating might be the result of inaccuracies in the plan or of a change in the membership of the committee. For these reasons, some companies do not assign numerical values but indicate the performance in descriptive terms. No employee should be told how another employee has been rated.

The ratings should be reviewed with the employees by the foreman or a representative of the industrial relations department. If an employee is warned that his rating is low, a written record of the interview should be made for reference in case a subsequent discharge is challenged by the worker or the union. Employees with high ratings may be rewarded by promotions or salary increases. Promotions made

in this manner are likely to be based upon merit rather than upon favoritism, pressure from supervisors, or requests of individual workers. If a company has an efficiently administered rating plan in addition to job evaluation, it should be unnecessary for an employee to ask for a raise.

Weaknesses of Merit-Rating Plans. A plan for employee rating cannot be expected to work perfectly and to eliminate all dissatisfaction. It is humanly devised and administered for the rating of human beings, and it is subject to human limitations. As Gardner and Moore say, merit systems "do not seem to work quite according to theory."[2] One difficulty is that the management does not always include in the rating scale those things for which it is willing to pay. If an employee's production record is low, the company may be unwilling to increase his pay merely because he is given a high rating on co-operativeness, dependability, or other such traits. Earnings are also limited by the evaluation of the job, and consistent effort on the part of an employee to improve his rating will not bring an increase in pay if he has reached the maximum for his job. Pay raises are affected by economic conditions, the general trend of wages, and the cost of living in the community. The number of pay raises which a foreman may get for his men is determined in part by his budget. If he asks for too many increases, his supervisors may be inclined to charge him with leniency in making the ratings. Another limitation is that workers whose ratings are lowered seldom receive reductions in their pay. Pay cuts are so serious to the affected workers that the business may fare better when employees whose ratings are poor are paid at their established rates of pay, unless they are transferred to lower rated jobs.

The criticisms which have been made of merit-rating plans do not invalidate the technique. They indicate only that the ratings are a matter of opinion rather than of precise determination. A definite plan of rating employees, which is known to all persons concerned is much better than rating on general impressions, hunches, and secret negotiations. The merit-rating plan provides the best available method of dealing with promotions, demotions, transfers, and discharges.

QUESTIONS

1. How is a merit-rating program related to job evaluation?
2. Distinguish between a merit-rating program and the measured day-rate method of wage payment.

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[2] Burleigh B. Gardner and David G. Moore, *Human Relations in Industry* (rev. ed.; Chicago: Richard D. Irwin, Inc., 1950), p. 162.

3. If an employee improves his merit rating, is he thereby assured of an increase in pay?
4. If merit ratings are used as a basis of granting increases in pay to factory workers, what factors should be heavily weighted?
5. What was the advantage of the man-to-man rating plan which was used in rating army officers during World War I? What was the weakness of the plan?
6. Why is it essential to select a typical person or officer at each level or degree in the man-to-man rating plan?
7. Is it necessary that the various traits in the rating plan be weighted? May an employee be rated separately on each trait and encouraged to improve his rating on certain traits?
8. What is the advantage of describing a trait instead of naming it? Should the name of a trait be omitted on the rating sheet?
9. Should the quantity and quality of work be included on the rating sheet and heavily weighted, or should data as to quantity and quality of work be used to supplement the plan? Does the answer to this question depend upon the uses to be made of the ratings?
10. Mention objective traits which may be used instead of the following:
    a) Health.
    b) Loyalty.
    c) Pride.
    d) Personality.
    e) Imagination.
11. Why can it be said that most merit-rating systems do not work entirely according to plan?
12. Explain the extent to which merit ratings may be used for each of the following purposes:
    a) Wage increases.
    b) Promotions.
    c) Counseling.
    d) Training programs.
13. Are merit-rating programs more suited to judging foremen and junior executives than factory workers? Why?

CASES

52. OPERATION OF MERIT-RATING PLAN

The Stein Clothing Company employs 275 persons in the manufacture of children's clothing. Factory workers are guaranteed an hourly rate as base pay and are given an opportunity to increase their pay through a piece rate. It is expected that after a probationary period, all employees will produce enough to earn more than the guaranteed hourly rate.

The personnel manager recommended to the president and the vice-president in charge of manufacturing that a merit-rating plan be developed for the rating of factory employees. Ratings would be made by foremen, who would be

trained in rating methods and procedures by the personnel manager. After discussion, the management agreed that such a plan would be developed by the personnel manager as a means of reducing absenteeism and tardiness and developing co-operation between foremen and workers. Ratings would be used in recommending promotions and transfers to positions offering greater opportunities of advancement.

The personnel manager devised a merit-rating plan by the point system, with five degrees for each trait to be evaluated. The traits and the point values were as follows:

Regularity and punctuality	20
Loyalty to the company	20
Ability to shift to other jobs in emergencies	20
Dependability	20
Observance of safety precautions	20
	100

Although the plan was explained to union officials and employees, the company found that it met with an unco-operative or even antagonistic response. The union officials contended that the piece rate was all that was necessary to secure co-operation and that workers should be judged solely on the basis of productivity. Decisions as to transfers and new jobs should be made on the basis of seniority. The merit plan, the union said, would be used as a means of playing favorites and discriminating against employees whose conduct was displeasing to the foreman.

When the plan was put into operation, all workers who were given low ratings on the traits of loyalty and dependability challenged the ratings. They complained to foremen, asked foremen to explain why the low ratings were given, and registered complaints with the union if the ratings were not changed. Foremen disliked to attempt to explain the reasons for the ratings, and they found that an undue amount of time was spent in discussing the ratings. Consequently, when workers were rated the second time, foremen were inclined to assign all employees average ratings on the two traits; and no employees were assigned lower than average. After one year's experience with the plan, the company quietly dropped the program, without any announcement to the employees.

Questions:

1. How is the failure of the plan to be explained?
2. Should workers on a piece rate be rated on other traits than productivity and quality of work?
3. What uses might be made of merit ratings for factory workers?

53. NEED FOR A MERIT-RATING PLAN

In one of its periodical surveys of employee opinion, the personnel department asked a number of questions concerning foremen and their treatment of employees. Several criticisms were made, including the following: handling of situations by writing memorandums to employees instead of consulting with

them directly; violating shop rules while expecting employees to observe them; requiring that employees observe exact time schedules for such things as getting hungry or visiting the rest room; claiming credit for himself for suggestions made by employees; playing favorites in job assignments and recommendations for wage increases; and evading responsibility by blaming all trouble on the front office.

The personnel manager was unable to determine from the unsigned reports how general the complaints were or what foremen were at fault in their supervision. He considered the following courses of action: forward all reports, together with statistical summaries, to the plant superintendent; organize a class in methods of supervision; have an informal talk with each foreman on problems of his department; and talk with a few employees to determine whether the complaints represented the general situation.

Questions:

1. What should the personnel manager do about the complaints?
2. How might a merit-rating plan be used to correct the situation?

54. DESIRABLE QUALITIES IN SUPERVISORS

During periodical interviews with employees and with persons leaving the company, the personnel manager receives many favorable comments on the work of foremen and supervisors. He had learned that employees especially appreciate such treatment as the following: words of praise for work well done; impartiality in the assignment of work and particularly in the assignment of agreeable and disagreeable tasks; willingness to listen to complaints and fairness in dealing with them; freedom from officiousness or insistence upon observance of rank and position; permission to employees to follow their inclinations as long as they get the required amount of work done; and personal interest in employees.

The personnel manager believes that personnel relations are generally good, and he is uncertain whether he should keep silent on the matter or whether he should commend foremen who are known to be well liked. He thinks that he might make a report to the plant superintendent.

Questions:

1. How should the personnel manager use the information concerning employee opinions of foremen?
2. Should the personnel manager take up with the plant superintendent the matter of good supervisory methods in the plant?

PART VII

Industrial Relations

CHAPTER XXVI

THE INDUSTRIAL RELATIONS DEPARTMENT

INDUSTRY is devoting an increasing amount of attention to the problems of human relations. Reasons for the growing importance of this phase of management may be found in the growth of labor unions and in the greater amount of federal and state labor legislation. Of equal importance, however, is the recognition of the necessity for improving personnel relationships. The greater variation in efficiency among plants within an industry is in the human element. It is probably easier to equip a plant with the right machines, materials, buildings, and layout than it is to provide a corps of trained and loyal workers who are integrated into an effective working organization. A company which is equipped with efficient machines and buildings may be wrecked by dissatisfaction, strife, constant unrest, strikes, slowdowns, and excessive labor turnover. An efficient work force with a high state of morale is essential to the success of any enterprise.

Although the problems of personnel management permeate the entire organization and cannot be segregated and managed by a separate department, the general policy has been to establish an industrial relations department or a personnel department to study workers and their problems, to formulate policies concerning workers, and to assist in the handling of activities pertaining to the workers. The work of the personnel departent in no way minimizes the need for the practice of sound policies in dealing with human problems on the part of the foreman and other officers of the line organization. On the contrary, it indicates that management regards the problem of manpower as being so important as to require the aid of specialists in the field.

Industrial Relations a Staff Function. The industrial relations manager is not a supervisor or a boss except in so far as the employees in his own department are concerned. He cannot give orders to either

the worker or the foreman. His authority over activities in the shop is limited to assisting the foreman in dealing with problems as they arise and in advising with top management concerning policies as they relate to personnel. He manages directly none of the work of production but only those activities which concern employees, such as recreation, health, and cafeteria service. This situation is a frequent cause of irritation to both the line and the industrial relations department. The industrial relations manager cannot issue commands but can only advise. If his recommendations are not followed, he can refer the problem to higher superiors; but he cannot take direct action.

The foreman is frequently irritated by interference by a representative of the industrial relations department. A further irritation may arise as a result of communications within the organization. In the absence of staff departments, all communications concerning conditions in a manufacturing department originate with the foreman; and some unfavorable facts may be suppressed or glossed over through the averaging or totaling of weekly or monthly production figures or other data. The staff departments, on the other hand, are anxious to straighten out difficulties and to report them to officers up the line in order that they may prove how useful they are to the organization. The foreman would prefer not to report his personnel difficulties and problems which the industrial relations department may want to play up as justification for its existence. This situation requires tact on the part of the industrial relations manager and his staff.

The personnel function increases in importance with the size of the company and the plant. In larger companies, there is danger that the top executives will lose sight of employee desires and interests and that the employees will misunderstand the motives of top management. The difficulty is due in part to the existence of a number of horizontal levels in the organization. In multiplant companies the plants are smaller and the local management may establish fairly close personal relationships with the workers. In such a company the industrial relations manager at the main office formulates general personnel policies which are made effective through a local representative or industrial relations manager at each plant. Relations with labor unions at all plants are usually governed by a contract between the union and the company as represented by the top executives of the company.

Development of Industrial Relations Function. The first personnel departments, as explained in Chapter II (p. 24), were no more

than employment departments. Although their activities were slightly expanded prior to World War I, the scope remained rather limited. In 1916 a progressive personnel manager explained that the purposes of his department were to improve human relationships and to reduce labor turnover through employment and placement activities. The employment department sought to develop a better labor force by studying the requirements of the various jobs and by employing people who could best meet the requirements. Since new employees were not always fully qualified for their jobs, the employment department carried on a limited amount of training. Exit interviews with departing employees were designed to find instances of poor placement and to eradicate the causes of employee dissatisfaction with their work.[1]

After World War I the work of industrial relations steadily expanded. Many new techniques were devised, and old methods were improved. Notable progress was made in methods of selecting and training workers; and personnel activities were expanded to include numerous employee services, employee counseling, job evaluation, merit rating, and other activities.

Personnel Activities. The activities of the industrial relations department vary with the size of the commpany, the situation within the community, the attitude of top management, and other factors. Although the activities are discussed at greater length in subsequent chapters, they will be briefly summarized at this time.

Employment. This activity consists of discovering, developing, and maintaining sources of labor supply and interviewing, testing, and investigating applicants for employment. It also includes induction of newly employed persons and maintaining records of transfers, promotions, layoffs, and dismissals.

Labor Relations. The director of labor relations advises management concerning union relationships, assists in the negotiation of union contracts, and represents management in handling complaints and grievances of employees.

Employee Training. The training director is responsible for developing and maintaining a program for orienting and training new employees, for increasing the interest and developing the capacities of all employees, for developing specialized training courses, and for co-operating with outside educational institutions.

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[1] Philip J. Reilly, "The Work of the Employment Department of Dennison Manufacturing Company," *Annals of the American Academy of Political and Social Science,* Vol. XLV (1916), pp. 87–94.

Job-Evaluation and Employee Rating Programs. These two techniques, which have already been discussed, are the joint responsibility of the industrial relations department and line executives. The job analyst develops job questionnaires and writes job specifications as a basis for selection, training, counseling, and wage determination.

Employee Counseling. This activity includes the development of a program for handling employee complaints and personal problems, for co-operating with labor unions and community agencies for solving employee problems whenever possible, and for determining employee attitudes towards the company.

Community Relations. The industrial relations manager endeavors to explain and interpret labor policies and programs to employees and to the community adjacent to the plant. The development of good community relations depends upon satisfactory policies and practices in such matters as buildings and grounds, smoke and waste control, stabilization of employment, wages, and hours of work. Agencies used to develop better community relations include newspaper announcements, advertising, open house, and plant visitation programs.

Safety and Health. The safety program includes the checking of mechanical devices and safety methods, the organization of safety committees and participation in their activities, the management of safety campaigns and contests, the investigation of accidents and the rendering of reports, and the maintenance of accident records. The health program includes first aid and the elimination of unsanitary conditions and health hazards.

Recreation. This activity includes a wide range of activities which vary with the company and the community and may be changed from year to year. In addition to the supervision of recreational activities within the company, the recreation director co-operates with organizations in the community for the promotion of various activities.

Employee Services. Many companies render such services as savings plans, credit unions, accident or life insurance, retirement plans, cafeterias and lunch counters, company stores, and housing.

Personnel Research and Statistics. Research in personnel problems might include investigation of any phase of industrial relations, such as safety, labor turnover, results of the training program, cost of living in the community in relation to wages paid, or a comparison of various methods of selecting or inducting new employees.

The work of industrial relations as it is conducted by the Caterpillar Tractor Company is shown by the chart in Figure 50. The departmental

organization in this company should not be regarded as fixed because the details of the organization vary with the company. The Caterpillar Tractor Company has an unusually elaborate program of personnel activities.

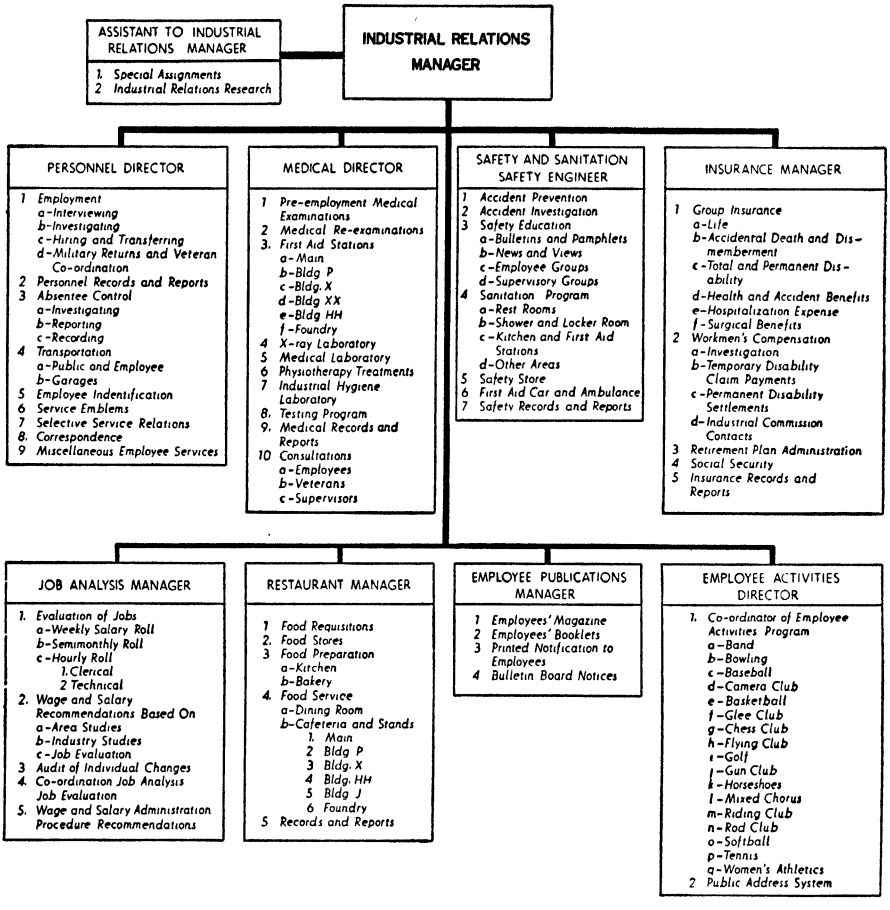

FIG. 50. Organization of Industrial Relations Department

Used by permissoin of Caterpillar Tractor Co.

Objectives of Industrial Relations Activities. The principal objective of early personnel departments was to reduce labor turnover by proper methods of selection, placement, and transfer when necessary. This still remains one of the principal aims. However, personnel work is now directed also at developing a loyalty toward the company and an understanding of its problems. This objective is accomplished by a manifestation of a genuine interest in the welfare of the worker and a recognition of his worth as an individual. Activities which are designed

solely to develop loyalty to the company or to create a better understanding of company problems will usually be recognized as such by the worker and branded as propaganda. The union is likely to denounce such a program as a snare to trap the worker and to undermine the position of organized labor. Consequently, the work of the industrial relations department must be motivated by a sincere interest in the worker as an individual. Loyalty to the company and improved morale should be by-products of policies which can be justified on other grounds.

Although the industrial relations manager is expected to present to management the possible effect of a proposed change on employee morale and attitudes, he cannot afford to put himself in the position of opposing changes which will be to the ultimate benefit of the company. He is, after all, a part of the management; and his purpose is to increase company profits. The industrial relations manager is therefore in a very different position from that of an officer of the union. While both are expected to oppose policies which would be detrimental to the worker, the industrial relations manager cannot become a partisan. The employee, therefore, cannot expect him to carry a controversy up through the higher levels of management as the union may do. The industrial relations manager himself can never be sure how far he may safely go in advocating a policy or in urging concessions for a worker, since he may undermine his own position. The worker, therefore, is likely to regard with some suspicion the representations of management that the industrial relations department exists for the protection of his interests.

To develop the interests and the loyalty of workers, the industrial relations department should have an understanding of the worker and his problems. The more significant wants and interests of the worker have been discussed in Chapter XIV on "Morale and the Worker" (p. 103). His most pressing interests concern working conditions, security, and pay. The view of the average worker is limited in scope, but he feels keenly concerning the things which he does see. From his point of view, the most important representative of the management is his supervisor. In a less significant position are the members of the industrial relations department, the time-study and standards department, and other staff departments with which he comes in contact. Top management, although actually more significant, is farther removed and assumes a less prominent position. The attitude of the average worker is also profoundly affected by the fact that his job and his

future are insecure. A managemment which can offer security will profit in many ways from an improved worker attitude.

A personnel policy must take cognizance of the fact that the worker belongs to the group. The procedure for selection and placement of workers will fail unless due allowance is made for that fact. White persons may not readily accept a Negro; Polish workers may not accept a Greek; and men may resent the employment of women in jobs which they regard as men's work. Group solidarity is often based upon religion, social relationship, club membership, attitudes, and prejudices, just as social cliques, gangs, and boys' clubs are formed. Groupings within the factory, both formal and informal, are known to be a potent force in the motivation of workers. Experience has shown that the existence of groups is essential to plant solidarity and stability. New enterprises which have not established a group relationship are plagued by excessive absenteeism, a high rate of turnover, and low morale.

Every person desires the respect of his fellows. This desire is most keenly felt in closely knit groups, although it exists in all societies. How much work a worker does may be more affected by what the group expects than it is by the score he makes on intelligence or manual dexterity tests. This significant fact must be recognized in the formulation of personnel policies. It may work for or against the interests of the company.

Personnel Policies a Matter of Record. Recognizing that the worker is intensely interested in the policies of the company in so far as they relate to him and that uncertainty as to policy breeds fear and suspicion, many companies now publish in booklet form their personnel policies and place a copy of the manual in the hands of every employee. The handbook is designed to give an understandable and interesting statement of company aims and attitudes, to improve the relationship between worker and management, and to present thorough and concise information concerning the rules and regulations of the company and the benefits and privileges which it provides for its work force. It is designed to replace fear and suspicion with trust and confidence.

Employee handbooks use varied methods in presenting the information concerning company policies. Some are formal, factual, and dignified in their approach; and others are informal, friendly, and conversational in tone. Some give a great deal of information about the company, its product, its history, and its financial condition. Some stress rules and regulations; and others emphasize recreational activities, credit services, and other benefits provided for employees. The difference is partly indicated by differences in title. Some books are given

formal and factual titles, such as *Employees' Handbook, Employees' Manual, Employees' Guide, Employee Relations,* or *Interpretation of Company Policies.* Others have informal and friendly titles, such as *Your Work, Our Company, Introducing the Company to You, Our Business,* or *Your Job and Your Company.* In some cases the titles incorporate the company name. Examples are *Harvester Policies for Harvester People, Information for General Electric Newcomers, The Wright Way of Working,* and *On the Job with Lilly.*

Requirements of a Good Industrial Relations Manager. The qualifications of an industrial relations manager are evidenced by his duties, which may be summarized as follows:

1. Managing the various activities of his own department and supervising its personnel.
2. Co-operating with other executives on personnel problems.
3. Advising with top management concerning problems of policy as to industrial relations.
4. Representing the company in dealing with the workers and possibly the union.
5. Assisting in the development of sources of labor supply.
6. Supervising methods of selecting workers.
7. Assisting in job evaluation and merit rating of employees.
8. Recommending policies concerning employee services and benefits.

The personal qualifications necessary to a successful industrial relations manager include the following:

1. Sincerity in his determination to be fair to management and employees.
2. Ability to analyze a situation and decide upon the best policy.
3. Fearlessness in expressing his point of view, even to major executives.
4. Willingness to change a policy when circumstances change and new policies are needed.
5. Interest in people and a recognition of the dignity of the individual.
6. Freedom from racial or other prejudices.
7. Tact, diplomacy, salesmanship.
8. Willingness to let others have credit, particularly the foreman and the worker, to build up the prestige of the foreman and the self-respect of the worker.
9. Discrimination in judgment, ability to detect the true situation from what is not said, as well as what is said, by foreman and workers.

10. Realization of the costliness of error in dealing with human lives and a desire to protect the worker and the company.

QUESTIONS

1. What is the responsibility of the industrial relations department for such problems as hiring, transfer, discipline, and discharge?
2. An applicant who has been interviewed, tested, and investigated by the employment manager is recommended to the foreman for employment. He is accepted by the foreman. If he fails to make good on the job, who is responsible?
3. The industrial relations department knows that certain foremen fail to treat employees properly, give orders in a brusque and irritating manner, and fail to develop proper personnel relations. What can the department do about it?
4. The personnel manager finds that foremen are not properly informed on the provisions of the union contract or the requirements of federal labor laws and regulations. Foremen refer to the industrial relations department many complaints which they should settle on their own authority, and other cases which they attempt to handle result in appeals where the foremen are overruled. What should the personnel manager do?
5. If a worker grievance is taken to the industrial relations manager and he satisfactorily disposes of it, should he report the matter to the general manager in order that he may receive credit? What difficulty does this situation present?
6. Are personnel problems likely to be brought to the attention of the industrial relations department by the foreman, the union steward, or the worker? Why?
7. Explain in what way, if at all, the industrial relations department is concerned with the following matters:
   a) Quarrel in the plant between the union steward and an employee over failure of the employee to pay his union dues.
   b) Failure of the company to provide equipment with the best safety devices.
   c) Exposure of workers on the job to chemicals which cause skin infection.
   d) Fight in the plant between two employees.
   e) Failure of the company to authorize the operation of the plant cafeteria for the second shift.
   f) Use of a complicated system of bonus payment which many workers do not understand.
8. What can the industrial relations department do to see that the worker is fairly treated in matters of promotion, transfer, and discharge?
9. What is the purpose of the employee handbook?
10. Why should the personnel policies be made a matter of record?
11. What preparation should a person have to become an industrial relations manager?

CASES

55. SCOPE OF PERSONNEL ACTIVITIES

In 1931, J. C. Reese began the manufacture and sale of brushes in a small shop in Brookfield, Massachusetts. There were 7 employees at the end of the first year. The business was quite successful; and the product line was gradually expanded to include additional types of brushes, cleaners, and other household items. In 1940 the enterprise was incorporated under the name of the Reese Hôme Products Corporation. In 1952 the company had 800 employees, of whom 600 were production workers.

From the beginning, Mr. Reese sought to maintain good working conditions, pay satisfactory wages, and provide supervision that would assure fair treatment of employees. He attempted to stabilize production and provide steady employment. To assure adequate attention to employee problems, a personnel department was organized in 1940. At that time the employees numbered 375.

Mr. Reese believes that recognition of individual worth is a basic principle of human relationships. His favorite saying is that the man is more important than the plan. One manifestation of this principle is shown in weekly luncheons called "family group luncheons," which are held every Friday for 25 employees chosen from all departments. At these luncheons, company affairs are freely discussed by Mr. Reese and other officers of the company. Rules and regulations are kept at a minimum, and company policies are stated in positive form. The personnel manager attempts to listen patiently to all complaints and strives to arrive at a solution that is just. He attempts to assist an employee with any personal problem presented to him, but he waits for the employee to ask for advice or assistance.

Recreational and social activities are conducted under the supervision of an organization of employees which is called the Reese Co-operative Association. Membership is open to all employees. The expenses of the association are defrayed entirely by dues. Activities vary somewhat from year to year. They include dances, picnics, hobby shows, and athletic events.

Labor relations are conducted through an independent union which represents all employees in matters pertaining to wages, hours, and working conditions. The union is represented in each department by a shop steward who listens to worker complaints and represents the union in conferences with the foreman. Complaints not settled by the foreman to the satisfaction of the worker and the steward may be appealed to the plant manager. The company agrees to arbitrate any grievance not satisfactorily settled by the plant manager.

Questions:

1. What is meant by recognition of individual worth?
2. Should social and recreational activities be managed by employees without assistance from the company?
3. Can the program of this company be said to be paternalistic? Explain.

56. TREATMENT OF PROBLEM EMPLOYEES

A study of disciplinary cases, absenteeism, and other personnel problems at the American Brake Company disclosed that a small number of employees

accounted for an undue amount of absenteeism and disciplinary cases. Investigation of the records of problem cases showed that their average age was 45 and that their average length of service was 10 years. Many of the problem employees had developed special skills and were not easily replaced.

Upon recommendation of the personnel manager, a special counselor for problem employees was assigned to the personnel department. He soon learned that many of the problem employees were alcoholics and that their records were usually good except when they were under the influence of alcohol. He made an especial effort to help these people. He had frequent conferences with them; and he also made use of an outside organization, Alcoholics Anonymous. He endeavored to get them interested in plant clubs and recreational activities. After one year the counselor was able to report that absenteeism in this group had been substantially reduced and that their earnings had been increased. While some of the men had to be discharged, others had been helped to rehabilitate themselves.

Questions:

1. Should the company concern itself with employees addicted to the use of alcohol, or should it expect them to help themselves?
2. Can a program to help problem drinkers be classed as paternalistic?
3. How can the program be expected to help morale throughout the company?

CHAPTER XXVII

RELATIONS WITH UNIONS

THE ORGANIZATION of labor unions and the development of the technique of collective bargaining was the inevitable result of the system of factory production. The individual worker cannot bargain on an equal basis with the management of a large enterprise concerning wages and conditions of work, and he cannot adequately protect his interests against arbitrary acts of the employer and his agents. Federal legislation guaranteeing the right of self-organization and the right to designate representatives of the employee's own choosing to negotiate the terms and conditions of employment was first enacted in 1932 with the passage of the Norris–La Guardia Act. These rights were reaffirmed in the National Industrial Recovery Act of 1933, the National Labor Relations Act of 1935, and the Labor Management Relations Act of 1947. The most significant causes for the rapid increase in union membership, power, and prestige after 1933 may be found in such developments as the increased size of corporations, the large numbers of workers employed by individual companies, the insecurity of workers in urban communities, the failure of management to stabilize production and employment, and the widespread suffering which resulted from unemployment during the depression of the 1930's. Legislation and a sympathetic federal administration aided but did not cause the spread of unionism.

Reasons for Labor-Management Conflict. Strikes and labor conflict in industry are the exception rather than the rule. However, in many cases where conflict does not flare into the open, both management and labor question each other's motives. Management and labor often fail to develop a feeling of mutual confidence which would produce the co-operation envisioned by Frederick W. Taylor and by others since his day. Each feels that its own position is entirely fair and that

the failure to develop trust and confidence is due to a misunderstanding on the part of the other. The attitude of some managements is summarized by one or more of the following propositions:

1. Some employers believe that the union is unnecessary. They feel that their workers do not need to join a union to gain security in the job, fair wages, or good working conditions.
2. The union creates a distrust of management. It attempts to create a gulf between management and men to justify its own existence.
3. The union takes credit for improvements and wage increases granted by management. Even when a change is instituted by management on its own initiative, labor leaders claim that fear of the union was the cause.
4. The union attempts to assume what are rightly the prerogatives of management in such matters as hiring and firing, transfers, promotions, and wage increases for meritorious employees.
5. The union encourages limitation of output and the setting of low standards for each job.[1]

Where organized labor and management fail to develop co-operation, the attitude of labor may be reflected in one or more of the following statements:

1. The employer is not genuinely concerned with the welfare of the workers. He is interested in the workers because they are necessary to the management. The union is the only organization which is interested in the worker as an individual.
2. Any concessions made to the workers are designed to prevent complete unionization or to weaken the position of the union in the minds of employees.
3. The management would like to be rid of the union. It will do what it can to undermine the position of the union by creating suspicion, by discriminating against its members and officers, and in other ways.
4. The position of the union must be constantly strengthened and made more secure. Any management techniques which will permit discrimination against union officers or members must be strenuously opposed.

Importance of Harmonious Relations. The development of harmonious relations between management and labor is important for the well-being of both, as well as the public. The interests and the ambi-

[1] See F. H. Harbison, "The Basis of Industrial Conflict," in W. F. Whyte, *Industry and Society* (New York: McGraw-Hill Book Co., 1946), chap. ix.

tions of the worker center around his job. He wants uninterrupted employment at good wages; and he cannot achieve these purposes in an atmosphere of suspicion, bickering, and strife. Management also wants uninterrupted production in volume. As industrial engineers have constantly stressed since the days of Taylor, high wages, as well as profits, depend upon the co-operation of management and labor. The worker and the union have a better chance to enjoy a large piece of pie if they work together to produce a larger pie instead of confining their efforts to an attempt to obtain a larger share. A rising standard of living for both management and labor is dependent upon increased production, which in turn is dependent upon the development of understanding and a co-operative attitude.

In many companies, union-management co-operation has resulted in better management policies and improved personnel relationships. The necessity for dealing with the union has caused management to give more attention to personnel policies. The union has provided a channel for the clearing of misunderstandings and dissatisfactions. Management has devoted more attention to the prevention of arbitrary acts of foremen in matters of discipline, and it has developed better methods of communication. Unions have been partly responsible for such management policies as the stabilization of employment and the removal of discriminations in pay between jobs.

Principles of Understanding. Complete co-operation cannot be achieved until management and labor have agreed upon the principles for co-operation. Acceptance of such principles cannot be achieved so long as each side insists upon its rights to the neglect of its duties and obligations to the other. Instead, each must agree to certain basic principles and must trust the other party to act in good faith. A good statement of principles is the industrial relations charter which was adopted by management and labor in Toledo, Ohio, in 1946. The principles are as follows:

> Management acknowledges the right of employees to form and join labor organizations without interference or coercion from any source, and to bargain collectively through their bargaining agents. For their part, bargaining agents recognize their duty to demonstrate leadership and responsibility in keeping with the trust reposed in them.
>
> Labor recognizes the inherent right of management to direct the operations of the enterprise. In the exercise of these rights, Management recognizes its duty to demonstrate the type of leadership and responsibility it expects of the representatives of Labor.
>
> Neither Labor nor Management should discriminate against any employee because of race, creed, or color.

Management and Labor agree that improvements in productive efficiency and technological advances result in lower costs and selling prices and wider markets for the products of industry, thereby making possible higher wages and a rising standard of living and increasing employment.

Management and Labor, while attempting to prevent differences and disagreements realize that they will arise from time to time, and believe that the damaging effects of such differences and disagreements on the community should be minimized by joint discussion and by the voluntary utilization of mediation, fact-finding, and arbitration facilities as may be made available by this Labor-Management-Citizens Committee.

Management and Labor agree that an educational program is desirable to promote a better mutual understanding between workers, stewards, union officials, supervisors, foremen, and managers. As a means to that end, an educational program shall be organized as an essential activity of this Labor-Management-Citizens Committee.[2]

The Union-Management Contract. The relations between the company and the union are usually stated in a formal contract signed by the representatives of the union and the management. The scope of this contract has been extended until it usually includes a wide variety of clauses. The union-management contract would always provide for the recognition of the union as the bargaining agent of the employees, or a part of them. It also defines the groups of workers for whom the union is authorized to bargain. It usually provides for the checkoff, or the deduction of union dues and assessments from the pay of employees. Miscellaneous clauses provide for seniority rights, the conditions under which seniority rights may be lost, the manner of spreading work to prevent layoffs, the order in which workers will be laid off, discharges, and promotions. Other provisions pertain to extra payment for nightwork or other odd shifts, overtime, paid vacations, holidays, and other compensation. The contract sometimes provides for various phases of working conditions, such as health, safety, and sanitation. The contract states the date when the agreement will become effective, the duration, the date of termination, and the method of renewal.

Coverage of the Union Contract. The scope of the union-management contract may be limited to a single plant, or it may include a number of plants. The area coverage of group bargaining may be limited to a single plant, or it may include all of the plants owned by one corporation. The coverage of some contracts is limited to the plants in the industry within a city, county, or metropolitan area. In

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[2] The full text of the charter is reprinted in Edward T. Cheyfitz, *Constructive Collective Bargaining* (New York: McGraw-Hill Book Co., 1947), pp. 150–54. The situation at Toledo is unique because most of the workers in the city belong to the same labor union.

other cases the coverage is extended to a geographic or regional area or to an entire industry throughout the United States.

When a corporation which owns several plants in various locations negotiates a contract, the union attempts to bring all plants of the employer within the provisions of the agreement. This type of contract frequently includes a large number of workers. Bargaining within a city, county, or metropolitan area is practiced in such industries as baking, soft drinks, men's clothing, women's clothing, confectionery products, dairy products, meat packing, and newspaper printing.[3] Bargaining by geographic areas is practiced in such industries as canning and preserving foods, dyeing and finishing textiles, fishing, hosiery, paper and pulp, and metal mining. Industry-wide bargaining is practiced in the following industries: coal mining, elevator installation and repair, glass and glassware, installation of automatic sprinklers, pottery and related products, stoves, and wall paper. In the railroad industry, the usual bargaining unit is the individual railroad system. Occasionally, certain questions of major importance, such as wages, have been settled on a nation-wide basis.

Union Security. The first concern of the union is for its own security. If the employer refuses to deal with the union, or if he seeks in various ways to undermine its position, the power of the union may be dissipated and may ultimately disappear. The union seeks to protect itself against encroachments by rival unions, to prevent its position from being weakened by employer discrimination, and to prevent a relaxing of the interest and support of the members. The position of the union as the bargaining unit for the employees is stated in Section 7 of the Labor Management Relations Act as follows.

> Employees shall have the right to self-organization, to form, join, or assist labor organizations, to bargain collectively through representatives of their own choosing, and to engage in other concerted activities, for the purpose of collective bargaining or other mutual aid or protection, and shall also have the right to refrain from any or all of such activities except to the extent that such right may be affected by an agreement requiring membership in a labor organization as a condition of employment as authorized in Section 8 (a) (3).

The law further states in Section 8 (a) that the following constitute unfair labor practices for the employer:

1. To interfere with, restrain, or coerce employees in the exercise of the rights guaranteed by the act.

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[3] See Bureau of Labor Statistics, "Collective Bargaining with Associations and Groups of Employers," *Bureau of Labor Statistics Bulletin 887* (Washington, D.C., U.S. Government Printing Office, 1947).

2. To dominate or interfere with the formation or administration of any labor organization or to contribute financial or other support to it.

3. To encourage or discourage membership in any labor organization by discrimination in regard to hiring or tenure of employment.

4. To discharge or otherwise discriminate against an employee because he has filed charges or given testimony under the Labor Management Relations Act.

5. To refuse to bargain collectively with the representatives of his employees.

The union contract usually states that the union is the legal bargaining unit of the employees within the meaning of the law and that the company recognizes the union as the exclusive representative of the employees for the purpose of collective bargaining. The contract may further strengthen the position of the union through a clause which declares that the company recognizes and will not interfere with the right of employees to become members of the union. The company may expressly agree not to exercise discrimination, interference, or coercion against any member because of membership in the union. The company and the union may also agree that there shall be no soliciting of membership in any union on company time or on company premises except by agreement with the employer. This clause strengthens the position of the union because it prevents solicitation by a rival or unrecognized union.

The question of what constitutes a refusal to bargain collectively has been the subject of much controversy before federal agencies. It has been held that a refusal of the employer to state the terms upon which he will deal with the union or to which he will agree in a contract constitutes a refusal to bargain collectively. The rejection of all the demands of the union without a counterproposal is also a refusal to bargain. Furthermore, the proposals made by the employer cannot be impossible or grossly unfair. The meaning of the phrase "to bargain collectively" is stated in Section 8(d) of the Labor Management Relations Act as follows:

> To bargain collectively is the performance of the mutual obligation of the employer and the representative of the employees to meet at reasonable times and confer in good faith with respect to wages, hours, and other terms and conditions of employment, or the negotiation of an agreement, or any question arising thereunder, and the execution of a written contract incorporating any agreement reached if requested by either party, but such obligation does not compel either party to agree to a proposal or require the making of a concession.

The Checkoff as an Aid to Union Security. The union frequently requests the employer to deduct from the pay of the workers the various payments due the union, such as initiation fees, dues, fines, and assessments. The contract specifies what deductions may be made. The union may agree to submit to the company a notarized list of members, together with a statement of the amounts due from each member. The company may protect itself by a provision that initiation fees, dues, and assessments shall not exceed a stated amount.

Management sometimes objects to the checkoff on the ground that making the deductions is an expense for which the union should pay. A further objection is that the union is made a preferred creditor and is paid before any other obligations of the workers are paid. A more serious objection, from the point of view of management, is that in the absence of proper safeguards the checkoff may result in compulsory payments to the union to which workers object. The Labor Management Relations Act prohibits the making of deductions from the pay of employees for dues in a labor organization unless the employer receives "from each employee, on whose account such deductions are made, a written assignment which shall not be irrevocable for a period of more than one year, or beyond the termination date of the applicable collective agreement, whichever occurs sooner."

The Union Shop and Union Security. Four types of employment policies in relation to union membership are possible. These are:

1. The closed shop, where only members of the union may be employed.
2. The union shop, where nonmembers may be employed, provided that all new employees join the union after employment or after serving an agreed probationary period.
3. The preferential shop, where union members are given preference. The employer is free to hire nonunion members only when qualified workers cannot be obtained from the union membership.
4. The open shop, where no requirement for union membership exists.

The union prefers the closed shop or the union shop. It regards the closed shop or the union shop as essential to union security. Without security, the union is not free to work for its members or to co-operate with management in bettering working conditions or correcting grievances. Until the management has recognized the necessity for the union shop, it has not evidenced its willingness to bargain with the union in good faith. The union believes that all employees should

be willing to join the union and to support it because all of them benefit from its activities.

Management usually objects to the closed shop, and it sometimes objects to the union shop. Management wishes to be free to employ the best applicants regardless of union membership, though it may readily agree that employees should be required to join the union after a period of probation. The situation is difficult for management if the union refuses to admit certain groups to membership. In a closed shop, expulsion of an employee from the union would require that he be discharged even though management regards him as a desirable employee. Management may also contend that the closed shop or the union shop may result in irresponsible leadership within the union, since the union is relieved of the necessity for selling itself to the members.[4]

The closed-shop contract has been made illegal under the laws of some states. The Labor Management Relations Act prohibits the closed shop and the preferential shop but not the union shop, provided that the workers themselves approve such a contract. The law makes it illegal for the employer, by discrimination in regard to hire or tenure of employment or any term or condition of employment, to encourage or discourage membership in any labor organization. The act then states that an employer may make an agreement with a labor organization to require, as a condition of employment, membership in the union on or after the thirtieth day following the beginning of employment. Section 8(a)(3) states that no employer may discriminate against an employee for nonmembership in a labor organization if the employee is not permitted to join the union on the same terms and conditions as other members or if membership was denied or terminated for any reason other than nonpayment of dues or initiation fees.

Worker Security. The second objective of the union is security for the worker and particularly for members of the union. The management also seeks to establish security for the worker; thus, many policies of management are designed to give the worker a feeling of security. The union contract may attempt to make the worker more secure through a provision for an increase in wages to compensate for an increase in the cost of living. Security may be sought through an equitable provision for relieving the worker from the effects of technological unemployment. Additional security may be achieved through

[4] For full discussion of union-management relationships, see Lee H. Hill and Charles R. Hook, Jr., *Management at the Bargaining Table* (New York: McGraw-Hill Book Co., 1945).

equitable policies concerning pay-offs and discharges. The grievance procedure is designed to increase worker security by providing a channel for the clearing-up of misunderstandings and for warning workers if their conduct is unsatisfactory. A feeling of security may also be developed by guaranteeing to the worker the right to advancement to a better job when he merits promotion.

The Labor Management Relations Act includes a number of provisions which are designed to make the worker more secure against arbitrary discriminatory action by the union or the management. The more significant of such provisions are as follows:

1. Employees have the right to choose the unit for collective bargaining. The election for choosing the bargaining unit is supervised by the National Labor Relations Board.

2. Employers cannot discriminate against an employee because of nonmembership in a labor union, in case membership has been denied or terminated on some ground other than failure to pay dues or initiation fees. Labor organizations are not permitted to cause or attempt to cause employers to make such discrimination.

The initiation fee required by a union cannot be an amount considered by the National Labor Relations Board to be excessive.

4. Members of unions are entitled to financial reports of their union. This right is established through the provision in Section 9 (f) that no investigation shall be made by the National Labor Relations Board pursuant to a complaint made by a labor organization unless the labor organization has filed specified information with the Secretary of Labor. The information includes copies of its constitution and bylaws; a report in a form prescribed by the Secretary of Labor describing its organization and giving details as to salaries of officers, the method by which officers are elected, initiation fees and dues, and other information; and a statement of cash receipts and cash disbursements and a balance sheet. The report filed with the Secretary of Labor must also indicate that copies of the financial report have been furnished to all members of the union.

Security for the Employer. The employer desires to be free to operate and manage his business in an efficient manner. He also desires a continuous operation of the plant, without interruption from strikes, slowdowns, or other interference. The prerogatives or rights of management may be stated in the union contract by a clause similar to the following:

Except as specifically limited by this agreement, exclusive functions of management shall include the hiring, promoting, demoting, and rehiring of employees, the suspending, discharging, or otherwise disciplining employees, the laying off or calling to work of employees in connection with any reduction or increase in the working forces, the assignment of work, the scheduling of work, and the control and regulation of the use of all equipment and other property of the company.

Other rights of management sometimes specified in a contract are the selection of tools and equipment, decisions as to the product to be manufactured, the prescribing of the methods of manufacture, and the control of raw materials and parts. It is questionable whether the reservation of certain rights by management is necessary or desirable, however, since management may be presumed to have such rights and prerogatives as are not mentioned in the contract.

The Labor Management Relations Act contains several provisions which are intended to protect the rights of employers against arbitrary actions by unions. Some of these provisions are as follows:

1. Refusal by a union to bargain collectively is an unfair labor practice. A refusal to bargain collectively would probably include a refusal to state the terms demanded by the union and the making of unreasonable demands upon the employer.

2. The employer cannot be required to pay for services which are not performed or not to be performed. This provision is directed at make-work rules of unions and contracts requiring employers to hire workers not needed. Such practices are commonly referred to as "feather bedding."

3. An employer cannot be coerced by a union in the selection of his representatives for the purposes of collective bargaining or the adjustment of grievances.

4. The expressing of any views, argument, or opinion in any form does not constitute an unfair labor practice if the statements made contain no threat of reprisal or force or promise of benefit.

5. Foremen's unions are not entitled to the protection extended to unions under the law. Foremen are not denied the right to organize; the law declares that supervisors are not employees, as that word is used in the Labor Management Relations Act.

6. Strikes for certain purposes are declared to constitute unfair labor practices. These are as follows:

a) A strike to require an employer to cease using or otherwise deal in the products of any other producer or manufacturer.

b) A strike to require an employer to recognize or bargain with a union other than the certified bargaining unit.

c) A strike to force an employer to assign particular work to members of a certain union or craft, unless the employer is failing to conform to an order of the National Labor Relations Board determining the bargaining representative for employees performing the work.

7. Disputes between the employer and the union may be presented to the Federal Mediation and Conciliation Service for settlement. Neither the employer nor the union is required to accept the proposals made by the Mediation Service. The union contract must be continued in full force and effect for a period of sixty days after notice is given to the Federal Mediation and Conciliation Service, unless the contract expires sooner. Resort to a strike or a lockout during the specified period of time constitutes a refusal to bargain collectively.

Interpretation of the Union Contract. Two types of questions arise in the interpretation of the clauses in the union contract: (1) alleged violations of the provisions of the contract by either labor or management and (2) controversies concerning the meaning of the contract provisions. The union contract usually stipulates the procedure to be followed in the settlement of both types of differences.

In day-to-day relationships with the union, management is represented by the foreman with the assistance of the industrial relations department. The foreman receives complaints from workers and usually settles difficulties without any necessity for consulting anyone else. Some questions may be referred to the superior, who may be the plant superintendent or the general foreman. If the complaint is not handled by the foreman in a manner that is satisfactory to the worker, the problem may be referred to the industrial relations department by either the worker or the union representative.

The departmental representative of the union is the shop steward. He holds a regular job and attends to union matters as occasion requires. He has the duty of hearing complaints of workers in the department and seeing that worker interests are protected. The shop steward also signs up new members; collects union dues, provided that the company does not deduct dues from the pay of employees; and issues stamps or dues cards as receipts. He holds departmental meetings of union members and announces local or plant meetings of the union. In general, he represents the union in its dealings with union members at the plant level; and he keeps the union office informed of departmental developments. Above the shop steward is a divisional committee, a plantwide committee, and the union officers.

It is important for both the company and the workers that grievances be settled at as low a level in the organization as possible. This arrangement results in a prompt settlement of the difficulty and adds to the prestige of the foreman. The contract may provide for a procedure along the following lines:

1. The aggrieved employee or steward should present the grievance directly to the employee's immediate supervisor as soon as the grievance arises. The employee should be present when the grievance is presented to the supervisor by the steward.
2. If the grievance is not satisfactorily settled or an answer is not given by the immediate supervisor within two working days, the steward may refer the matter to the chief steward, who should take the grievance to the general foreman.
3. If the grievance is not satisfactorily settled or an answer is not given by the general foreman within two working days, the grievance committee of the unit should present the matter in writing to the division chief, who arranges a meeting for the discussion of the problem.
4. If the grievance is not settled within five working days, the grievance committee should present the matter to the factory manager. At this point the grievance should also receive the consideration of the industrial relations department.

Questions of interpretation of the union contract may be settled by the procedure prescribed for the handling of grievances. Differences of opinion not settled in this manner may be submitted to arbitration upon the request of either party. Within five days after the receipt of a written request for arbitration, the parties should meet in an effort to agree upon the selection of an arbitrator. When they cannot agree upon an arbitrator, either party may request the Federal Mediation and Conciliation Service to appoint an arbitrator. The decision of the arbitrator is final and binding upon all parties to the dispute. The expenses of aribtration are borne equally by the union and the company.

QUESTIONS

1. About the beginning of the twentieth century, labor relations were usually called the relations of labor and capital rather than those of labor and management. What is the difference between the two concepts?
2. To what extent are the interests of labor and management identical? To what extent are they opposed?
3. How may the union assist management in the handling of personnel problems?
4. Why might a union seek to develop distrust in the motives of management?

5. What is meant by union interference in the prerogatives of management? Explain why the union might be interested in management policies concerning the following:
   a) Plant location.
   b) Installation of laborsaving machinery.
   c) Organization of production on an assembly line basis.
   d) Promotion policies.
   e) Layoff and spread-the-work policies.
6. Does a higher rate of wages paid by one employer or by the employers in one industrial center necessarily result in higher unit costs for the product? Do higher unit costs necessarily result in higher selling prices for the product?
7. Which of the six principles of co-operation as stated in the Toledo charter of 1946 are sometimes not accepted by management? Which are sometimes not accepted by labor?
8. Should the provisions of the union-management agreement be stated in a written contract? Is the written contract an advantage to management as well as to labor?
9. Can the union be required to observe the contract? What is the penalty for violation?
10. Discuss the effect of industry-wide bargaining from the point of view of —
    a) The management.
    b) The union and the worker.
    c) The public.
11. What are unfair labor practices as prescribed by federal law?
12. Distinguish between the closed shop, the union shop, the preferential shop, and the open shop.
13. What is the objection of management to the closed shop?
14. Why are arbitrary restrictions upon union membership unfair to the employer and workers when combined with the closed shop?
15. Some union leaders contend that, if unions do not restrict their membership, the employer may hire stooges. When these persons join the union, they can act as spies at union meetings. The employer contends that he, and not the union, should select his employees. Can these two points of view be reconciled?
16. Distinguish between security for the union and security for the employee who is a member of the union.
17. How may the closed shop cause management to become involved in political controversies within a union?

CASES

57. CONSULTING THE UNION ON LAYOFFS

In the fall of 1952 the management of the Ryan Corporation decided that a temporary cutback in the labor force was necessary. The management did not consult with the union on this problem because such a decision was regarded as

a prerogative of the management. However, it asked the union for a recommendation as to the method of determining which employees should be laid off. The union recommended that financial need rather than seniority or merit should be the deciding factor and that married women whose husbands were employed should be the first group to be laid off. The management informed the union that it preferred not to inquire of its women employees whether their husbands were employed by other companies. The officers of the union then offered to obtain this information for the company. Consequently, the first employees to be laid off were the women whose husbands were employed by the Ryan Corporation or by other companies in the community.

Question:

Did the company follow the best and fairest procedure in laying off employees?

58. ALLEGED FAVORITISM OF FOREMAN

A year ago, Albert Schwartz was made foreman of the corrugated box department of a glass company that employed a total of about 600 employees. Schwartz had been employed by the company for five years and was familiar with all of the work in the department and had worked in most of the jobs required for boxmaking.

Before he was made a foreman, Schwartz had been a member of a car pool, which included Hermann Schmidt, a fellow employee in the boxmaking department, and two employees from other departments in the plant. Schwartz and Schmidt became very good friends. They usually ate lunch together and were together on various other occasions during working hours. After Schwartz became foreman, he continued the car-pool arrangement and the other associations with Schmidt, and he also made an effort to develop friendly relationships with other employees.

In time, Schwartz was asked to recommend an employee for transfer to the maintenance department for a newly created job at good pay. After a careful review of the qualifications of all of the men in the department, he decided to recommend Schmidt, who had the necessary qualifications but was junior to Patrick O'Hara in number of years of service with the company. When O'Hara learned of the appointment, he registered a complaint with his union steward, alleging favoritism. The union protested the appointment of Schmidt and asked that O'Hara be given the position.

Questions:

1. What should an employee do about his friendships with other employees after his promotion to the position of foreman?
2. Should employees be transferred or promoted on the basis of seniority or merit?
3. Should the company follow the recommendation of Schwartz, or should it give the position to O'Hara?

CHAPTER XXVIII

EMPLOYMENT PROCEDURES

THE employment procedure was the first phase of personnel work to receive the attention of management, and it has increased in importance in recent years. Under present labor laws and strong union organization, a worker who is once employed soon achieves a claim upon his job which makes it difficult for management to discharge him. The importance of employment procedures is increased also by the policy of promotion from within, since future executives enter the service of the company by way of the employment office.

Sources of Labor Supply. The employment of workers requires attention to the sources of labor supply in order that the number of qualified applicants may be adequate. The sources of supply vary with the business, the industry, and the community; and every business should determine for itself which sources are best. This may be done by asking each applicant how he heard of the job or what person suggested that he apply. Persons who are employed should be followed up to determine the number of applicants hired, the cost per applicant attracted and per applicant hired, and the average time employees recruited from each source remain with the company.[1]

The sources most commonly relied upon are mentioned in the following paragraphs, together with a brief evaluation of each. Most businesses should use more than one source.

Workers Presently Employed. A job vacated by separation of an employee is often supplied by transfer or promotion of another worker. This may require the hiring of another person to fill the job at the lower level, or a rearrangement of duties may be all that is necessary.

[1] See Paul E. Black, "Five Ways to Get Workers in a Tight Labor Market," *Factory Management and Maintenance*, Vol. CIX, No. 12 (1951), pp. 94–96.

Persons Recommended by Present Employees. This is a good source because the applicant is likely to know both the desirable and the undesirable features of the job. Moreover, an employee will hesitate to recommend a person who will not succeed.

Former Employees. Persons formerly employed, particularly women, may have quit because of illness in the family or other temporary difficulty. Little risk is taken in employing such persons, since their records on the job are known.

Unsolicited Applicants. If the company has a reputation as a good place to work, many qualified applicants may appear at the employment office or make application by mail without any effort on the part of the company.

Employment Agencies. Employment agencies are either public or private. Public agencies are supported by state or federal taxation. Private agencies charge a fee which is usually paid by the applicant. The reliability of employment agencies varies widely; some use discretion in the selection of the persons whom they recommend, while others are less careful.

Schools and Colleges. For certain types of work, graduates of colleges and universities, business colleges, trade schools, and high schools constitute a reliable source of help.

Labor Scouts. Representatives of the company who search for persons with desirable qualifications are used by many companies. Scouts frequently visit colleges to solicit applications from graduates in chemistry, engineering, business administration, and other courses.

Advertising. Advertising for applicants by newspaper, radio, or television is a reliable source for many types of workers, particularly in larger cities. Some employers use advertising only when other sources fail to supply enough applicants. The objection to advertising is that many unqualified persons are led to apply and that the time of the employment section is wasted. Specialists in such fields as accounting, time study, costs, and budgeting may often be reached through trade and professional magazines.

Other Companies. The soliciting of the employees of other companies is regarded as unethical, unless it is done with the knowledge of the other employer. Labor pirating may result in retaliation to the detriment of both companies.

The Requisition for Employment. When a worker is needed, the foreman prepares a requisition for help. After the requisition has been approved by the division chief, it is sent to the industrial relations de-

partment. The employment section has on file the job descriptions and job specifications for the various jobs. The employment section may also have on file an application from a qualified person. If so, that person is invited to call. For higher ranking jobs, some of the present employees may be available by transfer or promotion. If the job cannot be filled by a present employee or an applicant previously interviewed and investigated, it may be necessary to select a worker from those currently making application.

Procedure for Employment. The procedure for employment depends upon the kind of job to be filled and also varies with the company. Some companies give much more elaborate tests than others. The procedure for employing salespeople would necessarily be different from that for factory assembly line workers. The following procedure is used by one employer in selecting factory workers:

1. Applicant enters from the street through a divided doorway with separate entrances for male and female applicants. A receptionist examines the job-seeker's credentials, notes his name, and admits him to the application room inside.
2. Applicant is directed to a table or armchair, provided with pencil and application blank, and, after completing the form, is referred to an interviewer.
3. Prospective employee outlines previous vocational experience to interviewer. He is advised of openings for which he might qualify, union agreement provisions which concern him, and company policies and regulations affecting employment.
4. If the applicant desires a job for which he appears qualified, he is directed to the physical examination room. His record is written up for file purposes.
5. Applicant undergoes a physical checkup.
6. X-ray picture is taken.
7. If applicant has met the physical qualifications of the job, he steps into the photographic identification room, receives his employment credentials and instructions as to where and when to report for work, then steps into the street at the exit.[2]

Methods of Selecting Workers. Methods and devices for selecting workers are not expected in every case to result in the employment of applicants who will succeed on the job and the rejection of those who would fail if employed. Employment methods cannot be expected

[2] Stanley R. Kuhns, "Making Job Applicants Feel They Belong," *Factory Management and Maintenance,* Vol. CIII, No. 10 (1945), pp. 97–100.

to rank or to grade workers in a manner which would be predictive of the degree of success. While much progress has been made in the development of scientific methods of selecting employees, no method or combination of methods can be relied upon always to result in the best selection. Employment methods can be considered to be good if they make possible the classification of applicants into three groups: those likely to succeed on the job, those likely to fail, and those whose success is doubtful.

Since few employers rely upon one method of selection, a combination of methods is usually used. The following are possible:

Preliminary interview.	Personal investigation.
Application blank.	Mental tests.
Letter of application.	Special aptitude tests.
Photograph.	Trade tests.
Employment interview.	Social interest tests.
Recommendation.	Physical examination.

Preliminary Interview. The preliminary interview is the initial greeting of the applicant by the receptionist together with a brief discussion of the purpose of his visit to the employment office. Its purpose is to find what type of job the person is seeking, to inform him whether such a position is available, and to instruct him to fill out an application blank if that is the proper procedure. When no job suited to the applicant is open or in prospect, the applicant should be told that this is the case in order that he may save his time and continue on his way. This is desirable for both the applicant and the company.

Application Blank. The application blank should be filled out by the applicant. The information requested may be classified into four groups as follows:

1. Information designed to identify the applicant and to make it possible to communicate with him later. This information includes name, address, date and place of birth, telephone number, business address, social security number, and color of hair and eyes.

2. Information designed to indicate the kind of job for which the applicant is suited and the prospects of success on the job available. This information is difficult to evaluate because it varies with the job and is in many cases a matter of opinion. The information of this type may include sex, height, weight, citizenship, marital status, number of dependents, education, languages spoken, military record and physical disabilities sustained in service, homeownership, employment experience, and machines operated.

3. Information to enable the employment section to verify statements made. This information consists of name and addresses of former employers and persons named as references.

4. Information to enable the industrial relations department to serve persons employed. This includes fraternity or lodge affiliation, athletics or sports activities, musical instruments played, and hobbies. Unless the applicant understands the purpose of such questions, he may regard them as an intrusion. He may refuse to answer such personal questions as whether his wife works and whether he is a vegetarian. The applicant may also think it unfair to ask what was his salary in his last position and what is the lowest salary he would accept.

While some information may serve more than one purpose, there should be a definite reason for the inclusion of each question. Application blanks of various companies have been found to be very much alike. This fact indicates that employers have not given adequate consideration to the form of the blank and the types of information desired of applicants.

The uses of the application blank are indicated in part by the four classes of information requested. The information given in the blank may also be used as a basis for opening the interview, since the interviewer knows the name of the applicant and something about his education and experience. It also makes for a better interview by eliminating any necessity for recording personal data during the interview. If no suitable opening is available when the application is received, the blank may be filed for future reference. If the applicant is hired, the blank becomes a part of his permanent file.

Letter of Application. Applications for positions, particularly for the staff departments, are frequently received by mail. They supply personal information concerning the applicant and also afford some basis for judging his ability, unless the applicant had assistance in composing and writing the letter.

Letters of application are necessarily supplemented by other methods of selection before the employment contract is completed. Their value is that they may indicate whether personal interviews, letters of recommendation, tests, and investigations are desirable.

Employment Interview. One purpose of the employment interview is to get information from the applicant. An attempt is made during the interview to reach an opinion as to the applicant's general ability; his technical training and experience; his success in positions previously held; his physical defects, if any; his health; and other qualifications varying with the job and also the interviewer.

Another purpose of the employment interview is to inform the applicant concerning the job and the company. The interviewer should undertake to sell the job to the applicant but not to oversell it. He should point out both the desirable and undesirable features. The applicant especially wants to know the rate of pay, the hours of work, the duties of the job, the conditions of work, the possibilities of promotion, the probable duration of the job, the dates of paydays, accident hazards, uniforms or clothing required on the job, and many other facts concerning employment. However, the interviewer should not take time to inform the applicant of the job if he decides that the applicant is not qualified for it.

The interview is also intended to create a friendly attitude toward the company on the part of the applicant regardless of whether he is offered a job. A person who is to become an employee should receive favorable first impressions. In handling large numbers of applicants day after day, the interviewer sometimes forgets that each applicant approaches the employment office with anxiety and perhaps timidity. The experience is often a new one for the applicant. The interviewer should attempt to treat each case as one requiring individual attention. A rejected applicant should leave the employment office with the feeling that the management appreciates the worth of an individual and that the company would be a good place to work. This attitude is very desirable not only because persons seeking employment have great need of sympathy, encouragement, or perhaps vocational guidance but also because the number of rejected persons residing in the community may, after a period of years, be large enough to affect the attitude of the public toward the company. By showing courtesy, sincerity, and a personal interest in the applicant, the employment section can exert a strong influence upon the public relations of the company.

The interview is conducted in various ways. The principal methods are as follows:

The Conversational Interview. When this method is used, the interviewer discusses the various features of the job and attempts to get the applicant to talk freely about himself. Without a fixed procedure, he lets the discussion follow a natural course. Before the interview is ended, he undertakes to learn from the applicant any facts which have not been adequately considered.

The Aggressive Interview. This method consists of an attempt to put the applicant to a test to see how he will handle himself in a trying situation. For example, the interviewer may ask the applicant why he considers himself qualified for the position. He may constantly ask

other questions which put the applicant on the defensive. This type of interview may fail to accomplish the three purposes previously stated. When the procedure followed in the employment office becomes generally known, the method will become ineffective for accomplishing whatever purpose was intended. This system is usually regarded as having little to recommend it. As Herbert Moore says, the interviewer "should avoid being an authoritative impertinent cross-examiner who puts the applicant on the defensive and prevents a natural expression of hopes and interests."[3]

Formal Questioning. The interviewer may follow a fixed set of questions and record the answers as they are given by the applicant. This method is often used when no application blank is required of the worker, and it is also used to obtain additional information after the application blank has indicated that the applicant may be qualified. The information may be recorded during the interview or after the applicant has departed.

The Grading Interview. The interviewer may evaluate or grade the applicant on the basis of the various qualities required on the job, such as personal appearance, conversational ability, enthusiasm, general knowledge, attitude towards the company, and experience in the job for which the applicant is being considered. The applicant may be rated separately on each trait, and the ratings may be recorded without averaging. Another method is to figure a total score for each applicant on the basis of the ratings assigned on each quality. A total score must be used with caution because a low rating on one quality might in fact completely disqualify an applicant.

Recommendations. Letters of recommendation are widely used but almost universally discounted. Their value depends upon these conditions:

1. That the person writing the letter knows what qualifications are important for the position and can judge the kind of person who will succeed in it.
2. That he knows the applicant well enough to speak of his qualifications for the job.
3. That he is honest and will say what he believes regardless of whether the applicant gets the job.

Letters of recommendation may fail on any one of the three counts. The applicant may be expected to give as references the names of per-

[3] Herbert Moore, *Psychology for Business and Industry* (New York: McGraw-Hill Book Co., 1939), p. 96.

sons with whom his record has been best and who he believes will write favorable letters. The honesty and sincerity of the person recommending may be affected by the circumstances under which he is asked to write, of which there are three:

1. The letter is requested by the applicant and is given to him for forwarding to the employment officer. Such letters are of little or no value.

2. The letter is requested by the applicant but is sent directly to the employment officer. This type of letter is occasionally of some value. It should be judged by the faintness of praise given the applicant or the enthusiasm manifested by the writer.

3. The inquiry is received from the employment officer, and a confidential reply is made directly to him. This type of letter is more likely to be a true and honest statement. Its value may be increased if the initial inquiry indicates the qualities desirable for the job. Many employment officers also point out that failure on the job will have a bad effect upon the applicant and that, in fairness to him, he should not be recommended for a position in which he is likely to fail.

Personal Investigation. An investigation by the employment section may be made by personal visitation or by telephone. It is used to verify statements made on the application blank and during the interview. Personal investigations sometimes reveal dishonesty, excessive drinking, and other serious facts which would otherwise not be detected. Since the applicant may request his associates to tell only certain things concerning him, the scope should be broad enough to prevent collusion. Questions which are asked should be of the type that cannot be answered by "Yes" or "No." The investigator might ask, for example, what the nature of the responsibility of the applicant was or what program he initiated or completed.

Two objections may be made to the personal investigation. First, it is too costly to be generally used. Second, the wrong kind of questions asked of landlords or business associates may cause them to believe that the applicant is suspected of wrongdoing. To avoid this danger, the questions should be worded with care; and the investigators should be trained to follow prescribed methods.

Mental Tests. Mental or general intelligence tests have been the subject of much controversy and much experimentation. While opinions differ, most authorities consider that the tests are of value, provided that they are carefully prepared and administered and that exclusive reliance is not placed upon them. The use of mental tests in

employment assumes, first, that intelligence is important for the job and, second, that the tests measure intelligence. As for the first assumption, a high degree of intelligence is not necessary for all jobs. In some types of work a person of lower mental capacity may be more satisfied and more willing to stay on the job than an ambitious, aggressive person of high mental capacity. Persons with low test scores should not be placed in jobs where they might cause great damage to materials or equipment or where they might cause themselves or fellow workers to be injured. If the tests measure intelligence, a distinction must be made between intellectual capacity and achievement, that is, between ability to learn and present experience, education, and training.

An example of a short general intelligence test is given in Figure 51.

A good test should meet the following requirements:

1. Directions to the candidate should be clear and concise. If questions have varying weights, the weighting should be indicated.
2. Separate instructions should be given to true-false, matching, completion, and multiple-choice questions.
3. The test should require a minimum of writing.
4. Each question should include only one basic point or idea.
5. Only one correct answer for each question should be possible.
6. Statements should be positive or contain single negatives. Double negatives should be avoided.
7. The number of questions should be large enough to reduce the possibility of chance scoring.
8. Questions should be so difficult or so numerous that few or no persons will measure perfect. Few should make scores of zero.
9. The range of grades should be as wide as possible to permit the ranking of the applicants.

In giving the test, the examiner should endeavor to quiet the fears of the candidates, since the results may be affected by their nervousness. All should start and stop at the same time because the time required is important in the scoring. Interruptions during the test should be prevented, if possible. Grades should be assigned, and the candidates should be ranked. If the group is sufficiently large, the candidates should be classified into percentiles for purposes of comparison with other groups of persons taking the test. It is usually considered inadvisable to tell the people their rank on the test because they may attach too much significance to slight differences. If the applicants are a select group, as a result of eliminations at earlier steps in

the employment procedure, the results of the intelligence tests may be misleading. Tests should not be given to executives. Such a procedure would likely result in criticism of the whole program by those who made low scores.

GENERAL INTELLIGENCE TEST

Check the one best answer to each of these questions

1. A nose is to a man as a snout is to a:
   Dog.... Cat.... Pig.... Fish.... Bird....
2. Write a number after each word to show the order in which it should be used if a good sentence is to be made of all the words.
   embankment ( ) train ( ) down ( ) lost ( ) an ( )
   people ( ) lives ( ) rolled ( ) many ( ) the ( )
   and ( ) their ( )
3. A place in which to eat begins with:
   m.... c.... i.... o.... f....
4. is to .... as .... is to: ....
5. If Anna had four times as much money as Jean plus $8, she would have $24. How much money does Jean have?
   $4.... $8.... $12.... $16.... $64....
6. A and B had a race. B had a start of 30 yards, but A ran 4 yards while B ran 3. A won by 40 yards. How long was the course?
   150.... 350.... 320.... 280.... 240....

FIG. 51. A Short Intelligence Test

Designed by Donald E. Super, for publication in *Look* magazine, Vol. X, No. 24 (1946), p. 55. Reproduced by permission of the author and editor. Other tests are from the same source.

The test itself should be tested. This is done by administering the test to present employees and correlating the results with employees' records on the job. The scores made by new employees when hired should also be compared with their later success on the job. Test scores should be compared with such data as regularity of attendance, freedom from accidents, time required to learn the job, number of days on the job before leaving the company, and ratings assigned under the merit-rating plan. Tests may be improved by eliminating those which do not show a correlation with experience on the job or which do not result in an adequate distribution of scores. Experience indicates that test scores are more closely correlated with performance for office workers than for factory workers doing skilled or semiskilled jobs.

Special Aptitude Tests. Numerous tests have been perfected to test special or particular ability which may be necessary to the perform-

ance of a specific task. Special aptitude tests usually require the use of especially designed equipment or mechanical devices. Tests are available for measuring such capacities as space comprehension, distance judging, quickness of motor responses, ability to distinguish colors, and manual or finger dexterity. Some of them test abilities

CLERICAL APTITUDE TEST

In the following number series, cross out any number in the second series which is not the same as the number in the first series. For example: 2396 – 2366
The first "6" in the second series of numbers is crossed out because it should be a "9", corresponding to the "9" in the first series.

Check following figures in same manner:

9763 – 9763	2193 – 2133	7681 – 7688	7629 – 7629
1354 – 1154	2976 – 2976	3191 – 3791	1918 – 1918
1376 – 1376	6711 – 6711	8124 – 8124	5255 – 5255

Check following names in same manner:

James and Co. . . . James and Co.	Watson, Mills. . . . Watson, Mills
Maine and Co. . . . . Main and Co.	Johnson Bros. . . . Johnson Bros.
Wright Ditson. . . Wright Ditson	Munson Wears. . Manson Wears
Spalding Co. . . . . Spalding Co.	Jersey Bros. . . . . Kersey Bros.
Knight, Dunlap. Knight, Dunlop	Schiele, Co. . . . . Scheile, Co.

FIG. 52. A Short Clerical Aptitude Test

which may later decrease in effectiveness, such as tests of vision. Others test abilities which may be developed by training, such as manual dexterity or memory. When used in conjunction with other methods of selection, special aptitude tests have much value. A brief clerical aptitude test is reproduced in Figure 52.

Trade Tests. Trade tests, sometimes called "achievement tests," attempt to measure the knowledge of a trade skill in performing certain types of work at the time the tests are given. They are not intended to determine the ability of the applicant to learn. One type of trade test consists of a list of questions which are asked orally by the examiner. The advantage of this type of test is that it eliminates the danger that the applicant will misunderstand the questions. Persons who are not accustomed to take written examinations may do best on the oral examination. Care may be required in making the test standard.

The trade test may include pictures of tools or parts which the appli-

cant is asked to identify or explain. This type of test is practical and can be made as difficult as desired. The test may be unfair if the tools or machines used are of a different make or model from those which are familiar to the applicant. A short test of this kind is shown in Figure 53.

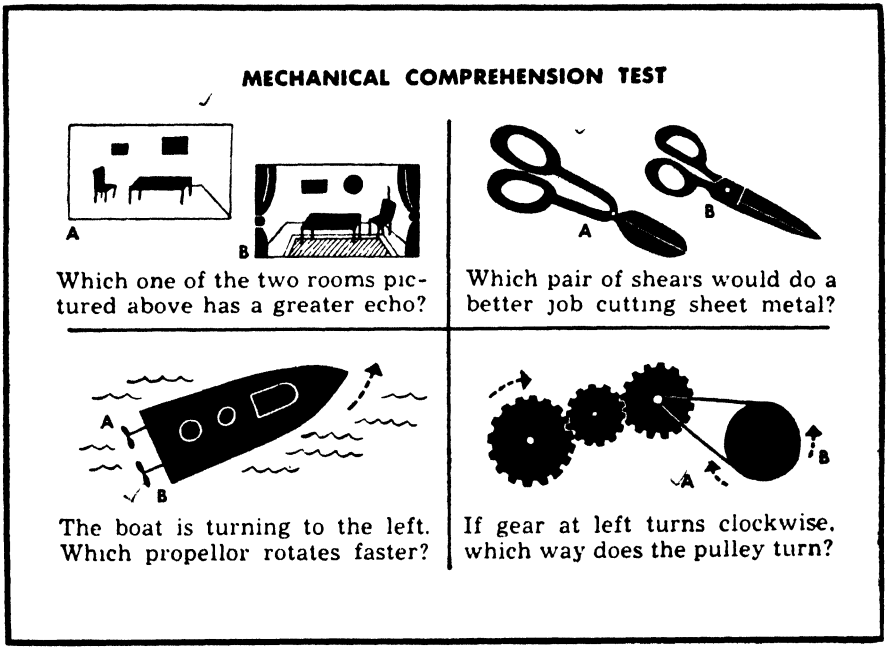


FIG. 53. A Short Mechanical Comprehension Test

A good type of trade test is the performance test, which requires the applicant to perform a small task which is similar to the job. This kind of test has been standardized, and the time allowed the applicant has been established by repeated use. Rules for scoring indicate the penalties for errors and omissions. Performance tests are usually expensive to design and administer.

Social Interest Tests. Social interest tests of various kinds are intended to indicate the things that a person would like to do or is suited to do. Tests have been designed to determine the applicant's absent-mindedness, love for showmanship, jealousy, aggressiveness, sensitiveness, or other traits. The principal value of such tests is in vocational guidance. They are of little value in an employment office because the applicant is inclined to give the answers which he thinks will be most likely to get a job for himself. A social interest test is reproduced in Figure 54.

PERSONALITY INVENTORY

These are questions about your aptitudes and feelings. Check each under "yes", "no" or "?". There are no right or wrong answers.

	Yes	No	?
Do you like to be "different"?	☐	☐	☐
Do you blush easily?	☐	☐	☐
Do you like to be praised?	☐	☐	☐
Do you hesitate to make up your mind?	☐	☐	☐
Are you sometimes too talkative?	☐	☐	☐
Have you ever heckled a public speaker?	☐	☐	☐
Would you rather work for yourself?	☐	☐	☐
Do you write better than you speak?	☐	☐	☐
Do you tend to trust people?	☐	☐	☐
Does your work tire you too much?	☐	☐	☐
Have you ever asked for a raise?	☐	☐	☐
Do you enjoy the people you work with?	☐	☐	☐
Are you inclined to daydream?	☐	☐	☐
Does anyone dominate you at home?	☐	☐	☐

FIG. 54. A Short Personality Test

Physical Examination. Physical examinations may be used for either the selection and rejection of applicants or their placement in work suited to their physical abilities. In hazardous industries, physical examinations may be desirable in order that workers may be protected from injuries due to their inability to hear or see well or to do heavy lifting, or due to their susceptibility to certain diseases. To be effective, examinations should be given at regular intervals and not merely at the time of their initial employment.

One purpose of the physical examination is to reduce employment and training costs by selecting workers who are qualified and who will profit from the training. Accident rates may be reduced by the proper placement of new employees. Another purpose of the examination is to reduce illness and absenteeism and also claims for compensation due to illness or disease existing at the time of employment. Fellow workers and customers may be protected from exposure to infectious diseases.

Physical examinations may be complete, or they may be limited in scope. They usually include tests of blood pressure, heart action, lungs, chest X-ray, and eyes and ears; and they may include urinalysis. In a small plant the examination may be given by a local physician who is employed on a retainer basis. The examining physician may be asked to indicate whether the applicant can perform work which requires lifting

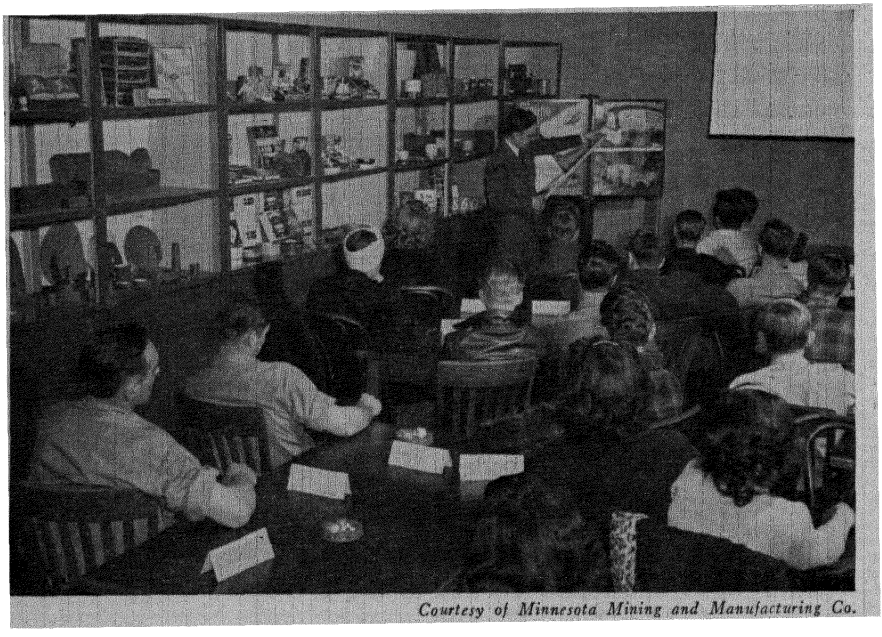
to the waist, lifting above the waist, standing, walking, climbing, use of one or two hands, use of hands and feet, or exposure to dust, fumes, heat, noise, or moisture.

Workers frequently object to physical examinations. The principal reason seems to be a fear of rejection; if all employers gave such examinations, some applicants might be unable to get permanent employment with any company. Another objection is that some employers have used them as a means of combating the union or refusing employment to applicants known to be active in the union. When physical examinations are used fairly, they are advantageous for the worker as well as the employer.

Introducing the Worker to the Job. The final step in the employment procedure is the introduction of the worker to the job. This phase should not be neglected, for many separations result from failure of the applicant to become adjusted to the new situation. One objective of the induction procedure is to make the new employee feel that he is a part of the company and that he belongs to the group. It should also impart additional information concerning the company and the job. The induction procedure of one large employer includes the following:

1. The applicant, after being employed, signs an employment card, payroll forms, and forms required by the government for purposes of social security and income tax deductions.
2. The applicant is assigned a clock number and is given a temporary pass. He is instructed to return within two weeks for a permanent pass.
3. The employment manager gives an induction talk to a group of new employees. He gives the essential facts concerning company history, explains how the company started and how it expanded, discusses the policies of the company toward its employees, and explains the position of the factory in relation to the entire organization of the company. At the conclusion of his talk, he gives each new employee a copy of the union contract and a safety instruction booklet. Figure 55 shows a group of new employees receiving preliminary instruction.
4. New employees are welcomed by the industrial relations manager, who endeavors to make them feel at home as a part of the organization.
5. The employee is taken to the department to work. He is introduced to the superintendent, who explains the work of the department and explains also the safety rules to be observed on the job.

6. The employee is taken to the foreman, who inducts him into the job. The foreman shows him the locker room, washroom, and other employee facilities and tells him how to get tools and materials. The foreman also tells the new employee what to do if he is injured, how his pay is figured, and what his hours of work and his lunch period are.



Courtesy of Minnesota Mining and Manufacturing Co.

FIG. 55. Use of Visual Aids for Induction Talk to New Employees

7. The employee is introduced to the timekeeper and shown how to punch the clock card.

8. The employee is introduced to his fellow workers.

9. He is given specific job instruction by the foreman and begins work on the job.

10. The employment manager writes a letter to the worker at his home. The letter is to be read by all members of the family and is designed to gain their loyalty to the company.

11. After two weeks on the job, the employee reports back to the employment section for his permanent pass. At that time an effort is made to learn whether the employee has had any difficulties on the job and whether he is in need of further assistance. Employee services not explained on the first day, such as clubs and recreation facilities, are discussed with the worker.[4]

[4] See J. P. Woodward, "Select the Right Workers," *Factory Management and Maintenance*, Vol. CIII, No. 8 (1945), p. 84.

QUESTIONS

1. A young man is appointed personnel manager for a small enterprise which has not had a separate department for the handling of personnel relations. Explain fully how he should proceed.
2. What can an employment manager do to build up the sources of labor supply?
3. What information is contained in the requisition for employment?
4. What is the purpose of the preliminary interview?
5. What purposes are served by the application blank?
6. The applicant is frequently asked to list on the application blank all the positions he has held and to indicate in each case the reason for leaving. Can the applicant be expected to tell the truth in case he was discharged?
7. Application blanks are frequently filed and held until a suitable position is open. How can the employment section keep its file of application blanks up to date?
8. What is the value of a photograph in the employment procedure? Can honest persons be distinguished from dishonest persons by their personal appearance?
9. The purposes of the employment interview have been summarized in three phases: to get information, to give information, and to make a friend. Explain what information may be obtained and given and how the interview may be used to make a friend.
10. "Letters of recommendation are sealed with a shrug and opened with a smile." What is the meaning of this statement?
11. "Letters of recommendation should be written with triple space to permit reading between the lines." Explain what is meant.
12. What is the value of personal investigations?
13. How may a test be tested?
14. What special aptitudes may be determined by means of tests?
15. What is the value of the social interest tests? What is its principal limitation?
16. What are the purposes of the physical examination as to test for employment?

CASES

59. PAYMENT OF EXPENSES OF APPLICANTS FOR POSITIONS

The Toledo Rubber Company each year employs a number of college graduates in the fields of chemistry, engineering, accounting, and business administration. The personnel manager arranges for interviews at various colleges and universities, and he then arranges for the most acceptable candidates to go to Toledo for interviews with other persons in the management and for a visit to the plant. It has been the practice of the company to pay all of the expenses of applicants for this trip. However, the personnel manager has learned that some applicants make a number of such trips to the main offices of various

companies, and he believes that some of them go to Toledo for the sake of the trip when they have no intention of accepting a position with the company. Inquiry indicates that about half of the corporations which solicit applications from college graduates pay all expenses of all applicants. Others pay only half of the expenses or none of them, and some pay only after the applicant has been hired and has worked for thirty days.

Questions:

1. What arrangement, if any, should the company make for paying traveling expenses of applicants?
2. What other information should the personnel manager assemble before he makes a decision?

60. INTERVIEWING THE JOB

In the Watkins Corporation, about 30 per cent of the separations of employees were found to occur during the first 60 days after employment. The personnel manager believed that an important reason for the terminations immediately after employment was that the employment department did not succeed in explaining clearly to applicants all of the conditions of work. Even though the interviewer might explain that the workplace would be dirty, noisy, or otherwise disagreeable, applicants were not able to visualize from an interview just what the conditions were like. The manager sought some way to correct this difficulty.

On a trial basis the personnel manager asked the employment department to have the applicant "interview the job." If an applicant measured up to the requirements of the interview and the tests given in the employment office, he was taken to the place where he would work. He was introduced to the foreman and workers in the department and shown the work station where he would be assigned if employed. He was permitted to remain with the foreman and at the work station for an hour before he was returned to the employment department. During the first two months that the new plan was followed, separations in the total labor force decreased from 10 per cent to 6 per cent per month.

Questions:

1. What costs arise from labor turnover?
2. What could the applicant learn by inspection of the job?
3. What objections might be made to the plan?

61. SIZING UP APPLICANTS DURING INTERVIEW

The employment manager of a large corporation each year interviews a number of college graduates with a view to employing some of them for training for executive positions. He always asks them, "Why do you want to work for this company?" Here are some typical answers:

"I know that the company has a strong financial position; and I am sure that, with its present management, it will continue to be a strong company. If I

make good, my position will be secure; and I will have no worries for the future. Retirement pay of the company is adequate, and I know that I will be able to live comfortably after I retire."

"The company produces a good product, and its research program gives assurance that it will maintain its competitive position. I know that the company watches its young executives and gives them an opportunity to prove their worth. In a growing company that promotes on merit, I believe that I will be able to go as far as my capacities permit. I want an opportunity to see what I can do in a good company."

"I like the company's policies and the way it treats people. The company deals fairly with the union and does not try to undermine its position. It seeks to maintain a proper balance between the interests of employees, consumers, and stockholders. I want to be associated with a company that thinks first of its people and second of profit."

Question:

How should the employment manager rate the applicants in their answers to this question?

62. CONTRASTING TYPES OF EMPLOYMENT INTERVIEW

A woman interviewer received a call from a woman applicant during a slack season when few people were being employed. After a few minutes of discussion, the interviewer became convinced that the applicant was not qualified for any vacancies. Instead of dismissing the applicant, however, she led her to talk of her qualifications and interests in an effort to help her. In the course of an informal discussion of about 30 minutes, the interviewer mentioned several other companies where the applicant might find employment; and she also gave her information concerning courses in local schools. After the applicant had left the office, the interviewer found a note in a box near the door, which read: "I did not get a job today, but I got the courage to go on."

In another company the interviewer for prospective sales personnel followed the practice of pretending to be very busy when the applicant entered the room. After keeping the applicant waiting for a few minutes, he directed a series of rapid-fire questions to him in an effort to see how the applicant could handle himself in a difficult situation. Typical questions were: "What experience have you had to qualify yourself for this position?" "What reason do you have for thinking you can sell our product?" "What do you think you have to contribute to the company?" If the applicant withstood the barrage of questions, he was led into an informal discussion for a free expression of ideas.

Questions:

1. What types of interview are represented by the two cases?
2. What might be accomplished by each type of interview?

CHAPTER XXIX

TRANSFER, PROMOTION, DISCHARGE

POLICIES and problems concerning transfer, promotion, demotion, and discharge of employees are the joint responsibility of the industrial relations manager and the line executives. Problems of this kind were formerly handled solely by the foremen in their respective departments. This situation was unsatisfactory because foremen were untrained in personnel problems and also because their point of view was too limited. Occasionally, a worker might be transferred from one department to another by joint arrangement of the two foremen, although more frequently each foreman formulated his own policies and acted without regard to conditions elsewhere. Foremen frequently discharged workers in one department, only to have them apply for and receive jobs in another department. Subject to little or no control in their authority over men, foremen were known frequently to discharge workers for inadequate cause and sometimes only for the purpose of giving expression to their own frustration. In most companies the foreman may now recommend such action. Discharge must be approved by his superior, who has the advice of the industrial relations department.

Transfer of Workers. Transfers may be made from one job to another within a department or from one department to another. Transfers within a department leave the worker under the supervision of the same foreman. Transfers to another department may require the worker to perform an entirely different kind of work and also may place the worker under the supervision of another foreman.

One reason for the transfer of a worker is an expansion in the volume of business of one department accompanied by a decline in another. An example is the relationship between the streetcar and bus industries. Seasonal variations require similar short-time transfers.

For example, a department store may transfer salespeople from the millinery department to books or porch furniture to meet changes in seasonal demand. Transfers may also be made to enable workers to leave blind-alley jobs or departments whose promotional opportunities are limited. For purposes of training executives, some employees may be transferred from one department to another in order that they may receive experience in many different kinds of work. Workers who have completed training programs on or off the job may be transferred to give them opportunities to use their training. Transfers are also advantageous if the worker dislikes the duties of his present job. For example, a clerical worker may prefer shopwork, or a machine tender might prefer a bench job. A transfer of a worker who has been unable to co-operate with his foreman or his associates is more difficult to justify. Occasionally, transfer affords the best permanent solution to personal difficulties.

Transfer usually provides greater opportunity to the worker to increase his pay or to advance within the organization, although this is not necessarily the result. A worker who is transferred because his job has been dispensed with as a result of the introduction of labor-saving machines or a change in the design of the product or the introduction of new methods of production may be given a job with a lower rating or a tighter standard. In that case the transfer may result in lower earnings. This situation is frequently the subject of a clause in the union contract which may provide that employees shall not be subject to reduction in rates because of a transfer from one classification to another, except by mutual agreement between the company and the shop committee of the union. A clause which is somewhat more favorable to management permits the union to challenge the reduction in pay and to present the matter to an appropriate committee.

Promotion. In the minds of some persons, promotion means an increase in authority over persons and perhaps a change in title. It may also mean an increase in wages or salary on the present job. The worker may consider that he has been promoted if he is given a higher rated job or is transferred to a location carrying greater prestige or less exposure to undesirable working conditions. The social prestige of an incumbent may be increased by the granting of special privileges or exemptions, such as a special place to park his car, or exemption from the requirement to punch the time clock.

Every person wants promotion, provided it means only increased pay, greater social prestige, or better working conditions. Many workers do not want increased responsibility or greater authority over

other persons. Their reasons are that responsibility means care and perhaps worry and that such a promotion carries with it the possibility of failure.

The Promotion Chart. Every worker should know the direction in which he may be advanced. If his present position offers no chance of promotion but only transfer, the worker should know it. Blind-alley jobs may include those of office boy, mail clerk, telephone operator, elevator operator, doorman, and some stenographic jobs. Mr. and Mrs. Gilbreth recommended that a promotion chart be prepared for each job showing all possible directions of development and promotion. This chart, which they called "the glory chart," was to be made a part of the personnel record of the worker. It was to be shown to him at regular periods of counseling, when his work was reviewed with him and vocational guidance was given.[1] The promotional chart does not make provision for advances due to off-the-job training. For example, a stenographer might become a cost accounting clerk or a production control clerk as a result of the completion of special training courses.

A promotional chart for a technician in a telephone company is shown in Figure 56. This chart shows that if a person starts as a lineman, he may transfer to the position of installer repairman, frame man, or cable splicer's helper as indicated by the broken lines. If he makes the transfer after he has been advanced in pay as a lineman, he may transfer at approximately the same wage rate as his pay as lineman. This relationship is indicated by the horizontal broken lines in the middle of the chart. The top pay for each job in relation to the pay of the other jobs is indicated by the distances from the top rectangles to the base of the chart.

Basis of Promotion. The reasons for promoting a worker are many. An increase in pay may be awarded for performance on the present job or after a specified number of months of satisfactory experience. Salary advances may also be based upon age or the completion of a training program. Promotion to a position requiring greater responsibility for machinery or materials or the supervision of the work of others should be made on the basis of the qualifications of the person for the increased responsibility.

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[1] F. B. Gilbreth and L. M. Gilbreth, "The Three Position Plan of Promotion," *Annals of the American Academy of Political and Social Science,* Vol. LXV (1916), pp. 289–96. For illustration of the "glory chart" or "ladder of success," see *Fortune,* Vol. XLII, No. 1 (1950), p. 94.

The union is interested in the promotion of employees because the management might discriminate against union members or union officials in promotions. An employee who thought that union activity would close the door to his advancement with the company would have little interest in working for the union, since the union offers a career

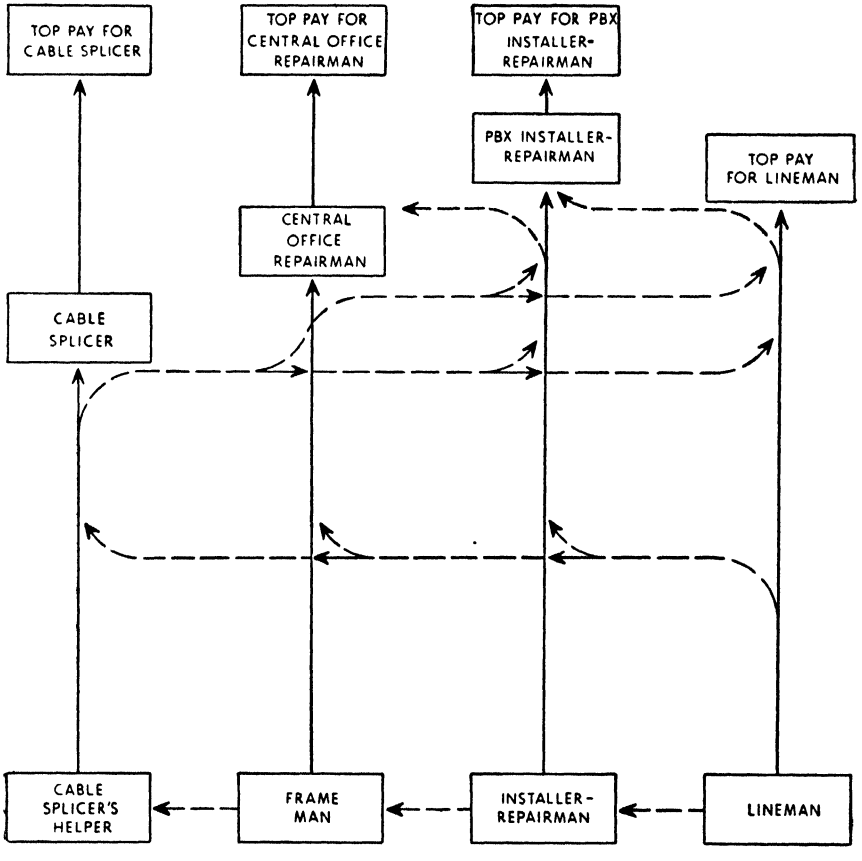

FIG. 56. Promotion Chart for Technician in Telephone Company

(PBX means Public Branch Exchange. Lines of promotion are solid. Lines of transfer are broken.) Chart by courtesy of George O. Clark.

to very few persons. The union, therefore, often insists that wage rates be subject to review by a board composed of representatives of the company and the union or that union approval be required for all promotions to supervisory positions. Another provision that has been incorporated in some union contracts is that no person can be promoted to a supervisory position unless he is in good standing with the union when the promotion is made.

Seniority Rights. Seniority may be a recognized factor in promotions, wage increases, discharges, layoffs, rehiring, preferences as to shifts or jobs, and preference in the scheduling of vacations. Management usually objects to making promotions on the basis of seniority because the oldest worker may not be the best one and may not have the personal qualities necessary for a good executive. Persons who would make good executives may be unwilling to start at the bottom of the organization and to wait for vacancies, as they would be required to do if positions were always filled by promoting the person with the longest service. To prevent discrimination against union members, the union may ask that seniority be one factor in promotions. This may be accomplished by a provision that representatives of the union and of the company will agree upon six persons who are qualified for promotion and that the man in the group who has the greatest length of service will be promoted. Even this provision is objectionable to management, which considers the making of promotions to be its own prerogative. Most companies would prefer to make promotions on the basis of merit.

The principal seniority rights are the right to the job in case the work force must be reduced and the right to be taken back first when the work force is increased. In other words, layoffs are in the reverse order of seniority, with the workers most recently hired laid off first; and rehiring is in the order of seniority, with the workers of longest service rehired first. The right of workers who have seniority to choose the shifts they prefer may result in putting newly employed workers on night, Sunday, or holiday work. This provision makes many kinds of work unattractive to young women. If they refuse certain kinds of work or night and Sunday shifts, they may not acquire the seniority which would give them the right to ask for more desirable jobs or hours.

Even though the management policy as to seniority has been established, there remain several questions concerning the acquisition and termination of seniority rights. To have seniority, it is generally agreed that the term of service of the worker should be unbroken. When the worker quits or is fired, he loses his seniority and must again start at the bottom if he is re-employed. Workers who are temporarily laid off or go on strike do not lose their seniority, but such time does not count in figuring months of service. Time spent in the armed forces during World War II must be counted, since this is required by federal law. A worker who is called back after being

laid off and who fails to return within a specified number of days usually loses his seniority rights. Continued absence may also cause a loss of such rights.

Seniority rights may or may not be lost upon transfer to a new department. For example, a streetcar motorman who becomes a bus driver for the same company may have to start at the bottom of the seniority ladder in the bus division. A worker who fails to make good in his new job and must go back to his old job may or may not retain his seniority. The employer usually prefers that seniority be plantwide because he meets with less objection from workers who are transferred. The union also frequently prefers plantwide seniority because the union is interested in protecting workers with seniority rights regardless of department. However, many unions do not insist that seniority rights be recognized because the union does not wish to discriminate between its own members. The attitude of the individual worker usually depends upon the effect of the rule on his own status.

The strict observance of seniority as a basis for laying off and rehiring workers has significant effect for the worker, the employer, and the community. The seniority rule discourages the movement of workers from one company to another or from one place to another. Persons who have been laid off are inclined to remain in the community in the hope that they may soon be rehired. The effect is to increase the labor reserve in the industry and to decrease the effectiveness of the total labor force.

The number of men who are affected by technological change is increased. A worker whose job is dispensed with because of technological change takes the job of a junior employee who in turn takes the job of a worker with less service. Without seniority rights, only the worker who is no longer needed would be affected. The effect of seniority rights is to increase the opposition to technological change. For the same reason, workers are more interested in "feather bedding" or make-work practices.

Observance of seniority rights makes discharge a severe penalty because the discharged worker must start at the bottom of the seniority scale with another company. Seniority rights prolong the working life of the worker because older workers are retained when the force is reduced. Workers are less willing to strike if they think that seniority rights may be threatened.

Pension plans receive wider support because workers are more inclined to remain with one company long enough to earn participa-

tion rights. Men having seniority are encouraged to join the union in order to protect their seniority rights.[2]

Demotion. Demotions should be avoided, if possible, because of the effect upon the individual. The person who has been advanced in rank or status and then put back in his former position is likely to be dissatisfied with himself and his employer. The necessity for demotion may be avoided by advancing on a temporary basis a person being considered for promotion. He may be promoted for a trial period during the absence of the regular incumbent because of illness, vacation, or other reasons.

Failure to receive a promotion which was expected or believed to be merited may have as serious an effect upon a person as a demotion. A change which is generally regarded by the associates or subordinates as a decrease in authority also has the same effect as a demotion, even though an announcement is made that the change is only a reorganization. For example, the shifting of a division or an activity from the authority of one executive to another or the placing of office workers in the same building as shopworkers whose jobs are regarded as inferior in status may be regarded as a demotion, even though no changes are made in rates of pay.

Unless reductions in rank are made with great care, the person who has been demoted is likely to lose interest in his work and may ultimately be lost to the company. If the worker can find another job with similar rates of pay and working conditions, he is likely to leave. If he remains with the employer, he may cause trouble by creating dissatisfaction among the other workers, violating company rules when he considers it safe to do so, absenting himself from work when he feels like it, filing charges of discrimination with the union steward, and possibly increasing his participation in union activities in order that he may build up his self-confidence and overcome his feelings of frustration.

Layoffs. A decrease in the amount of work available may require the laying off of a number of the workers or a reduction in the hours per week of all of the workers. The policy to be followed may be left entirely to the employer, or an agreement may be included in the union contract. Some unions prefer not to assume responsibility for the decision, since the efficient workers or the workers having seniority may consider a spreading of the work unfair to them, while older,

[2] For full discussion of the effect of seniority on management, see S. H. Slichter, *Union Policies and Industrial Management* (Washington, D.C.: Brookings Institution, 1941), pp. 151–61.

less efficient workers may regard a spreading of the work as a fairer solution. Unions which wish to have a voice in the decision contend that, if the decision is left to the foreman, he may play favorites; that the men may be required to be subservient in order to hold their jobs; and that control by the union is necessary to prevent the workers from speeding up in order to justify their retention on the job. A union contract may make provision similar to the following:

> When a decrease in the force is necessary because of lack of work, the employees hired during the last 6 months (or year) shall be laid off. If further reduction is necessary, the hours of work shall be reduced but they shall not be less than 35 hours per week. When further reduction is necessary, employees hired during the last two years shall be laid off. When further reduction is necessary, the hours of work shall be reduced but they shall not be less than 30 hours per week.

The agreement may make provision for further reduction in the work force or for further reduction in the number of hours per week.

When the reduction in amount of work is temporary, a spreading of the work may be preferable in order to avoid throwing the full cost of reduction upon a part of the force. This policy enables the employer to hold his men, although it creates some problems in scheduling hours. In a declining industry, spreading the work does not solve the problem but encourages workers to retain their jobs at a time when they should seek full-time employment elsewhere. It causes a reduction in the weekly pay and lowers the standard of living of the workers and their families.

Discharge. The dismissal of some workers is inevitable regardless of the care exercised in selection and employment and in supervision. Discharge should be used as a last resort after all other procedures have been exhausted. Positive action to prevent the necessity for discharge is a duty of management to both the employee and the company.

The union recognizes the right of management to discharge workers for cause. This is necessary for the security of management, for, unless management can dismiss undesirable workers, the company may eventually cease to operate efficiently. During a specified probationary period, which may be six months, management has an unlimited right to discharge. The firing of an employee during that period cannot be made the subject of a grievance under the union contract. This provision is desirable, since management should not have to justify the discharge of every probationary employee. After the agreed period, management retains the sole responsibility for discharges; but union members cannot be discriminated against because of their union affiliation.

Since the discharge of workers is subject to review by the union to prevent discrimination, it is often necessary that the rights of management to fire unsatisfactory employees be defined. While every justifiable cause for discharge cannot be enumerated, two of the common causes are incompetence and social maladjustment. Incompetence includes lack of trade skill or knowledge, inability to meet production standards, excessive spoilage, poor quality of work, and physical limitations. Discharge for incompetence requires justification because management is presumed to have determined during the probationary period that the worker was competent.

Social maladjustment is the more common cause for discharge. The reason probably lies in the fact that employment techniques are more likely to detect the lack of technical skill than the lack of the necessary social or personal qualifications. Personal causes of discharge include assault on a supervisor or a fellow employee, general insubordination, continued violation of rules regardless of warnings, drinking liquor on the premises, theft of property of the company or fellow employees, habitual lateness or absenteeism, troublemaking or clowning, accidents due to carelessness, and laziness or loafing on the job.

The union can question the discharge of any employee after the end of the probationary period. Some employers feel that the union is inclined to question the discharge of every union member and that it is unsafe to fire a minor union official.[3] To justify the discharge of any employee, the employment section should have in its personnel record for each employee the following data:

Copy of warnings sent to the worker by the foreman, or memorandum of any conference with him at which he was warned.

Memorandum of attempt made by the foreman to help the worker correct his deficiencies.

Records of production, rejects, absences, tardiness.

Records of merit ratings of the worker and reports of conferences for discussion of how his rating might be improved.

Copy of letter notifying him of his discharge. The letter should state the reason for the discharge.

Application blank. This is of value in case it has any incorrect statements.

Report of physical examinations and results of aptitude or other tests.

The Preclearance Interview. Every worker who leaves or is discharged should be interviewed by a representative of the industrial relations department. Some companies send the worker's last pay

[3] See Daniel T. Pierce, "How the Union Disillusioned Us," *Factory Management and Maintenance,* Vol. CIV, No. 1 (1946), pp. 94–96.

check to the department and notify him to call there for it. It has also been found to be good practice for the man who interviewed him at the time of employment to conduct the exit interview. In the case of workers who quit, the preclearance or exit interview is designed to accomplish these purposes:

1. To get information on the causes for leaving. These data may assist in correcting undesirable shop conditions and in improving employment and training methods.

2. To induce the worker to remain and to save the investment which the company has made in him through the employment, induction, and training procedure.

3. To prevent hasty decisions by the foremen. The foremen may be called in case the worker has had difficulties or misunderstandings with him. The difficulty may be corrected by changing the worker to another shift, improving work conditions, or removing an accident hazard. If the worker decides to stay, the foreman is put on notice that he has some responsibility to the worker.

4. To maintain the good will of employees and the public. The final interview affords an opportunity to explain the policies of the company which are misunderstood. Some departing employees may be given assistance in finding positions elsewhere in case a worker is leaving the city, or possibly in overcoming personal difficulties.

Report of Termination. The industrial relations department attends to the various details pertaining to the termination of employment. To make certain that no necessary action is omitted, it may prepare a termination report on which the various steps are checked. This report would show that the following details had been completed:

Company pass returned.
Union notified.
Group insurance canceled.
Deductions for social security, income tax, and union dues verified.
Company store notified, bills paid.
Personnel record posted.
Addressograph department notified.

QUESTIONS

1. What is the responsibility of the industrial relations department and the foremen for transfer, promotion, demotion, and discharge?
2. Does the turnover of workers within a plant result in costs when it is due to transfers from one department to another?
3. Labor turnover may result in the following costs and expenses: advertising for workers, interviewing, testing, training, higher accident rate, increased

spoilage, loss from idle machines, interruption of the flow of work to other workplaces, and more supervision. Which of these costs and expenses may also result from transfers?

4. Which of the following are satisfactory reasons for transfer to another department?
   a) Completion of a course of training in preparation for a job in another department.
   b) Dislike of one or more fellow employees in a department.
   c) Refusal of fellow employees to accept another on friendly terms.
   d) Inability to co-operate with the foreman.
   e) Personal preference for another kind of work.
   f) Disagreeable working conditions in a department.
   g) Blind-alley job in the present department.
   h) Present job injurious to health because of physical limitations of the worker.
5. Why should a company adopt a definite policy concerning acceptable reasons for transfer?
6. Should promotion be based upon merit or seniority? What is the usual attitude of unions?
7. In what respects is the seniority rule socially desirable? What results of seniority are socially undesirable?
8. Why it is better to place a person in a position which does not require his full capacities and later promote him rather than follow the reverse procedure?
9. A company is unable to provide full employment for all its employees at certain months of the year. Should it lay off some workers and provide full employment for others, or should it spread the work among all workers? What management problems arise in the spreading of the work? Should the workers and the union be consulted concerning the plan to spread the work?
10. Which of the following might be considered causes for discharge on the first offense?
    a) Drinking intoxicants on the premises.
    b) Gambling on the premises.
    c) Acting as bookmaker in gambling pools.
    d) Fighting on the premises (the aggressor).
    e) Insubordination.
    f) Willful destruction of company property (small value).
    g) Smoking in restricted area.
    h) Absence without excuse.
    i) Falsifying labor time ticket.
    j) Punching time clock for fellow employee.
11. Why is social maladjustment a more frequent cause of separations than incompetence or inefficiency?
12. Why have unions made detailed employee records more necessary?

CASES

63. PROMOTION FROM WITHIN

The Laney Machine Works was established in 1935 with 5 employees. By 1952 the business had expanded to the point where it had 250 employees. As the business has grown, higher and intermediate positions have consistently been filled from within.

When the business was first organized, employment and job assignments were handled by the owner, J. C. Laney. Later, Mr. Laney turned his attention to problems of product development, the negotiation of subcontracts with larger corporations, and plant expansion. Job assignments were made first by the works manager and later by the personnel manager.

In interviewing applicants, the personnel manager seeks to employ some persons who might be trained to assume increased responsibilities. Such persons are placed in initial jobs which would provide opportunity for advancement. The personnel manager believes that if such people are placed in dead-end jobs with the idea that they will later be transferred, they may be forgotten; or they may quit before they are transferred.

From the beginning, Mr. Laney has held weekly meetings of foremen and other people in the management group. At these meetings, new positions and vacancies are discussed; and the qualifications of employees are reviewed. The personnel manager investigates the persons mentioned and discusses their possibilities with supervisors. Employees are also interviewed. The personnel manager believes that best-qualified person is usually selected.

To overcome the natural tendency of foremen to hold their best employees, Mr. Laney believes that foremen should be trained to think of company needs rather than departmental needs. In addition to stressing this point of view at weekly meetings, the management encourages foremen to join foremen's clubs and other organizations and to take special courses in local night schools. Promising employees are also encouraged to take additional training, although no promise of promotion is made for taking such courses. The personnel manager obtains from the school the names of employees who have completed technical courses. With this information and with recommendations from persons in the management, the personnel manager is able to make recommendations for promotion when a vacancy occurs.

Questions:

1. Should the company strive to fill all top and intermediate positions by promotion from within?
2. Why are foremen inclined to keep some promising employees who might improve their own position and be more effective in other departments?
3. Does the policy of the company put pressure upon an employee to attend night school? Is this fair to the employee who is not in a position to go to night school?

64. COMMUNICATING WITH EMPLOYEES ON WORK CHANGES

In the summer of 1952, James J. Higgins, president of the Higgins Corporation, learned that the company could get a subcontract from an airplane manu-

facturer for the production of certain airplane parts. The contract would keep 50 per cent of the facilities fully occupied for a period of a year. The contract might be renewed; and in view of the national emergency, it seemed likely that the company would be kept busy for an indefinite period with a series of such contracts.

The principal business of the company was the making of parts for vacuum cleaners and other appliances. Parts were made for a number of companies according to the specifications of the customer. Materials were becoming scarce and already were subject to allocation by the government. There was a distinct possibility that the production of appliances might be seriously restricted. Mr. Higgins had also learned that, during recent years, many appliance manufacturers had increased the production of parts for their own use. After consultation with other top executives, the president signed the contract in the name of the company.

Mr. Higgins saw no reason to make a public announcement of the new contract because several weeks would elapse before production of airplane parts could begin. In the meantime, full details of the new program would be worked out. Some employees would have to be shifted to new kinds of work, but the president was sure that no employees would be dismissed. Instead, additional people would be employed.

At lunch, a clerical employee in the office of the president mentioned in strict confidence the new contract to some of the other girls. They began to speculate concerning the effect upon them and, in the case of married women, their husbands. Before long, all sorts of rumors were circulating through the plant. Older employees, particularly those over 45, thought that the company might take this opportunity to discontinue their jobs and employ younger persons on new work. Although they had spent many years at factory work, they had not acquired a high degree of skill and would have difficulty finding other work. Some workers thought they might be transferred to lower paying work. People in the sales division thought that fewer people might be required in the office as well as in the field. Similar rumors spread through the accounting, shipping, and billing departments. The results of the uncertainty began to show up in the amount of time spent away from the machines, in the number of complaints and in the general attitude toward supervisors.

Questions:

1. What should management do to communicate information concerning the new contract?
2. At what stage in the negotiations should information have been communicated?
3. What method of communication should have been used?
4. What is the usual attitude of employees and foremen toward change? Why?

CHAPTER XXX

EMPLOYEE TRAINING

IN THE DAYS of Frederick W. Taylor, employee training was not considered a responsibility of the management. Helpers or laborers were expected to learn principally from mechanics, bricklayers, or other skilled workmen with whom they came most in contact. Those workers who seemed most capable or who seemed to know most about the job were promoted by management.[1] This system was unsatisfactory because the worker learned the job well only when he observed and imitated a craftsman who used effective methods. Poor methods were perpetuated. An excessive amount of time was required for an employee to learn a job. In establishments where the foreman was expected to instruct and train the worker, the system was not satisfactory because the foreman might be a poor teacher. Moreover, as Taylor showed, the foreman had so many duties that he neglected some of them. Employee training was a responsibility which he often neglected.

Need for Training. While the development of management methods has simplified the work of the person who tends a machine, it has resulted in the organization of staff departments and has complicated interdepartmental relationships and thus increased the need for employee training. Even on routine jobs, as Gilbreth showed in his bricklaying studies, workmen will use wasteful and inefficient methods if they are not properly taught. Poor training or a lack of training results in a low rate of production, poor quality, excessive spoilage, and low wages.

Although any one company may obtain a supply of workers who have been trained elsewhere, a training program is essential for the advancement of industry. In 1915, Richard A. Feiss, a well-known

[1] Henry L. Gantt, *Industrial Leadership* (New Haven: Yale University Press, 1916), p. 42.

leader in the management movement, said that "skilled and fit men are not born, but made, and it is an essential function of any industrial organization to train men and make them fit for specific positions."[2] In 1917, Henry L. Gantt said that "the nation which does not so develop its industries as to produce men will not for any great length of time hold its place in the world. The men produced by industrial methods are far more important to the life of the nation than the wealth and luxury by which we set so much store."[3] Gantt was of the opinion that the training of employees should stress motivation as well as methods of work. Habits of industry, he said, are more valuable than knowledge and skill — "without industry, knowledge and skill are of little value and sometimes a great detriment."

Purposes of Training. Employee training may be designed to prepare the employee to advance to a new job or to transfer to a higher rated job. Training for new employees is intended to enable them to adapt themselves to new situations or new jobs. Present employees may require training for new jobs because of technological changes, transfers to other jobs where opportunities for advancement are greater, or variations in the rate of production due to seasonal or cyclical variations in demand. Training for present employees may also be desirable in order that each person may be able to perform the duties of more than one job. A versatile work force facilitates internal reorganization and adjustment to changes in production requirements.

Training may be intended to teach employees to do old jobs better. Work simplification and motion-study training are of this type. Courses for foremen may be designed to teach them to perform their work more effectively.

Training may be general in nature and not specifically related to any job. General training may be given to enable an employee to understand the basic or scientific principles of production. Examples are courses in industrial chemistry, physics, shop mathematics, and economics. Training of this kind may provide avenues of growth for employees who show promise or have demonstrated their ability to advance. General training may be intended to inform employees of developments affecting the industry, the company, or the product. Instruction of this kind is sometimes called "employee education" rather than employee training. Employee education was discussed in Chapter VII on "Morale and the Worker" (p. 103).

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[2] Richard A. Feiss, "Scientific Management Applied to the Steadying of Employment," *Annals of American Academy of Political and Social Science*, Vol. LXI (1915), p. 106.

[3] Gantt, *op. cit.*, p. 37.

Selection of Persons for Training. Tests of various kinds are used in selecting persons to take training courses and in dividing them into classes. New employees are chosen through the employment procedure. Old employees may be selected for special training on the basis of recommendations of supervisors, merit ratings, special tests, or scores on tests given at the time of their employment.

The value of testing programs for selecting persons to take training courses was demonstrated by the United States Army Air Forces during World War II. Candidates for training as pilots, navigators, and bombardiers were given extensive tests, including the following types: practical reasoning ability, word knowledge, factual information, deductive reasoning ability, mechanical comprehension, common-sense judgment, reasoning in reading, syllogistic reasoning, and interest in aviation. The effectiveness of the qualifying examination was demonstrated by an experimental group of approximately one thousand applicants who were permitted to enter training regardless of their test scores. The results are shown by the training of candidates for pilot training. In the experimental group, 88.9 per cent of the men who failed the qualifying examination failed to complete the training program; and 11.1 per cent completed it. Of the men who passed the qualifying examination, 65.2 per cent failed to complete the training program; and 34.8 per cent graduated.[4] The results also indicate that the higher the score on the qualifying examination, the greater was the chance of success in the training program. The grades of 185,367 men on the examination were ranked and divided into nine groups called "stanines." The men who made the highest grades were in stanine 9, those who made the lowest grades were in stanine 1. The percentage of the candidates who were eliminated in the pilot training program at each stanine were as follows:

Pilot Stanine	*Percentage Eliminated in Pilot Training*
9	4
8	10
7	14
6	22
5	30
4	40
3	53
2	67
1	77

These results indicate that a testing program does not select persons

[4] Army Air Forces, *Report of Aviation Psychology Program* (released in 1947).

who are certain to succeed or certain to fail. They indicate that tests can be used to make the training program more effective.

Vestibule Training. The word "vestibule" means a passage or hall between the outer door and the interior of the building. Vestibule training means preparation for the job which is given immediately after the employee has been hired and prior to his induction to the job. The name of the program indicates the time when the training is given and the nature of the training rather than the place where the school is conducted.

According to one plan for vestibule training, a small group of employees is given an intensive course in the function, design, manufacture, and assembly of the product. They are shown the relation of the various operations to each other and the consequences of improper workmanship at each step. After the preliminary instruction is completed, the members of the group are taught to make or assemble a product. At the completion of the course of training, workers are transferred to the regular production lines, where they are taught some specific job. A course of this kind may extend over three to five days with groups of five to eight employees in each class.[5]

Vestibule courses usually consist of a production line which duplicates the line or a part of the line in the factory. All workers in the line in the vestibule school are new employees. The instructor keeps records to show the progress made by each employee. He observes the employee's patience, emotional stability, willingness to co-operate, and resistance to monotony and fatigue. Production is secondary because instruction, training, and placement of new employees are the primary aims. Supervision is closer than the foreman usually can give. The regular production lines are not slowed by the training program. The time and skill of the instructor are more efficiently utilized because all the persons under his supervision are learners. The time spent by the employee in the vestibule school depends upon the time required to develop skill and speed at the work and the need for replacements on the production line in the shop.

In some vestibule schools, machines are set up for certain types of work but not for all operations. For example, a shirt manufacturer maintains a vestibule school in which cuffs, collars, pockets, or the main section of the shirt may be made. As the parts are finished, they are moved to the main production line for assembly. This plan permits the use of a smaller school at lower cost.

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[5] Marvin R. Collins, "Vestibule Sessions Set the Stage for Quicker On-the-Job Training," *Factory Management and Maintenance,* Vol. CV, No. 1 (1947), pp. 133–35.

The vestibule school is a practical plan only for the large company. If a complete production line is established, balance in the line is not easily maintained. The labor turnover on some jobs is more rapid than on others, and more replacements must be trained for such jobs. Perhaps the greatest problem of the vestibule school is that of keeping abreast of developments within the shop. Any change in product design, machines used, layout and arrangement of workplaces, or sequence of operations in the line in the shop should be matched by similar changes in the vestibule school. Unless the methods are identical, new employees will learn the wrong methods and will have a problem of relearning and readjustment when they transfer to the regular line.

Apprenticeship Training. An apprentice is a person who is bound by contract to work or serve for a stated time with a view to learning a trade. Formerly, such a contract was made with a master craftsman, who agreed to instruct and train the apprentice in the skills of the trade and to provide him with the means of subsistence. At the present time, such contracts may be made by a corporation. The apprentice is usually a minor who cannot make a legally binding contract, and his parent or guardian therefore signs with him. The apprentice studies to learn a trade rather than a job. A trade includes a number of jobs.

Apprenticeship training has been used since ancient times. It was used in ancient China, Egypt, and Greece. During the medieval era, it was the usual way for a person to learn a trade. The apprentice system was greatly weakened by the industrial revolution and the colonization of the New World. However, the system has never entirely disappeared; and it is still the accepted method of training in such trades as bricklaying, carpentry, plumbing, engraving, printing, sheet-metal work, and patternmaking.[6]

While practices differ among employers, the apprentice training offered by a large machinery manufacturer may be cited as an example. Four-year apprentice courses are provided for machinists, pattern-makers, and foundrymen. Apprentices are on trial during the first six months. During that time, they must demonstrate their ability to continue the course. They are assigned to jobs in the plant as soon as they enter training, and the management sees that they are gradually advanced to more difficult jobs and learn to operate more complicated machines. The apprentice machinist, for example, may begin with the speed drill or bench assembly. Later, he receives experience on milling

[6] For list of unions regulating apprentice training, see S. H. Slichter, *Union Policies and Industrial Management* (Washington, D.C.: Brookings Institution, 1941), pp. 580–81.

On-the-Job Training. Much training is given on the job, where the worker is taught improved methods of work, care of machines and equipment, tooling and machine adjustment, and safety. In this type of training the employee deals in realities and can be assured that the methods he learns are practical. Since the instruction is usually given by the foreman, the worker can be sure that he will not later be required by some other person to do the work in another manner. The competition of other workers spurs each one to put forth his best efforts and to learn as quickly as possible. The disadvantage is the limited time which can be given to employee training by the foreman and the fact that many foremen are not trained in methods of teaching.

Training for Upgrading. Training for advancement may be given to employees, foremen, and executives. The courses may be designed to train skilled workers or supervisors, and several types of training may be given as parts of one program. A small company, for example, has given courses in metallurgy, metallurgical chemistry, public speaking, time study, operation-sheet writing, cam design, and work simplification. A larger company gives a two-year course in machine-shop work, a fourteen-month course in welding, and a three-year course in general office and production procedures. The courses are usually given on company time. Classes may meet for one or two hours each week.

Training makes extensive use of visual aids for demonstration and illustrative material. Charts, drawings, and pictures are widely used. Models of the factory layout are used to demonstrate the flow of work from one department to another. Motion pictures and slides are generally used for technical instruction and also in the safety program. Motion pictures are good, provided the subjects are carefully chosen. However, they should be used as supplementary aids rather than as the major part of the training work. The showing of the motion picture should be preceded by a period of instruction. The picture should illustrate the information presented in the instruction period. The value of pictures for instruction purposes decreases sharply after about fifteen minutes.[7] Slides permit the picture to remain on the screen until the instructor and the class have concluded their discussion. Slides may also be designed to show cutaway parts of equipment and to demonstrate the method of machine operation.

Organization for Training. Most training for employees is conducted by the foreman. Training for other persons in the organization

[7] For suggestions concerning motion pictures to use in the training program, see Howard K. Morgan, *Industrial Training and Testing* (New York: McGraw-Hill Book Co., 1945).

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is most effective if it is given by the immediate supervisor of the persons being trained. If instruction is given by someone else, the wrong methods might be taught; or the learner may suspect that the wrong methods are being taught. The suspicion of the learner is strengthened if the principles are not followed by his supervisor, who might in fact be following methods that could be improved. However, courses in technical subjects, such as welding or machine design, are best taught by specialists, who might be drawn from outside the company.

The industrial relations department assists with the training program in many ways. Through its discussion of plant problems with foremen and workers, exit interviews, and studies of labor turnover, the department may determine what types of training are needed; and it may recommend certain types of training. It may assist in the selection of instructors and in the selection of persons to be trained. It may provide the physical facilities for the training, including visual aids. It should also make the necessary follow-up to determine the costs of the program, the results, and methods of improvement.

Training of Instructors. A comprehensive program of on-the-job training was undertaken by the War Manpower Commission during World War II. The need for such a program arose because of the large number of persons who were drawn into productive jobs, the shifting of workers from one job to another, and the upgrading of workers whose places at the lower levels were then filled by new employees. This program, known as "Training within Industry," was based upon the idea that the proper person to instruct a new employee was the foreman.[8] However, it was immediately recognized that much of the training would be ineffective unless foremen were first taught proper methods of instruction. Consequently, a group of instructors taught small classes how to instruct; and the students in turn taught others, until the program eventually reached throughout a large part of American industry. Such a program necessarily followed a fixed method of procedure. As finally developed, the method of instruction was as follows:

HOW TO INSTRUCT

First, here's what you must do to get ready to teach a job:

1. Decide what the learner must be taught in order to do the job efficiently, safely, economically, and intelligently.
2. Have the right tools, equipment, supplies, and material ready.

[8] *The Training within Industry Report* (Washington, D.C.: U.S. Government Printing Office, 1945).

3. Have the workplace properly arranged, just as the worker will be expected to keep it.

Then, you should instruct the learner by the following four basic steps:

STEP I — Preparation (of the learner)

1. Put the learner at ease.
2. Find out what he already knows about the job.
3. Get him interested in learning the job.

STEP II — Presentation (of operations and knowledge)

1. Tell, show, illustrate, and question in order to put over the new knowledge and operations.
2. Instruct slowly, clearly, completely, and patiently — one point at a time.
3. Check, question, and repeat.
4. Make sure the learner really learns.

STEP III — Performance try-out

1. Test learner by having him perform the job. Correct errors.
2. Ask questions beginning with why, how, who, when, or where.
3. Observe performance and repeat instructions if necessary.
4. Continue until you know he knows.

STEP IV — Follow-up

1. Put him on his own. Designate to whom he goes for help.
2. Check frequently to be sure he follows instructions.
3. Taper off extra supervision and close follow-up until he is qualified to work with normal supervision.

Remember — If the learner hasn't learned, the teacher hasn't taught.

Training Instructors in Work Methods. The persons directing the Training within Industry program recognized that, if foremen were not given instruction in methods of arranging the workplace and in the principles of human motions, they were likely to teach the worker to use wasteful methods. The earlier training of many foremen had been limited to the technical and practical phases of production. Consequently, a part of the program was a condensed and simplified training course in work simplification or motion study. The foremen were taught the principles of man-process charts, which listed the motions required to perform a task by the old method and by an improved method. The principles of job-methods improvement were summarized as follows:

HOW TO IMPROVE PRODUCTION METHODS

A practical plan to help you deliver greater quantities of quality products in less time by making the best use of Manpower, Machines, and Materials.

STEP I — Break down the job

1. List all the details of operations, moves, inspections, and delays, while operators are:
   a) Moving materials

b) Working with machines
c) Working with hands and tools

STEP II — Question every detail

1. Use these types of questions:
   Why is it necessary?
   What is its purpose?
   Where should it be done?
   When should it be done?
   Who is best qualified to do it?
   How is the best way to do it?
2. Question product design, material, material handling, layout, setups, tools and equipment, machines, operator qualifications, workplaces, and operations.

STEP III — Develop the new method

1. Eliminate unnecessary details.
2. Combine details when practical.
3. Rearrange to get better sequences.
4. Simplify all necessary details.
   a) Make the work easier and safer.
   b) Preposition materials, tools, and equipment at the best places in the proper work area.
   c) Use gravity feed and drop delivery.
   d) Let both hands do useful work.
   e) Use jigs and fixtures for holding.
5. Discuss your idea with others.
6. Write up your suggestion.

STEP IV — Apply the new method

1. Sell your suggestion to the boss. Get his approval for a trial.
2. Sell the new method to the operators. Give it a fair test.
3. Consider safety, quality, quantity, cost.
4. Get final approval from all.
5. Put it into effect. Use it until a better way is developed.
6. Give credit where credit is due.

Although this program was brief, it illustrates the principles which are essential to the organization of a successful on-the-job training course. The instructors should be practical men who know what is necessary for the manufacture of the product. However, the foreman usually needs training in methods of demonstrating the procedure for learning the job. He needs to learn the principles of motivation, habit formation, and follow-up, unless his previous training included such specific instruction.

Rewards for Course Completion. Employees who successfully complete formal training courses should receive appropriate recognition or reward. The nature of the reward depends upon the type of course, the amount of effort required of the persons enrolled, and the

duration of the course. Completion of a course might be recognized in one or several ways. Completion of an apprenticeship course should be recognized by formal exercises and the conferring of a diploma. For shorter courses a certificate of completion is frequently awarded. Even though grades may be assigned for purposes of personnel records, the grades are not shown on the certificate except perhaps for persons making exceptionally good records. The completion of any course is usually announced in the plant magazine, which is also used for much other publicity concerning the program.

More substantial rewards for course completion include some sort of monetary payment. Employees who buy books or other materials at the beginning of the course may be reimbursed upon satisfactory completion of the course. Employees who take technical courses at night schools are sometimes repaid for the cost of the tuition. A wage increase is usually not given automatically but depends upon transfer to a higher position. The employee may also benefit through greater security in the job or his ability to shift to a different kind of work.

Checking the Value of the Training Program. An attempt should be made to determine whether the program has accomplished its objectives. This is not easy. Cause and effect are not easily related where human relations are concerned. Conclusions as to the results of a training program are more reliable if the number of persons taking the course is large. Allowance should be made for any change in the work force during the time the training was given. For example, if women are employed for the first time, a comparison of the safety or the production record before and after the training was given will be inconclusive in establishing the value of the training. Changes in the work force may reflect such factors as age, color, or experience of employees.

The method of determining the value of employee training depends upon the nature and the objectives of the training program. The data which may be tabulated for this purpose are as follows:

Increase in the rate of output.
Reduction in the time required to complete a task.
Increase in the number of operators who meet the standards of production.
Decrease in the time required for new employees to reach the standard.
Decrease in the breakage of machine tools.
Reduction in the number of accidents.
Reduction in absenteeism.
Reduction in the rate of labor turnover.[9]

[9] C. H. Lawshe, Jr., "Eight Ways to Check the Value of the Training Program," *Factory Management and Maintenance,* Vol. CIII, No. 5 (1945), pp. 117–20.

QUESTIONS

1. Which of the following methods should be used to select the employees who are to take training?
   a) Mental, social interest, and special aptitude tests.
   b) Merit ratings.
   c) Seniority.
   d) Recommendations by supervisors.
2. What are the advantages and the disadvantages of training in vestibule schools in which workplaces in the factory are duplicated?
3. What is the advantage to the employee in enrolling in an apprentice program?
4. Why do some unions contend that the regulation of the apprentice program is not solely the prerogative of management?
5. What are the advantages to management and to the worker of training on the job?
6. Should training for the job be given by a member of the industrial relations department or by members of the manufacturing division?
7. Labor turnover is usually found to be much greater in some jobs and in some departments than in others. If a training program for newly employed persons could reduce turnover in those jobs and departments, what costs and expenses would be reduced?
8. If a newly employed worker who has been given a training course is found at the end of the training to be unsatisfactory, what costs and expenses can be saved if he is dropped immediately instead of being permitted to fail on the job?
9. Should tests be given and grades or certificates awarded at the completion of a training course, or may the employee merely be expected to demonstrate on the job that he has profited from the course?
10. How did the job-instruction program require the job-methods program as a part of the training of supervisors?
11. It was found in the job-methods program that, although supervisors gave verbal assent to the principles, many of them hesitated to put the principles into practice because they thought the executives to whom they were responsible might not approve. How might this difficulty have been avoided?
12. What reward should be given for satisfactory completion of a course of training for newly employed workers?
13. What precautions should be observed in using any statistical measures of the improvement resulting from the training program?

CASES

65. CO-OPERATION WITH LOCAL SCHOOLS

At a luncheon meeting of the local chamber of commerce, Ralph C. Riggs, plant superintendent of the Chase Electrical Company, happened to meet the director of a local technical school. The director remarked that employees of

the Chase Electrical Company enrolled in the school were good students. Mr. Riggs replied that he did not know of any employees who were enrolled. When the director recalled the names of three of the students, Mr. Riggs said he thought the director was mistaken as to the company as none of the men were employed at Chase.

Later, Mr. Riggs called the director and asked for the names of all of the students who were Chase employees. Comparison of the list of students with Chase payrolls showed that the three students mentioned as outstanding had left Chase for jobs in other companies where they could use their technical training to advantage. No one in the management at Chase knew that the men had completed courses at the technical school.

Questions:

1. How can the company keep informed of the training taken by employees in local schools or by correspondence?
2. What can the company do to encourage employees to take such training?
3. What department or person in the management should be made responsible for knowing that employees are taking technical courses?

66. NEED FOR A TRAINING PROGRAM

The Mary Belle Candy Company is one of the largest producers of candy in the United States. It has a good reputation for the quality of its products and for service to dealers. It operates six plants in different sections of the country. During the pre-Christmas season the Philadelphia plant operates on the two-shift plan. At the peak of the season the total number of employees is 150, of whom about 110 are women. Because of the seasonal nature of the work, labor turnover is fairly heavy. The plant is under the general supervision of a plant manager. The factory is organized into six departments, with a foreman at the head of each department. During the peak season, each foreman has two responsible assistants, each of whom supervises one shift. During slack seasons the assistants work at various factory jobs. All foremen and assistants are men.

The company was established in 1919. The management has always taken pride in its good employee relations. In 1937 the manager of the Philadelphia plant created the position of assistant plant manager with responsibility for continuing good personnel relations. He was given authority over employment, physical examinations, medical service, vacations, job evaluations, and merit rating. At that time a General Factory Committee was formed. Members of the committee were elected by the employees.

The plan of the company provided for using the committee as a channel of communication between employees and top management. Although the purpose of the committee had been carefully explained to the employees, the committee felt free to make any kind of proposal or suggestion, including a request for a general wage increase. When the management informed the committee that the original purpose was not being adhered to, employees began to circulate petitions asking that the company recognize a labor union as the official bargaining representative of the employees.

The president of the company asked the plant manager and the assistant to determine the causes of the labor unrest. In interviews with employees, a great many uncorrected grievances were reported. Men and women of presumably equal merit were receiving different rates of pay for the same work. Promotions which were supposed to be based upon merit were believed to be based upon favoritism. Employees were sometimes shifted from one job to another without apparent reason. One foreman was said to have promised to make changes in working conditions without ever making good his promises. Relief for workers for personal needs was often not available. These complaints were typical of the general situation.

The assistant plant manager thought that the difficulty lay with the foremen and the shift supervisors, who used faulty methods of supervision. He believed that the company had not given sufficient attention to the training of foremen in human relations. Foremen also seemed not to understand company policies and the extent of their own authority in handling situations within their departments. The committee plan had failed because of the number and nature of employee complaints. He recommended a training program for foremen and shift supervisors. He also recommended weekly luncheon meetings for keeping foremen informed on company policies and current developments.

Question:

What should the company do to improve methods of supervision and to develop better employee relations?

CHAPTER XXXI

ACCIDENT PREVENTION

FOR PURPOSES of a program of accident prevention, an accident is defined as an unplanned incident that causes injury to an employee and results in a loss of time from work beyond the day when the accident occurs. If the injury is treated in the plant and the employee is able to continue work, the incident is not regarded as an accident. An incident that results only in damage to machinery or equipment is not an accident unless it also causes injury to an employee.

The responsibility for the accident prevention program is usually placed with the industrial relations department. The program requires worker education and other activities pertaining to personnel. However, the success of the program requires the co-operation of other departments, both staff and line. Engineering work is particularly significant because safety is a factor in plant layout, machine design, methods of material handling, and other phases of physical equipment. The co-operation of foremen and other executives in the line is also necessary to the success of the program.

Accident Costs. Management is interested in promoting accident prevention not only because accidents are expensive but also because they cause suffering to the injured employee and inflict financial losses upon the worker and his family. The costs to the employer are direct and indirect. The direct costs include damage to machinery and materials, medical and hospital charges paid by the employer, lost time to the injured worker when paid for by the employer, and the increased costs of compensation insurance.

The indirect costs are more difficult to measure, but they are no less real. Other employees stop or slow up work because of curiosity, sympathy, or a desire to assist the injured worker. Shop morale may be affected, resulting in additional interference with production, slowed

deliveries, and decreased output. Additional expense includes the loss of machine time and the lost time of foremen and others in assisting the injured employee, investigating the accident, and training a person to replace the injured worker.

Legal Liability of the Employer for Accidents. By the common law, the employer could often evade liability if he could establish one of the following defenses:

1. That a fellow servant of the injured worker rather than the employer was responsible for the accident.
2. That the injured worker was himself responsible through his own negligence.
3. That the accident was the result of a risk inherent in the industry of which the employee was cognizant when he accepted the job.

Employers' liability legislation, enacted in many states beginning with Alabama in 1885, deprived the employer of the first defense named and modified the operation of the other two. However, it was still necessary for the employee to bring suit for damages, unless the employer voluntarily paid the injured worker. The liability of the employer was greatly increased by workmen's compensation laws. Maryland, in 1902, passed the first law in the United States providing for workmen's compensation. Almost all of the states now have such laws. Provisions differ as to the occupations covered, the benefits to be paid, and other details. All the laws set up a scale of benefits for different types of injury, such as the loss of wages for a stated number of days and indemnity for loss of hand, fingers, arm, or leg. Payments are a percentage of the injured employee's weekly wages. Most of the laws provide for compensation for occupational disease, such as disease which results from exposure on the job to acids, dust, or other substances. The significance of the workmen's compensation law is that a definite scale of compensation is established and that the worker is not required to prove damages. Lawsuits are unnecessary, and the expenses and delays of litigation are eliminated.

The workmen's compensation law is based upon the principle that the cost of accidents should be included by the employer and the industry as a part of the cost of making and selling the product. The employment of workers at hazardous jobs results in an accident cost that is just as real as depreciation, repairs, and breakage that result from the use of machines. Employers may be able to shift to consumers the cost of compensation paid to workers, although a close relation of cost to selling prices does not necessarily exist in all industries at all times.

The Safety Movement. Although the railroads did not conduct an organized safety movement until comparatively recent years, they early took the lead in installing safety measures. The steam whistle was invented in 1833, and telegraphic orders were first sent to trains in 1851. The Westinghouse air brake, a most significant safety device, was effectively used in the railway industry in 1870. The adoption of four standard time zones in 1883 was also a safety measure. The automatic coupler, steel passenger cars, and automatic block signals were other significant developments in accident prevention.

In 1916, the railroads initiated a joint program for the reduction of accidents at highway-railroad grade crossings. At that time the railroads adopted uniform approach warning signs, uniform use of red as a warning color at night, a uniform circular disc for use by crossing watchmen, and uniform painting of crossing gates with alternate black and white stripes. Since that time the railroads have conducted a continuous program of accident prevention.

Many industrial corporations began organized accident prevention programs as early as 1900.[1] About this time the slogan "Safety first," a contraction of "Safety first, quality second, cost third," was adopted and circulated through industrial establishments. The year 1907 is generally regarded as the beginning of a sustained and organized safety program in the steel industry. In that year an association of iron and steel electrical engineers created a committee which became the first industry-wide body for the promotion of safety. This association was the chief instigator of the organization of the National Safety Council in 1912. The Council, a nonprofit organization with headquarters in Chicago, has done a great deal to reduce the accident rate in homes and on the highways as well as in industrial establishments. It publishes booklets dealing with safety measures and safety practices, and it assists in the organization and management of safety programs. The Council also compiles accident statistics, organizes meetings for the discussion of accident prevention, and promotes safety measures in various other ways. In the steel industry, significant developments in safety since 1912 include the adoption in 1913 of the red disk as a symbol of danger, the appointment in 1939 of an industry-wide committee to develop safety goggles, the use of models of rolling mills in 1944 to train employees in the fundamentals of safety, and the development in 1948 of standardized color schemes to designate accident hazards.

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[1] *Steel Facts,* April, 1952, p. 7.

The safety movement is based upon the principle that accidents do not just happen but have definite causes. It seeks to determine the causes and to eliminate them as far as possible. Among the more important causes are improper layout, poor machine design, certain features of clothing, and unsafe practices of workers.

Relation of Layout to Safety. One of the most important problems of layout is that of materials handling, and this work is a significant feature of accident prevention. Many accidents are the result of improper handling of materials. Especially hazardous are barrels, drums, logs, pipe, rolls of wire, and wheels of trucks, which may injure the feet or bodies of workers. Improper methods of lifting or moving materials by hand truck may cause internal injuries. The movement of materials through narrow aisles interferes with normal work activities in addition to creating accident hazards. Further possible defects in layout are sharp corners, dark passageways, dark spaces in storage areas, open manholes, inadequate illumination, and failure to segregate hazardous processes.

Relation of Machine Design to Safety. The safety manager, in cooperation with foremen and engineers, should inspect all equipment to determine where hazards exist and should be assured that all equipment purchased embodies proper safety features. All machine manufacturers now attempt to design their equipment to meet rigid safety requirements.

Safety features embodied in machine design usually include mechanical devices to feed the material to the cutting tool and to eject the finished parts. Control devices may require the worker to use both hands to operate such machines as cutting and trimming machines in a bookbindery or a machine for pressing suits or ironing shirts in a laundry. Guards on circle saws may be designed to make it impossible for workers to get into the danger zone. Some machines are equipped with a device to push the hand of the worker out of the way of the tool as it advances toward the work. Numerous types of covers, fencing, barricades, and other enclosures protect workers from falling into shafting, moving belts, gears, flywheels, pulleys, and other moving parts.[2] As a further precaution, moving parts may be located away from rather than adjacent to aisles and passageways. Belts and cranes

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[2] For discussion and illustrations, see R. P. Blake, *Industrial Safety* (New York: Prentice-Hall, Inc., 1943); H. W. Heinrich, *Industrial Accident Prevention* (New York: McGraw-Hill Book Co., 1941); also U.S. Department of Labor, "Suggested Standards for Industrial Safeguards," *U.S. Department of Labor Bulletin* 7 (Washington, D.C.: U.S. Government Printing Office, 1942).

may move overhead, where the danger of contact with persons is decreased or eliminated. Automatic control levers, buttons, switches, and safety control devices should be located at a point on the machine where they are readily accessible to the worker at all times, in order that he may stop the machine in an emergency. The accident hazard is also reduced by having the machine do the heavy work. This arrangement allows the worker greater freedom of movement.

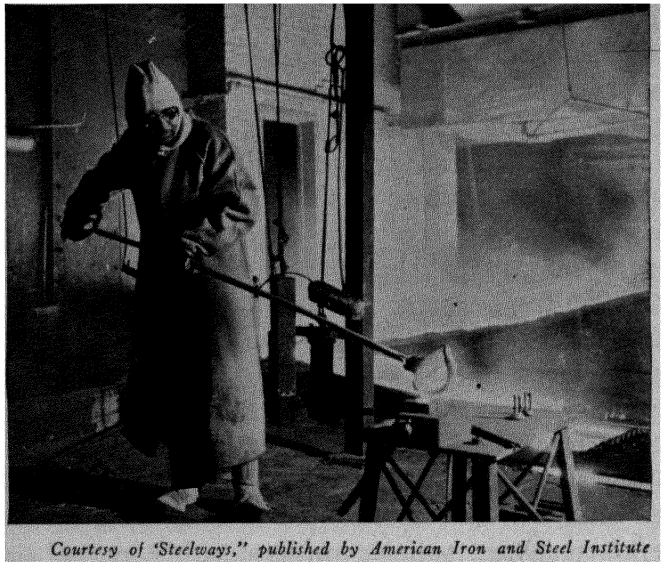
Regular inspections should be made to see that safety devices are in proper condition for emergency or for safe continuous operation. A cable with more than a certain number of broken strands may break under the weight of a heavy load. Fire extinguishers will fail if the fluid leaks out or evaporates. Safety valves, circuit breakers, fire-alarm systems, and elevator safety devices may become defective and uncertain in operation. All such equipment should be inspected at predetermined intervals. Schedules should be established to assure that each type of equipment will be inspected at the proper times. Inspections are also made by municipal and state authorities and by underwriters.

Clothing. Persons who work around moving parts should not wear loose clothing or clothing with loose ends which may become entangled in shafting, gears, or other moving parts of machinery. Dangerous features of clothing are bandannas, flowing sleeves, neckties, apron strings, and belts. Jewelry is frequently a cause of accidents, and it may increase the severity of an injury. Caps with celluloid or other inflammable visors are dangerous because they increase the fire hazard. Gloves should not be worn on operations that require finger dexterity. Women in many types of work require covering for the hair and low-heeled shoes to prevent slipping.

Safety clothing in the steel industry includes leggings, gloves, masks, steel-toed shoes, and asbestos coats and helmets. Safety clothing worn by a steelworker is illustrated in Figure 58. On some jobs, workers should wear aprons for protection against acids, oil, or other substances. Goggles are necessary in processes where protection is required against flying metal, dust, fumes, liquids, or molten metal and also in work where the eyes must be protected against glare or radiant energy, such as arc welding or cutting.

Unsafe Practices. Among unsafe practices of workers are the following.

Operating a machine, a truck, or a crane at an unsafe speed.
Failure to give proper and necessary warning signals.



Courtesy of "Steelways," published by American Iron and Steel Institute

FIG. 58. Safety Clothing Worn by Steelworker

The worker is taking a sample for chemical inspection. Note the goggles, helmet, coat, gloves, leggings, and shoes.

Making safety devices inoperative by removing guards and in other ways.

Using equipment which is in need of repair.

Loading materials on trucks and other equipment in an unsafe manner.

Storing loose materials on stairways, walkways, or aisles.

Taking an unsafe position or posture at the machine.

Working on moving or dangerous equipment.

Failure to use safe attire or personal protective devices.

Distracting, teasing, or startling other workers.

Leaving tools where they will fall and injure others.

Stretching unguarded air lines, water hoses, or electric cables across aisles and passageways.

Storing materials in such a manner that they will fall or cause persons to trip on protruding parts.

Leaving spilled acids, oil, water, or broken glass on the floor.

Permitting protruding nails, hooks, sticks, and saw blades about the workplace.

Scraping metal shavings from work benches with the hands.

Creating fire hazards by accumulating shavings, using matches improperly, and smoking in restricted areas.

Practices that create accident hazards should be prevented through proper training and instruction. Supervision is necessary to prevent lapses and to see that safety regulations are observed. An unsafe practice is illustrated in Figure 59.

Practices that create accident hazards should be corrected through

FIG. 59. An Unsafe Practice

This posed picture was used in promoting safety. It was entitled: "Picture of an Accident about to Happen." Workers are advised to look where they are going.

such measures as instruction at the time the new employee is inducted, instruction on the job by the supervisor, warnings posted at workplaces requiring unusual care, investigations of accidents, and various other means. A warning against an unsafe practice is illustrated in Figure 60. The co-operation of the supervisor in the prevention of unsafe practices is necessary. The foreman assists by instruction, supervision, and disciplinary action if necessary.

The worker is usually much interested in accident prevention. Labor unions may insist upon the inclusion of provision in their contracts with management to assure that machines and equipment are safe. The United Automobile Workers advocates a committee consisting of three members of the union and three members of management to make weekly inspections of workplaces, first-aid stations, and medical facilities. For health reasons, the union recommends that the committee supervise the handling and sale of food and refreshments in the plant. Most unions insist that no employee be required to work on a job or at a machine while its safety is being questioned by a committee and that the employee who is unable to work at his job because it is dangerous should be paid his regular rate even though he is transferred to a job carrying a lower rate.[3] An employee who is suffering from an occupa-

[3] Lee H. Hill and Charles R. Hook, Jr., *Management at the Bargaining Table* (New York: McGraw-Hill Book Co., 1945), p. 72.

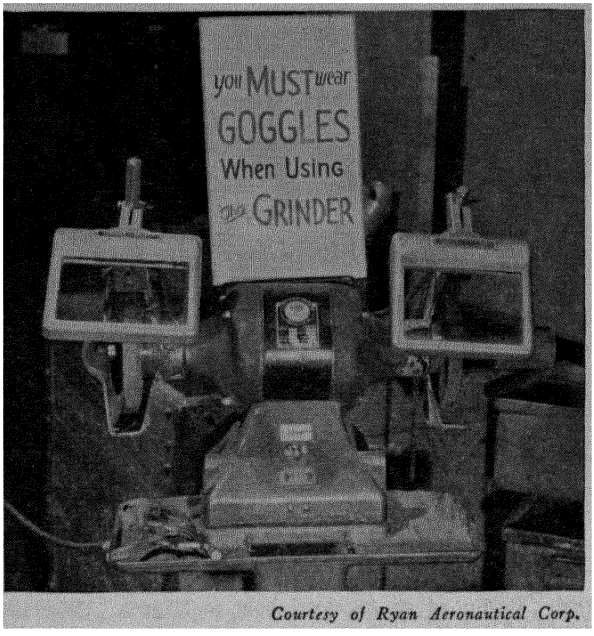


FIG. 60. Display of Warning Sign at a Machine
Note guards over grinding wheels.

tional disease, such as dermatitis, should be transferred to another job.

Statistical data for accidents indicate that some persons have more than their share of accidents, while other persons are infrequently or never involved. Accidents do not distribute themselves by chance but are the logical result of a combination of circumstances.[4] Because of differences in temperament, intelligence, physical strength, home environment, health, or other peculiar mental or physical traits, some workers are more likely to be victims of accidents than others. Such people are said to be accident prone or to be subject to accident proneness. It is the task of the safety engineer to locate the accident-prone individuals and to assign them to jobs where they are least likely to be injured. Such persons should be identified before rather than after they have had a series of accidents.

The emotional make-up of an individual affects his proneness to accident. Some people are impulsive. They may act quickly, without thinking of the consequences of their acts. Some persons are excitable; they may act irrationally in emergencies. Some people are not able to judge speed and distance accurately and quickly. Curiosity, a desire

[4] See Joseph Tiffin, *Industrial Psychology* (New York: Prentice-Hall, Inc., 1942), p. 283; Herbert Moore, *Psychology for Business and Industry* (New York: McGraw-Hill Book Co., 1939), pp. 347–57.

to see whether warnings are really based on fact, or a desire to see what will happen, is stronger in some people than in others. Some persons are more inclined to let their minds wander or to act mechanically without realizing what they are doing. Some people lack a feeling of responsibility. Other factors in accident proneness are worry, mental depression or mental elation, defective vision, lack of sleep, use of alcohol, and slowness of muscular reaction.

Older persons are less subject to accidents than younger people. A possible reason is that they are less impulsive or that they feel less need to prove their worth on the job. They may be more conservative because of family responsibilities, or they may have established safe habits.

Accident prevention work can be made more effective if the reasons for the higher accident rate among a small percentage of employees can be determined. Measures which are partially effective are physical examinations, examinations for hearing and vision, and tests for color blindness. Examinations of this kind should be given when persons are hired for jobs with special hazards. Employees over fifty years of age should be given annual examinations, and persons of lower ages should be given examinations at varying intervals.

The Safety Program. New employees should be given safety instruction, and other workers should be given refresher safety training. New employees, in addition to being given oral instructions, are frequently given a booklet of safety regulations with a perforated sheet which they are asked to sign and hand to the foreman as evidence that they have read the instructions.

Safety instruction to new employees is most effective if it is integrated with the training for the job. The employee is taught the proper way to do the task, which is the safe way. When safety regulations are made a part of job instruction, the worker is more likely to receive positive instructions rather than negative warnings. For example, instead of being warned not to hold a piece of metal in his hand while he bores a hole, he would be instructed that the first step is to fasten the piece firmly in the machine. Instead of being told not to push a chisel toward his hand while he trims a piece of wood, he would be instructed that he should clamp the piece of wood to the bench and direct the chisel in a certain manner. However, warnings of a negative sort may be necessary in addition to positive instruction.

Employees on the job are often subjected to a barrage of bulletin board posters, signs displayed at entrances or danger points, illuminated moving messages, and placards within or about the shop. Such a warn-

ing sign is illustrated in Figure 60. Signs of this kind should be used sparingly if they are to be effective.

Safety contests are often used to reduce accidents. The accident records of the various departments are tabulated or charted, and the results are reported on bulletin boards or in the plant magazine. At the end of a designated period, a citation or plaque is given the department which has the best record. The plaque may be displayed in the winning department until the end of the next contest period.

Opinion differs as to the effectiveness of safety contests. Advocates say that such contests develop a social attitude among employees in addition to promoting safety. It is possible that an employee may fail to report a minor accident or that he may stay on the job after an injury because he does not wish to ruin a good record for the department. Such conduct may result in infection or other serious consequences. All accidents should be reported and treated, regardless of the extent of the injury.

Many types of appeal are made in order to reduce accidents. The appeals should be varied from time to time to influence all types of personalities and to maintain interest in the program. The following kinds of appeal have been found to be effective:

1. Self-preservation. This appeal is made by showing that a hazard to life and limb really exists and that continuous care is required.
2. Desire for material gain. The worker may be reminded of the possible loss of pay as a result of injury.
3. Desire for praise or distinction because of a good safety record.
4. Desire to avoid disapproval for the use of unsafe practices.
5. Respect for the rights of other persons, including fellow workers and the family of the employee.
6. Responsibility for materials and equipment.
7. Loyalty to the foreman and the company.
8. Desire for leadership. Membership on a safety committee usually results in a more strict observance of safety regulations during and after the term of service.[5]

A safety program is made most effective by variety in the appeals to workers and in the publicity. A continuous program is necessary to prevent lapses into carelessness and to assure that employees will develop safe practices and use them without exception.

Reporting Accidents. A report should be made of minor as well as serious accidents, because the causes may be much the same. A

[5] Blake, *op. cit.*, pp. 240–43.

slight variation in the chain of events or in the circumstances could change a trivial accident into a serious one. Accident reporting is intended to determine the cause and to fix responsibility. The report should indicate the following information:

Time of day.
Day of the week.
Month of the year.
Age of the person.
The department.
Kind of work and machine.
Kind of tool and its condition.
Experience of the person responsible.
Length of service with the company.
Nature of the accident.
Nature of the injury.
Treatment given.
Extent of damage to material or machine.
Recommendations or suggestions for the correction of unsafe conditions.

Information of the nature given above may indicate the causes of accidents and may suggest measures to be taken to reduce them. Summaries of the reports should be sent to the foremen at the end of each month. A form used by foremen for the reporting of accidents is shown in Figure 61.

The report of the foreman may be followed by an investigation of the accident by the safety manager. The persons present at the investigation should include the injured worker if he is able to attend, the foreman, employees who witnessed the accident, and perhaps the union steward. The purpose of the investigation is not to criticize the person who was responsible but to determine the cause, fix responsibility, and recommend corrective action. The investigation may result in a recommendation to the foreman for the correction of an unsafe condition or practice.

Reports of accident investigations are summarized each month. The summary indicates the number of accidents in each department, classified by causes and by injuries. Reports are usually given to the general superintendent, the president, the manager of industrial relations, and the foremen.

Accident Statistics. The accident record is summarized in a numerical figure for the accident frequency rate or the accident severity rate. A method of computing the accident frequency rate has been developed by the American Standards Association. This method is used by the Bureau of Labor Statistics, the National Safety Council, and many

FOREMAN'S ACCIDENT REPORT
To
SAFETY ENGINEERING DIVISION
DEPARTMENT OF INDUSTRIAL RELATIONS

Name	Age	Clock Number
Date of Hire	Occupation	
Date of Injury	Time	A.M. P.M
What was Employee Doing?		
Where was Employee Working?		

Describe in full detail how the accident occurred:.....

.....

.....

.....

Cause of the accident:.....

.....

Responsibility: (Management or Employee) .....

.....

What immediate steps did you take to prevent recurrence? .....

.....

.....

WITNESSES:	Clock No.	Station or Department

....
Foreman's Signature Supervisor's Signature

.....
Department Name and Number

INSTRUCTIONS: This report shall be made out for each ACCIDENT, all questions answered, and shall be forwarded at once to your Supervisor, who shall countersign report and forward to Plant Safety Engineer the day of the accident.

TO BE MADE OUT IN DUPLICATE — COPY TO BE RETAINED BY SUPERVISOR

FIG. 61. Foreman's Accident Report

corporations. The accident frequency rate is the number of accidents per 1,000,000 man-hours worked. An accident is counted if it resulted in a loss of time beyond the day or shift on which the accident occurred. The rate is computed as follows:

Multiply the number of accidents by 1,000,000.
Divide by the number of man-hours worked.

To illustrate, if the total number of hours of work of all employees in one month was 250,000 and the number of accidents was 3, the accident rate would be computed by dividing 3,000,000 by 250,000. The frequency rate is 12. The reason for using 1,000,000 as the multiplier is that this procedure usually results in a whole number rather than a decimal fraction.

The accident severity rate makes allowance for the seriousness of the injury to the employee. Weights are assigned to various accidents according to the extent of the injury. The total of the injuries weighted in this manner is multiplied by 1,000. The product is divided by the number of man-hours worked. Some of the weights prescribed by the code of the American Standards Association are as follows:

	Weights
Death	6,000
Permanent total disability	6,000
Loss of arm at or above the elbow	4,500
Loss of hand	3,000
Loss of thumb	600
Loss of any one finger	300
Days lost, no permanent injury	Number of days lost

To illustrate the method of computing the accident severity rate, assume the following facts:

Accident in which a worker lost a thumb	600
Number of days lost by all other workers as the result of accidents	80
Total days lost	680

Computation of the severity rate:

$680 \times 1{,}000 = 680{,}000$

$680{,}000 \div 250{,}000$ (number of man-hours) $= 2.72$, which is the accident severity rate.

Accident rates are usually higher for small firms than for larger ones or for companies owning several plants. Many small plants have no organized accident prevention programs. Executives whose major responsibility is for some other work will often neglect safety work because it is less pressing than some other task that demands immediate attention. Since accidents occur infrequently, they appear to be due to isolated causes; and management is reluctant to make the expenditures which are necessary to eliminate known hazards. The managements of many small plants could profit by giving more attention to accident prevention and by correcting unsafe conditions.

QUESTIONS

1. Phases of accident prevention are engineering, education, enlistment, and enforcement. Explain what is meant by each phase.

2. "Most injuries result from a combination of physical hazard and faulty behavior." Explain and illustrate what is meant.
3. Accident statistics in some industries show that 15 per cent of the accidents are caused by physical hazards and 85 per cent by unsafe acts. An employer states that he will first eliminate the 85 per cent caused by unsafe acts and control the 15 per cent later. Why is his reasoning fallacious?
4. According to the United States Department of Labor, the indirect costs of accidents are four times as great as the direct costs. What costs are direct, and what costs are indirect?
5. A man has been appointed safety director in a plant which has not previously had an organized safety program. Explain what he should do and how he should proceed.
6. Indicate which of the following are accidents:
   a) A maintenance worker spills grease on the floor and leaves it, but no one steps in it until it is later cleaned up.
   b) Another worker slips on the grease but does not fall.
   c) Another worker slips on the grease and falls but is not injured.
   d) Another worker slips on the grease, falls, and suffers a leg injury.
7. Explain the relation of accident prevention to the following phases of layout and arrangement:
   a) Space for storing materials at the workplace.
   b) Clearance above moving equipment, such as traveling cranes.
   c) Aisle space for moving materials.
   d) Maintenance methods, such as window cleaning and machine repair.
   e) Air conditioning and lighting.
8. A worker who is operating a finishing machine is injured by a particle of material which lodges in his eye. The injury would have been prevented by the use of goggles, and the company proposes to buy the goggles and to issue an order that they be worn. Is this the proper procedure, or should the company first obtain approval of the union and the safety committee? In other words, should the company use the method of enforcement or enlistment?
9. Can the accident-prone worker be identified before he has caused a series of accidents? What types of tests or investigation may detect accident proneness?
10. What is meant by the statement that safety instruction should be integrated with training for the job?
11. What type of award may be given to the department which wins a safety contest?
12. What types of appeal may be made to employees to obtain their co-operation in accident prevention?
13. What is the advantage of safety committees in the organization of the safety program?
14. Why are accident rates usually higher in small firms than in large ones?

CASES

67. ACCIDENT STATISTICS

A company operates two plants. In one of the plants, employees worked a total of 400,000 hours during the year. There were 4 accidents, which caused a loss of 450 days. No employees were killed, and none lost fingers or other parts of the body.

In the other plant, employees worked a total of 600,000 hours. There were 5 accidents during the year. In one accident an employee suffered the loss of one finger; and in the other accidents, employees lost a total of 260 days. In making allowance for death or dismemberment, the company follows the recommendations of the American Standards Association.

Required:

Compute the accident frequency rate and the accident severity rate for each plant and for the entire company.

68. PLACE OF THE ACCIDENT PREVENTION MANAGER IN THE ORGANIZATION

The president of a medium-sized company which manufactures mattresses was disturbed about the number of accidents to employees, and he agreed with the director of personnel that the position of accident prevention manager would be created in the personnel division. When the accident prevention manager, Edwin C. Saunders, arrived, he met with the president and the director of personnel to discuss the new program. The president explained the plan as follows:

"We have had entirely too many accidents that have caused lost time and suffering to our employees. We also know that in many cases employees have barely escaped injury through what might be called near accidents. We want you to see that the proper safety precautions are taken all through the plant and that hazards are eliminated wherever this can be done without too much cost for new equipment or protective devices. In this program, you will work with the director of personnel and the plant superintendent."

Shortly after Mr. Saunders was installed in his new position, a girl who was employed in the cutting room tripped on the stairway and fell down the steps. Mr. Saunders talked with the girl, the union steward, and the maintenance manager. He found that the stairway was eight feet wide and had no center rail. The girl was wearing shoes with heels of medium height. Mr. Saunders first issued a memorandum to the maintenance manager requesting that a center rail be built. He also sent a memorandum to all foremen requesting that all women employees be asked to wear shoes with low heels. In later discussion with the maintenance manager and foremen, he learned that neither of them intended to comply with his requests.

Questions:

1. What mistake was made in setting up the new program?
2. What was wrong with the methods of Mr. Saunders?

CHAPTER XXXII

EMPLOYEE SERVICES

EMPLOYEE services include those activities of a company which are designed to provide employees with facilities not directly related to production. They are intended to supply the social and other needs of employees which can best be met through group rather than individual action. They are conducted for the purpose of making the work force more efficient by fostering loyalty to the company and an interest in its activities, by building up a feeling of group solidarity, by developing a feeling of financial and personal security, or by meeting some other need.

Employee service activities are of many kinds. No one company would provide all the services to be mentioned in this chapter, although most large companies would provide many of them. One of the most important is medical service.

Medical Services. It is estimated that the average employee in industry is absent from work seven days per year on account of illness. One of the absences is due to industrial illness and accidents, and the other six are due to illnesses to which the population in general is subject. However, the illness is not evenly distributed as between industries and individuals; and both illness and accidents cause great suffering in individual cases. A comprehensive health program would include attention to four types of plant problems, which are as follows:

Worker Environment in Relation to Health. Features of the plant and plant activities which relate to health include sanitation and rest room facilities, lighting, heating and ventilating, cafeteria and lunchroom facilities, noise, recreation program, and the use of machines for doing heavy work. Many of these phases of work conditions are not subject to direct control by the industrial relations manager.

Manufacturing Processes. Some departments or some operations

may subject the worker to special health hazards, such as abnormalities of air pressure or temperature, gases, dust, poisonous or irritating substances, or dampness. Diseases which are caused by conditions peculiar to industry or to certain processes are called "occupational diseases." The most common occupational diseases are dermatitis or skin irritation and lead poisoning.

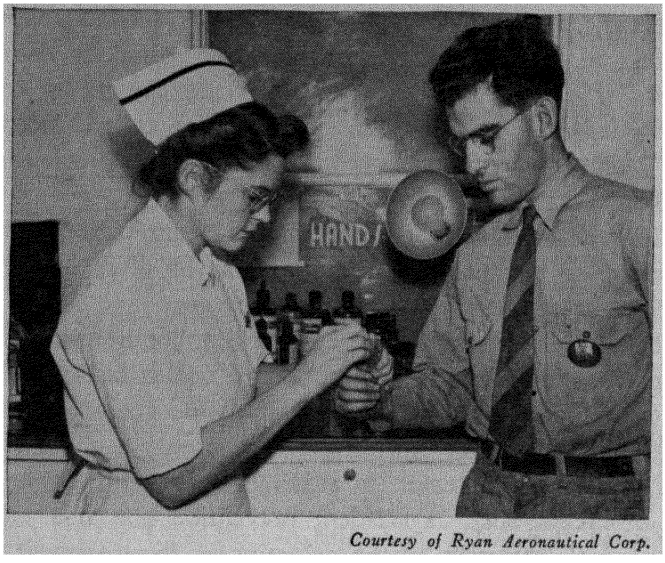
The Worker. One purpose of the physical examination is the fitting of the worker to the job. Examinations may be given at the time of employment, at regular times after employment, and at the time of transfer to another job with different working conditions. This phase of the program includes the elimination of health hazards, the maintenance of a first-aid station, and possibly the correction of defects of vision, teeth, and other infirmities.

Supervision. The foreman may be given training in health and accident problems, such as accident prevention and first aid. Many foremen require education on the necessity for the treatment of minor cuts, blisters, and skin abrasions which may result in infection.

When medical work was first introduced in industrial establishments, it was a subdivision of the work of the industrial relations department. In many companies, it retains that position. However, the medical officer is a highly trained person; and his position is a responsible one. For these reasons, the medical services are sometimes organized as a major division. While this arrangement has much to recommend it, the effect may be to place too many executives under the supervision of the general manager.

The organization of the medical services depends in part upon the number of persons on the staff and the extent of the work. Very small enterprises provide no medical service at the plant, whereas some use the services of a local physician on a part-time basis. Some companies arrange for applicants for employment to report to a local physician for a physical examination, and other companies arrange for a physician to spend a part of each day at the plant. In larger companies a full-time physician may be employed. Another arrangement is to employ a nurse on a full-time basis to operate the dispensary, with the assistance of a physician on a part-time basis. The service provided is illustrated in Figure 62.

When first-aid services are provided, it is usually necessary to require that workers report for the treatment of minor injuries, such as cuts, abrasions, and burns. Workers may hesitate to ask for treatment of minor wounds. They may need to be reminded that an infection is cause for discipline, while an injury may not be cause for criticism.



Courtesy of Ryan Aeronautical Corp.

FIG. 62. First-Aid Service in an Industrial Plant

Group Hospitalization and Surgical Benefits. To aid employees in meeting hospital expenses and surgeons' fees, many companies provide group insurance. Insurance premiums may be paid by the company, by the employees, or by the company and the employees jointly. One plan provides that each employee will pay a fixed sum each month, which is deducted from his pay. The remainder of the cost, which may vary, is paid by the company. Usually, no examination or statement of health is required of any employee who makes application for the insurance within thirty-one days of the date of employment. Employees who apply after the time stated may be required to pass a medical examination which is satisfactory to the insurance company. The protection afforded by the policy may include room and meals at the hospital for a period not in excess of seventy days, anesthesia, and certain other services not to exceed the amounts stated in the contract. The surgical protection covers the fee charged for any surgical operation, with a maximum of perhaps $150. The surgical allowance varies with the type of operation in accordance with a fixed schedule. The policy may specify that an operation is not covered by the contract if it arises in the course of employment. The employer bears the cost of accident or illness arising out of the employment, as required by workmen's compensation laws.

Group Life Insurance. The group life insurance plan usually provides for a scale of premiums and benefits which vary with the salary or earnings of the employee. New employees become eligible for

protection under the group policy after a stated period, say three months, provided the employee is actively at work at that time and has made prior application. A part of the premium for the life insurance may be deducted from the pay of the employee, and the remainder of the cost is paid by the company. No medical examination is required for employees who make application within thirty-one days after the date they become eligible. While the protection afforded by group insurance depends upon the policy, income for a period of years may be paid to beneficiaries, or a lump-sum payment may be made. If death is due to accidental causes, the payments may be increased. If an employee becomes totally and permanently disabled before he reaches 60 years of age, specified payments are made to him. Disability payments are made without regard to the cause of the disability, which might be occupational or nonoccupational. The policy may also provide for payments to an employee who loses a hand or a foot or is otherwise maimed, even though he may not be able to prove disability.

A few labor unions have experimented with hospitalization and other types of group insurance. According to the usual plan, the members pay the premiums to the union, which manages the insurance fund and makes payments to workers who are entitled to compensation. Experience with such funds has usually been unsatisfactory because the unions lacked statistical data on which to base assessments and benefits. Union officials were not trained in the management of the funds, which were sometimes improperly used for strike benefits.[1] Consequently, unions have urged that money for the payment of benefits to workers should be paid by the employer. Three types of management for such benefit funds are in operation: those administered solely by the union; those administered jointly by the employer and the union; and those administered by a private insurance company, with premiums paid directly by the employer to the insurance company.

Recreation and Clubs. Activities in the field of recreation and clubs assume many forms. One company defines the work of its recreation manager as follows.

1. Developing and supervising a comprehensive program of recreational activities for all employees, including:

Sports: basketball, bowling, rifle, golf, softball, boxing, horseshoes, tennis, and swimming.
Social activities: dinners, special parties, minstrel shows, picnics, and concerts.
Clubs: camera, stamp, mixed chorus, chess and checker, and orchestra.

[1] "Union Health and Welfare Plans," *Bureau of Labor Statistics Bulletin 900* (Washington, D.C.: U.S. Government Printing Office, 1947).

2. Stimulating plantwide interest and participation in recreational activities through publicity in the plant magazine, local newspapers, posters, and announcements.

3. Co-ordinating the recreational activities of the company with those of the community, and giving active support to community recreational and sports ventures.

Programs for recreational and social activities are an established phase of personnel work in most large companies. They are designed to assist employees to become more efficient workers, to provide diversion and collateral interests as an interruption to the routines of factory work, and to foster loyalty to the company. Some of the activities are properly regarded as a phase of health work. The programs may be financed by the company, by a benefit association supported by the workers, by club dues, or by profits from vending machines and lunchroom sales. Successful programs should meet the following basic requirements:

1. Adaptation to local needs, interests, and working conditions. A program which is suited to a plant in a large city cannot be used in a town or small city.

2. An absence of paternalism or charity on the part of the company.

3. Democratic administration, with participation by representatives of the employees.

4. Emphasis upon the recreational and competitive features of sports and an absence of professionalism.

Employee Publication. A magazine published by the company in the interests of better personnel relations is usually referred to as an employee publication or plant magazine. One purpose of such a publication is to integrate the interests of employees and management by informing each group of the interests and activities of the other.[2] However, most of the space and the notices should concern employees rather than management. The magazine should also build up an interest in the company as a whole by informing the employees in various departments of the activities in all parts of the plant. It fosters a group spirit by recognizing the work of various departments in such matters as safety records, attendance, and production. It helps to build up a feeling of importance in the individual employee through notices of personal events, such as marriages, births, wedding anniversaries, retirements, and vacations.

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2 Paul F. Bilken and Robert D. Breth, *The Successful Employee Publications* (New York: McGraw-Hill Book Co., 1945), chap. i.

The plant magazine is usually published under the direction of the industrial relations department. Policies may be supervised by a joint committee of employees and management. Papers sometimes appear weekly and sometimes monthly. In a small business the reporting is done on a volunteer basis. The paper may be mimeographed or printed by a more expensive process. Most of the items are of a personal nature or relate to employee activities. The mentioning of the names of employees is good technique, although care may be necessary to avoid devoting an undue amount of space to the publicity seeker.

The distribution of space in the employee publication depends upon employee interests, and constant reader checks are desirable to determine the topics which have the most appeal. Some papers submit questionnaires to readers every six months to sample reader opinion. The following has been suggested as a possible distribution of space: company policies, 25 per cent; personal items, 15 per cent; company sports activities, 10 per cent; photographs, 15 per cent; educational subjects relating to the company, 10 per cent; special features, 10 per cent; letters to the editor, 5 per cent; cartoons and humor, 5 per cent; editorials, 5 per cent or none.[3]

The information which is covered in the usual plant periodical omits discussion of the job itself, such as wages, hours, working conditions, the settlement of grievances, job evaluation, layoffs, and technological unemployment. Although these things are of vital interest to the worker, he must learn about them through other channels. Perhaps one reason such problems are not discussed in the plant publication is that they relate to company policies, with which the editors are not authorized to deal. The discussion of the relation of the company to the union now has significant implications under the labor laws.

The employee publication is sent or distributed to employees without charge. The most successful method of distribution is to place the papers at the exits at quitting time in order that employees may pick them up as they leave. Papers should not be taken to workplaces or read in the plant. To emphasize the timeliness of the paper, surplus copies should be removed from places of distribution after two or three days.

Plant Cafeteria. In-plant feeding is now a common and accepted practice in industry. Companies which formerly expected employees to eat at nearby restaurants found the arrangement unsatisfactory. Em-

[3] *Ibid.*, chap. xi.

ployees spent too much time going to and from lunchrooms outside the plant. Because of the rush at the lunch period, workers were unable to be served promptly; and many of them were late in returning to their jobs. An excessive amount of time was spent by clerical employees in checking workers in and out at the gate. Because the cost of the noon meal to workers was excessive, many workers brought their lunches to the plant and ate at their workplaces. This practice resulted in poor housekeeping and in accidents from milk bottles and other containers. Insects were attracted by particles of food dropped on the floor. The installation of a plant cafeteria has been found to correct these undesirable features and to improve employee relations in other ways. Absenteeism is decreased, and better social relationships within the plant are established.

A phase of in-plant feeding is the provision of sandwiches, milk, and soft drinks for use at the lunch period and during rest periods in midmorning and midafternoon. Dispensing counters are sometimes established at convenient points throughout the plant. Some companies provide dispensing units on wheels, which make the rounds through the plant. A third plan is for each department to appoint an employee from its group to fill orders for all employees by one trip to the dispensing counter. Taking time out for a short refreshment period may be more than compensated by increased production. Regulated and supervised rest periods of prescribed length are usually preferable to rest periods taken by workers in violation of company policy and winked at by the foremen.

In-plant feeding is managed in three different ways:

1. The company manages the facilities at cost or perhaps at a small loss.

2. The facilities are managed jointly by the company and the employees. Space is provided by the company for little or no charge. Any profit is used for employee activities, such as sports and social affairs.

3. The facilities are managed by a service company which specializes in operating plant food facilities. The service operates under the company name and is generally regarded as a part of the company which owns and operates the plant.

Company Stores. Company stores and purchase plans are of several types, including the following:

Discount on Company Products. Retail stores, mail-order houses, and a few manufacturing companies permit their employees to purchase limited amounts of the product or merchandise of the company

at a discount. To prevent abuse of the plan, the company usually stipulates that the merchandise must be for personal or family use.

Company Purchase of Special Articles. Under this plan the company buys from other manufacturers or wholesalers certain articles, such as silver, electrical appliances, and household necessities, for resale to employees at cost.

Company Co-operative Store. Capital for the store is supplied by the patrons of the store; and management is by the employees, with a minimum of assistance by the company.

Company-Owned Store. The company supplies the capital, furnishes space, and manages the store. Sales are made at cost or at cost plus a margin to cover operating expenses. In some cases the margin above cost has been so large as to amount to exploitation. Because some companies have taken advantage of workers by forcing them to buy from company stores, many states now prohibit the payment of employees in scrip which is redeemable only at the store. Such provisions are also frequently included in the union-management contract.

Many company stores have not been successful. Company stores and employee purchase plans do not operate advantageously during periods when merchandise is in short supply. Too much time is spent by the purchasing department in trying to find scarce items. In times of rising prices, employee ill will may be created because the company is blamed for the high prices. The competition of well-managed stores in the community is another factor. In some cases the closing of company stores was considered necessary to the maintenance of good community relations because of objections made to the store by local merchants.

Suggestion System. A suggestion system is designed to provide the machinery whereby an employee may contribute ideas for the improvement of conditions within the plant. In small companies the program for the soliciting of suggestions is frequently an organized campaign which terminates at a definite time. Large companies may conduct a continuous program for employee suggestions. The purposes of such a program are to encourage and stimulate a flow of constructive suggestions for the improvement of working conditions, to establish better relations between the management and employees through the exchange of ideas, and to direct the minds of all employees and officers toward work methods. Suggestions usually relate to proposed changes in tools, machines, workplace layout, and procedures for purchasing, storing, or issuing materials.

The management of the suggestion system is the work of a member

of the industrial relations department. His duty is to solicit and investigate suggestions. No suggestion can be received through the suggestion system from foremen, engineers, time-study men, or other persons in the management group. Suggestions are made in writing on a form prepared by the company and may be signed or unsigned. If they are unsigned, the person who makes the suggestion is identified by a number which appears on the form and also on a perforated slip which he detaches. Acceptable suggestions are rewarded by a cash prize which may be 15 per cent of the savings for the first year. A minimum award may be established. If the savings are indefinite, the award is based upon the importance of the idea.

Employees should be informed of the type of suggestions desired. One plan is to publish a booklet describing the system and the method of its operation. One such booklet describes a suggestion as "a positive constructive idea to improve methods, equipment, and procedures; to make for safer and better working conditions; to reduce time or cost of an office, factory, or sales operation; or to improve either industrial or public relations." Another way of indicating to employees the type of suggestion desired is to print in the heading of the suggestion form the classes or groups of suggestions which are solicited. The employee checks the appropriate heading and then writes a description of the plan or change he suggests. One such form contains the following headings: Time Saving, Material, Safety, Health, Co-operation, Buildings, Machinery, Equipment, Grounds and Landscaping, Sociability, Recreation, Education, Public Relations, Research, Sales and Publicity, Service, New Products, and Any Routine or Procedure.

Some companies have found suggestion systems to be very successful. Others have tried and abandoned them. Reasons given for discontinuance are various. In some cases the value of the suggestions was not considered sufficient to cover the cost of the awards and the time spent in managing the plan. In other cases, foremen resented suggestions for improving conditions in their departments. If one worker made a suggestion for improving the job of another, the worker on the job resented it. Both foremen and workers sometimes attempted to show that the old way was better even after the committee had approved the suggestion. Suggestion plans are said to generate an individualistic attitude and to interfere with the development of a team spirit. The failure of some plans should be attributed to poor management or a lack of enthusiasm for the plan.

Retirement and Pension Plans. Many companies have long provided for the payment of retirement allowances to employees with a

stipulated number of years of service. The enactment of the Social Security Act in 1935, which provided for old-age and survivors' benefits, did not cause a general abandonment of pension plans, as many persons had feared, but was followed by the adoption of pension plans by more companies. Possible reasons for the extension of retirement plans may be the recognition that payments under the Social Security Act are not large and that the law directed attention of employers to the need for greater retirement allowances. Other possible reasons are the growing strength of organized labor and an increased feeling of social responsibility on the part of employers.

Retirement plans differ greatly in their provisions.[4] Some plans cover all employees, and some cover employees earning in excess of a specified amount per year. Some cover only salaried employees earning in excess of a stated amount. In some cases, all the cost is paid by the employer; and in other plans a part of the cost is paid by the employee, and a part is paid by the employer. Some plans provide for the establishment of a fund, which may be managed jointly by the employer and the employees. Some provide for the payment of the joint contributions to a trust company, which manages the funds and makes payments to the annuitants according to the plan. Some plans provide for the purchase of an annuity from an insurance company. In some cases, no fund is established; and the company merely pays its retired employees the agreed amounts and charges the payments to payroll expense as they are made. Unless a fund is established, the rights of employees may be lost as the result of a merger. Funds have sometimes been set up on an unsound actuarial basis.

Benefits to employees are usually based upon their annual earnings and the number of years of service. For example, one plan provides for the monthly payment of 1 per cent of the compensation in the year preceding retirement, multiplied by the number of years of service. Social security benefits are sometimes deducted from the payments made under the retirement plan. Allowances may be payable in case the employee is disabled prior to the retirement age.

Employee Stock-Purchase Plans. Following World War I, many companies adopted a plan of selling capital stock of the company to employees. The price was usually somewhat below the prevailing market price at the time of the sale, and payment was made in installments deducted from the pay of the employee. The amount of stock which an employee was permitted to purchase depended upon his

[4] See Bankers Trust Company, *Retirement Plans* (New York, 1946).

annual earnings. The purpose of such a plan was to foster interest in the company, to permit the employee to share in the profits, and to make the employee feel that he was a part of the company. Many of the plans were abandoned after the stock market crash of 1929, and only a limited number of them have been revived.

The most serious objection to stock ownership by employees is that the employee becomes dependent upon the company for both his job and the security of his savings. Common stock in any one industrial company does not provide either stability of income or security of principal. A diversity of investments in senior securities might be preferable. When a company urges employees to buy stock, it may expect criticism if prices decline in the market to less than the purchase price. Disappointment in the stock investment may impair the confidence of employees in the management of the company.

Credit Unions. A credit union is a co-operative small-loan enterprise. The company credit union receives deposits of the savings of employees and makes loans in small amounts to other members of the group. Interest rates paid to depositors are higher than the rate paid on time deposits in banks and perhaps conservative investments in bonds. The charges on loans made to borrowers are low in comparison with charges made by small-loan companies. The credit union program is under the direction of a committee of employees, with a minimum of assistance by a representative of the industrial relations department.

Credit unions in industry made rapid progress during the decade of the 1930's after employee stock-purchase plans were found to have serious disadvantages. The increased real wages and steady employment have enabled workers to make considerable investments in credit unions, and such institutions have had substantial growth since 1940. They make their greatest appeal to workers who regard their relationship with the company as permanent.

Employee Counseling. A personal service which members of the industrial relations department may render to employees is that of counseling. Methods and purposes of counseling differ according to the company and the interviewer. Three types of counseling may be distinguished:

1. The counselor may attempt to aid the employee in the solution of his personal problems incident to his employment. This type of counseling service was widely used during World War II, when many persons were drawn into industry for the first time.[5] Some of the

[5] See Frances W. Trigg, *The Job of Industrial Counselor for Women* (Washington, D.C.: U.S. Office of Education, 1944).

problems with which the counselor might be concerned have been mentioned in connection with the discussion of induction of employees. They include methods of checking in and out, information as to rest periods, smoking rules, methods of wage payment and payroll deductions, clothing regulations, vacations, medical facilities, reporting of accidents and method of applying for a social security number. Employees may also be assisted in the solution of community problems, such as housing, shopping, transportation, schools, nurseries, and banking. This type of counseling is most valuable during periods of rapid expansion of the labor force.

2. The counselor may advise with the employee concerning his record on the job and methods of advancement. When employees are rated by some plan of merit rating, their records should be reviewed with them after each rating. Their strong and weak points should be noticed, and methods of improving the rating should be discussed. The counselor may discuss with promising employees the possibilities of special training courses. The counseling interview is valuable in stimulating the interest of the employee.

3. The counselor may endeavor to assist the employee in making a satisfactory adjustment to his job. The counselor does not attempt to give advice, and he does not argue with the employee. He listens to the employee; and, by means of well-directed questions, he attempts to have the employee work out his own solution of the difficulty. The theory of this method is that the employee frequently rationalizes concerning his problems without realizing it. He permits his attitudes and his work on the job to be affected by misfortunes at home, demotions, transfers which are interpreted as demotions, unemployment of other members of the family, disappointment in personal affairs, and numerous developments which are not relevant to the job. The purpose of the interview is to give the employee a chance to talk to an understanding listener, to reduce his emotional tension by talking it out, and to decide for himself the best procedure.[6] Discussions are confidential, and the interviewer can take no action to correct a situation of which the employee complains. The method requires great skill and patience on the part of the interviewer.

This method of counseling resembles the procedure used in counseling with the general public, where the method is called "psychotherapy." The principal difference is that in industry the interviewer

[6] See Nathaniel Cantor, *Employee Counseling* (New York: McGraw-Hill Book Co., 1945); F. J. Roethlisberger and W. J. Dickson, *Management and the Worker* (Cambridge, Mass.: Harvard University Press, 1939).

is less free to lead the employee to discuss all his personal problems than is a private practitioner in handling the case of a client who recognizes the need for a solution to his problems. The method has not been generally used in industry because of its cost.[7]

Other Services. Many other services are being rendered by various companies to their employees. It is not possible to give a complete list; but they include company loans for housing, company housing projects, legal advice, and nurseries for the care of young children. The types of services depend upon the size of the company, the nature of the business, the location of the plant, the needs and desires of employees, and the attitude of the management. The services may vary from year to year according to changes in business conditions and the experiences of the company.

QUESTIONS

1. Are employee services conducted as charity or welfare work, or are they intended to increase the profits of the company?
2. How can the industrial relations department determine whether a proposed activity is desirable from the point of view of the company?
3. In what ways may employee service activities affect costs and expenses?
4. Should proposals for an employee service come from the management, an employee, or a representative of a union? If the idea originates with a member of the industrial relations department, how might it arrange for the formal or definite proposal to come from someone else?
5. What is the relative responsibility of the manufacturing departments and the industrial relations department in matters affecting the health of employees?
6. What can the industrial relations department do about such health matters as alcoholism, neglect of employees to eat nourishing breakfasts, or the practice of making a lunch of soft drinks and sandwiches?
7. Is the net cost of life insurance decreased when a stated percentage of the employees are insured under a group arrangement? How can the life insurance company afford to write life insurance without a physical examination?
8. What are the advantages of having insurance funds managed by a private insurance company rather than by the company or by the company and the union?
9. How may the recreational and athletic programs of the company be coordinated with other programs in the community?
10. How does the publication of the plant magazine benefit the company?

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[7] The method is described in Carl R. Rogers, *Counseling and Psychotherapy* (New York: Houghton Mifflin Co., 1942).

11. Should employees be consulted concerning menus, type of food served, and prices charged in the plant cafeteria?
12. How may employees be taught to select the most nourishing and wholesome foods in the cafeteria?
13. Should the company store be operated at a profit? If so, who gets the profit?
14. What types of suggestions are desired through the company suggestion system? What types are not wanted?
15. Does an award of 15 to 50 per cent of the savings for the first year seem to constitute a fair compensation to the employee who makes a suggestion?
16. What are the advantages and the limitations of the plan of soliciting suggestions from employees?
17. Should the retirement plan be based upon actuarial principles and financed by the establishment of a fund, or should payments to retired employees be charged as expenses as they are made?
18. Indicate whether the company should make a charge for the following:
    a) Uniforms for a company baseball team.
    b) Nursery service at the plant for the care of young children of employees.
    c) Group life insurance for employees.
    d) Legal advice on personal problems.
    e) Subscription to the plant magazine.

CASES

69. PROPOSED CO-OPERATIVE HEALTH PROGRAM

J. C. Allen, personnel manager for the Scott Manufacturing Company, has been investigating the possibilities of a co-operative health program for small companies in the city of Stamford, Ohio. Since the company has only 280 employees, it cannot afford and does not require the services of a full-time physician, although its employees occasionally have need for health services.

Mr. Allen has learned that three companies in Atlanta, Georgia, instituted a co-operative health plan in the summer of 1950. The total number of employees of the three companies was 800. A central clinic was set up, and a full-time nurse was employed. The nurse spends five hours each day in the clinic and one hour in each plant. A doctor spends three hours per day in the clinic and the remainder of his time in private practice.

A somewhat different plan is used in Hartford, Connecticut, by eight companies employing 500 to 800 employees each. Each of the companies has a full-time nurse in the plant, and a physician on a full-time basis visits each plant each day. The salary of the physician is paid by the eight companies in proportion to the time spent in each plant. The services rendered by the physician are found to be as follows: pre-employment physical examinations with emphasis on matching the capacity of the worker with the job, treatment of employees for occupational diseases and injuries, health counseling, giving prescriptions for nonoccupational illness, checking on employees returning to work after prolonged illness, recommending changes in working conditions to

eliminate health hazards, and keeping records of illness for purposes of health insurance.

Questions:

1. What would be the advantages of a co-operative health program?
2. Should employees be entitled to medical services for all types of illness?
3. Should employees be required to pay a part of the cost of the service?

70. ESTABLISHMENT OF A SUGGESTIONS SYSTEM

Shortly after Albert C. Weems was promoted from the position of vice-president in charge of operations to that of president of the company, he brought before a committee of divisional executives the proposal that the company should establish a suggestions system. He was convinced that many employees could make worth-while suggestions for increasing operating efficiency if they could be assured that foremen would not take the suggestions as personal criticisms and if the person making the suggestion could be properly rewarded. After a discussion of the proposal, the committee authorized J. J. Black, the personnel manager, to work out a detailed plan. Mr. Black proposed that the plan operate along the following lines:

The program would be in charge of a full-time suggestions manager, who would conduct a thorough investigation of every suggestion made. The suggestions manager need not be an engineer, but he should have the advice of the engineering department if it was needed. The principal qualifications of the manager, Mr. Black thought, were an open mind, fairness toward all employees, general experience in various positions in the company, and a high school education.

Mr. Black believed that all suggestions should be signed by the person making the suggestion. The reason often given for keeping the identity of the person a secret — namely, a fear of favoritism — seemed to imply a lack of confidence in the integrity of the management. The identity of the suggester should be known in order that the manager could confer with him and ask for more details when necessary.

Many companies provide a blank which carries only the words, "I suggest . . ." Mr. Black recommended two additional headings: "My reason for making this suggestion is . . ." and "My plan would increase efficiency or lower costs by . . ." The additional headings would cause the worker to give more thought to the details of the suggestion and perhaps reduce the number of impractical or unprofitable ideas.

A definite schedule of awards would be established. Mr. Black recommended that the suggester be given 40 per cent of the anticipated savings for the first year. If new equipment was needed to carry out the suggestion, the cost of the equipment would be amortized over a three-year period to determine the net saving.

Foremen would be permitted and encouraged to make suggestions, even though attention to operating methods was a part of their regular jobs. A foreman who made an acceptable suggestion would be paid an award equal to 50 per cent of the amount that would have been paid to an employee making the suggestion.

After the suggestion had been investigated and accepted by the suggestions manager, it would be referred to a board composed of the plant superintendent, the chief engineer, and the personnel manager. Action by the board would be final.

The detailed plan presented by Mr. Black was approved by the committee of divisional executives, and it was put into effect. A suggestion was made by a worker which would save $250 a year in labor and $150 in materials. The suggestion would require the expenditure of $180 for a revision of the layout of the workplace. A foreman made a suggestion that would result in a saving of labor in the amount of $800 per year. The suggestion would require a new fixture which would cost $600.

Required:

1. Justify or criticize the details of the suggestion system as proposed by Mr. Black.
2. Compute the awards to be made to the worker and the foreman.

71. OPERATION OF SUGGESTIONS SYSTEM

Frank Lacey, an employee in the finishing department of the Kaplan Company, submitted a suggestion to the personnel manager that the company organize a Wise Owl Club. Membership in the club would be composed of employees who had been saved from eye injuries by wearing goggles while doing work on a grinder or other machine. Each member would be awarded a lapel button and an appropriate certificate signed by the foreman and the accident prevention manager. For this suggestion, Lacey was awarded a $25 government bond, in accordance with the plan of the company.

Six months after the award was made, Frank called at the personnel office and asked whether the Wise Owl Club had been organized. The personnel manager could not recall that such a suggestion had been accepted. Upon investigation, he found that one out of four suggestions accepted was never put into practice.

Questions:

1. Who should be made responsible for seeing that suggestions for which awards are made are put into practice?
2. Why is such follow-up necessary to the success of the system?

72. RELATION OF WIVES OF EMPLOYEES TO COMPANY PROGRAMS[1]

The C. A. Norgren Company of Denver believes that the company should develop the interest of the wives of employees in various company activities and policies. The personnel department keeps a record of the birthday anniversaries and sends each wife a birthday card and flowers on this occasion. The wives are regularly notified of the amount of profit to be paid on the profit-sharing plan as soon as the shares are determined. Profit-sharing checks

[1] Adapted by permission from *Factory Management and Maintenance*, Vol. CIX, No. 8 (1951), p. 111.

are distributed to the wives at the annual Christmas party given by the company. The wives are notified by letter of any significant changes at the plant, such as changes in work hours, schedules, overtime work, transfers, and promotions.

Some companies also attempt to develop a better relationship between the company and the wives of employees. The Armco Steel Corporation presents the wife of an employee of 25 years of service with a gold brooch, in addition to the recognition awarded the employee. Some companies extend special invitations to the wives of employees to visit the plant.

Questions:

1. What may be gained by developing an interest in the company on the part of the wives of employees?
2. Might an employee object if the company presents his profit-sharing check to his wife?
3. Could any legal complications arise as a result of this program because of separations or divorces?

73. ORGANIZATION OF OPEN HOUSE

The Johnston Textile Products Company, located in a city of 85,000, had never permitted plant visits by people in the community. The reasons of the management were, first, the accident hazard; second, the possibility of fire; and, third, the possible effect upon production. The plant superintendent considered plant visits a nuisance because members of the management would be expected to serve as guides.

The personnel manager learned from applicants for employment and from people in the community that there was much misunderstanding of company policies and conditions within the plant. Disgruntled employees made exaggerated statements concerning working conditions and management methods. There was a general feeling that the company was trying to conceal something. Many employees felt uncertain about their jobs because of rumors that the company was on the point of bankruptcy.

In an effort to improve community relations, an outside consultant was engaged. He advised that as a part of the program an open house be organized to extend over a period of one week. During that time, people in the city and particularly the families of employees would be invited to visit the plant to see what conditions were like. The suggestion was approved by the plant superintendent and the president of the company. The personnel manager was appointed chairman of a committee to work out the details.

A number of subcommittees were appointed for publicity, ticket distribution, reception, guide selection and training, and registration and information. A ticket distribution committee was considered necessary to assure that an excessive number of visitors would not report on any one day.

The plan met with a favorable response from the community. Capacity groups were shown through the plant each day. The families of employees were especially pleased to see the machines at which a member of the family worked. The plant superintendent and the personnel manager agreed that it

would now be more difficult for anyone to start a rumor in the community concerning the company. It was also expected that the employment department would have less difficulty in recruiting applicants for jobs.

Questions:

1. What costs arise from a plant visitation program?
2. What advantages might the company gain?
3. How can the management determine whether the program is worth its cost?
4. Would regular plant visits be preferred to the plan of the open house?

PART VIII

Procurement and Storage

CHAPTER XXXIII

PURCHASING

PURCHASING is an important activity of a business enterprise. The continuous operation of the business may be dependent upon the ability of the purchasing department to provide an adequate supply of materials. At all times, the purchasing department should keep the supply of materials in balance and in proper relation to the rate of use in manufacture. The prices at which materials are purchased may determine whether the business operates at a profit or a loss.

Types of Goods Purchased. The purchasing department of a large enterprise may make contracts for the purchase of four types of goods, which are as follows:

Materials for Fabrication in Manufacture. Merchandise of this type enters into the product with its form so changed that consumers cannot recognize the material by either grade or trade name. Examples are lumber, grain, sheet steel, pipe, wire, wool, cotton, paint, and copper. Consumer acceptance of the trade name or the good will associated with the name of the manufacturer of the material is not important in the purchase of merchandise of this sort. The purchase of such materials is usually made by commercial grade or specification, on the basis of suitability for manufacture.

Merchandise for Resale without Fabrication. Some manufacturing enterprises occasionally contract for the manufacture of the product for resale. For example, a shirt manufacturer may contract for the manufacture of fancy shirts of certain designs for which the demand is seasonal. This arrangement enables the company to concentrate on the manufacture of shirts of stable demand. Many manufacturers purchase various types of appliances and other merchandise for sale to employees or members of the management at a discount. As explained in Chapter XXXII, some companies operate employee stores, canteens,

or lunch counters where goods are sold as purchased. Parts, containers, and accessories may be purchased rather than manufactured. Examples are roller bearings, motors, carburetors, locks, tires, and tin cans. In all such cases, purchases may be made on the basis of brand, trade name, and consumer acceptance, as well as suitability for manufacturing.

Machinery and Equipment. The purchasing department usually makes purchases of machinery, furniture, office appliances, and other types of equipment upon requisition from the department for which the equipment is intended.

Supplies. This type of merchandise includes coal, fuel oil, cleaning supplies, lubricants, stationery, printed forms, athletic supplies, photographs, and literature for use in employee and public relations. Such purchases should be made on the basis of suitability for the purposes intended and of acceptability to the persons who will use the supplies.

The Purchasing Function. In the purchase of materials and supplies, the first responsibility of the purchasing department is to locate sources of supply and to select the best and most reliable sources. It also should keep informed as to prices, the quality of various grades and varieties, and the amounts available at the prices quoted. It negotiates the purchase contract, arranges for delivery dates, and follows up the purchase order to see that the goods are received on the dates wanted and are available on schedule. It attends to the details of compiling quotations for materials or bids on contracts, checks the invoices of vendors, and carries on correspondence with suppliers. It maintains the necessary records of bids received, prices quoted, and orders placed.

A number of activities are closely related to the purchasing function and are sometimes considered a part of it. For example, production planning requires the scheduling of the receipt of material in stock for use in meeting production schedules. The design of the product, which is an engineering function, may depend upon the availability of certain types of materials, their cost, and the existence of standard materials, parts, and accessories in the market. Purchasing is closely related to other procurement activities, such as traffic management, the handling of incoming shipments, storeroom management, and inventory control. Purchasing should also be co-ordinated with the activities of the line and staff departments for which the purchases are made.

Organization for Purchasing. The work of purchasing is usually placed under the direction of an executive with the title of purchasing agent. This title emphasizes the legal position of the purchasing officer as legal representative of the company in making purchases con-

tracts. The purchasing agent may report to the chief executive as the head of a major division, or he may report to the vice-president in charge of manufacturing. The position of the purchasing function in the organization depends upon its importance to the enterprise. In some companies, such as meat packing, flour milling, or sugar refining, the cost of the raw material constitutes such a large percentage of the total manufacturing cost that purchasing assumes a major importance. A mining company, at the other extreme, gets its raw materials from the ground and buys only certain supplies and equipment. In many companies, purchasing is placed in an intermediate position as a separate department but not a major division.

The organization within the purchasing department depends upon the extent of the activities for which it is responsible. If it handles only the purchasing function and none of the related activities of procurement previously mentioned, the principal activity would be that of letting purchases contracts. Each buyer under the direction of a purchasing agent would specialize on the purchase of a group of materials, such as finished parts, chemicals, and steel. The organization of the buying group would obviously depend upon the types of materials to be purchased. The buying group would be assisted by other sections which would attend to clerical details. A price and vendor section would maintain price information and data pertaining to sources of supply. A clerical section would keep records and check invoices. Other sections would follow up orders placed and prepare statistical and research reports.

In a multiplant company the principal question of organization for purchasing pertains to the extent to which purchasing is centralized. If each plant produces a different type of product, such as frozen foods, meats, or coffee, each plant may be permitted to make its own purchases. If all of the plants produce the same or similar products, such as shirts, wire and cable, or tin cans, purchasing is more likely to be centralized in the main office.

Centralized purchasing is usually preferred if the plan is feasible. Buying can be done in larger quantities at lower prices and easier credit terms. Materials and merchandise are more likely to be standardized throughout the organization. During periods of short supply, when materials are allocated by vendors or are controlled by a governmental agency, centralized purchasing may afford greater assurance of an adequate supply because the central office can devote more attention to negotiations with vendors and to governmental regulations. Purchase commitments and inventory plans may be controlled by the main office

in conformity with production plans and financial requirements. In times of uncertain price trends, many companies have found that programs of reducing inventories were not closely followed by local purchasing agents. The results of decentralized purchasing under such conditions can be disastrous to the company.

Centralized purchasing has other advantages. It permits better coordination of production with production planning. It also eliminates competition between the various local purchasing agents in the same markets for the same materials. It eliminates duplication of managerial organization and permits the employment or development of specialists in commodities. The legal phases of the contracts will receive closer attention.

Developing Sources of Supply. The purchasing department is responsible for locating the sources of supply and for determining their reliability. The purchasing agent may learn of possible sources in the following ways:

Interviews with salesmen.
Advertisements in trade magazines.
Solicitations received through the mail.
Responses to requests for bids published in newspapers and other periodicals.
Directories of trade associations.
Classified lists in the telephone book.
Suggestions from departments needing materials or supplies.
Publications of technical societies.

The maintenance of satisfactory relations with vendors is very important to the success of the purchasing program. This fact becomes apparent during periods of short supply, when vendors allot merchandise to persons or businesses with whom relations have been good. Vendor good-will may manifest itself in prompt shipments, liberal credit terms, strict adherence to purchase specifications, tips on possible changes in prices and on materials shortages, and many other ways. Some purchasing agents fail to realize that salesmen are engaged in a necessary type of work and can be very helpful to them. Some practices of the purchasing department which may result in the loss of vendor good-will are as follows:

Refusal to see salesmen.

Cutting interviews short and not permitting the salesman to explain his product.

Telling salesmen that the company is not in the market at a time when orders are actually being placed.

Asking salesmen for samples when the purchasing agent knows that no purchases will be made.

Requiring salesmen to wait an unduly long time for an interview.

Failing to keep an appointment for an interview.

Asking a salesman to state his case in the presence of other persons in the reception room instead of in a private office.

Making unreasonable and unnecessary delivery requirements.

Placing speculative orders with the intent of canceling them if prices decline.

Attempting to obtain a low price which does not afford a fair profit to the vendor.

Playing one vendor against another by misrepresenting the prices asked or the terms offered by other vendors.

Using a quoted price on an inferior article to drive down the price on a better one.

Failing to accept delivery of merchandise ordered.

Rejecting good merchandise on the ground that it does not meet specifications.

Refusing to compromise or arbitrate differences with vendors.

The good will attached to the name of the vendor is an important factor in the mind of the purchasing agent in the placing of orders. In addition to the price quoted for merchandise, he may take into account such factors as the following:

1. Discounts, datings, delivery point, and the payment of freight. These factors are really phases of the prices of the merchandise. For example, if the vendor grants a large cash or quantity discount or permits the discount to be taken some time after the merchandise has been delivered, he has in effect granted a price reduction. High freight rates from a distant source of supply may nullify a low purchase price.

2. Reputation of the vendor for fairness. Some vendors may ship materials differing from the goods ordered and may refuse to accept returns of such materials.

3. Reputation of the vendor for workmanship. The reputation of the vendor may assure the purchaser that quality will be as specified in the order. If the ultimate consumer can identify the product as that of a reliable manufacturer, the good will facilitates the resale of the merchandise. For example, the good will attached to the name of the manufacturer of automobile tires is a factor in the sale of the automobile on which the tires are mounted.

4. The amount the vendor can supply. The purchaser may at times buy his materials at a lower net price by placing orders for large quantities with one vendor, even though a small manufacturer has quoted a low price on a small quantity.

5. Promptness in delivery. Failure to make prompt delivery may be due to labor difficulties, inability of a vendor to acquire materials for manufacture, poor production planning by the vendor, or large volume of unfilled orders while new orders are being accepted.

6. Financial stability of the vendor. A purchaser who is interested in the development of a permanent source of supply would prefer that the vendor be sufficiently established and financed to assure stability.

7. Aids to the purchaser in judging market trends. The vendor may be able to assist the purchaser in anticipating the trend of prices or styles and in avoiding the difficulties incident to strikes, traffic congestion, and other developments. Some vendors may offer constructive suggestions for using overstocks of materials, eliminating waste, reducing scrap, or improving the product.

The purchasing agent may be required to use certain sources because the policy of the company requires him to buy from its customers. For example, an automobile company may buy tires from a rubber company because the rubber company buys its automobiles from the first company. A company making office forms may buy its machines and its paper from companies to whom it sells. A paint company may buy its linseed oil from a certain source because in another city it has a linseed oil plant which sells to the other company which has a plant in that area. This practice is known as "reciprocal buying."

Purchasing agents are usually opposed to the policy of reciprocal buying. They prefer to make their purchases on the basis of price, quality, or other features of the materials. When the policy of reciprocal buying is followed, the selection of sources of supply is made outside the purchasing department.

In the development of resources of supply, the purchasing agent may wish to assure a continued flow of materials without any interruption due to strikes, traffic tie-ups, or bankruptcies. This policy may suggest that orders should be placed with two or more vendors, in order that one source or a few sources may ordinarily be available. When this policy is followed, the quantity of materials ordered from any one vendor will be smaller than would otherwise be the case; and the price may therefore be higher. In some cases, purchases from more than one vendor may be necessary because no one vendor can supply the materials in the quantities required.

The purchasing agent should be entirely free to place orders with the best sources of supply. If he has accepted gifts from salesmen or vendors, he may be influenced, consciously or unconsciously, in the placing of orders. To free himself of any appearance of favoritism, he would do well to decline gifts of any kind. Commercial bribery is illegal as an unfair method of competition under the provisions of the Federal Trade Commission Act of 1914, although actually the practice has not been discontinued. Somewhat less objectionable is the acceptance

of entertainment offered by salesmen, including gifts of liquor, cigars, meals, and theater tickets. Entertaining customers and giving small gifts are not considered to be commercial bribery.[1]

What to Buy. The first question to arise in determining what to buy concerns which parts or materials are to be purchased and which parts are to be manufactured. Every business is required to purchase some parts or materials from outside sources of supply. Manufacturing the part may be preferred policy if the parts can be made at costs that are lower than prices asked by vendors. The manufacture of a part may also reduce the risk incident to an uncertain source of supply and may prevent an interruption of operations because of the lack of materials. Production of a part may make possible better planning of work and better integration of the activities of the various depatrments, and quality may be more closely controlled.

The purchase of a part may be an advantage if its manufacture requires a knowledge of specialized production methods or techniques, if a large capital investment is necessary, or if the quantity required by the purchaser is not large enough to permit low manufacturing costs. In some cases, parts or materials are purchased because the source of supply is located in a limited geographical area within or without the United States or because the materials are manufactured from a deposit of a natural resource which is limited. Examples are magnesium, aluminum, copper, lumber, and industrial diamonds.

Another question concerns the kinds of materials to be purchased. The establishment of specifications of materials usually requires the co-operation of the purchasing department and various other departments. Because of his contacts with salesmen and outside sources of supply, the purchasing agent should be able to suggest new and more economical materials for use by the manufacturing departments. He should also follow up the use of materials and supplies to determine their suitability to the requirements of the company.

Some commodities are purchased by brand or trade name, some by sample, and some by specifications. Many commodities may be purchased by commercial grade, as established by the National Bureau of Standards, the American Standards Association, or other agencies. The use of specifications or commercial grade in the making of purchases affords the following advantages:

1. The bids received from different vendors may be compared to determine whose price is really the lowest.

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[1] *New Jersey Asbestos Co.* v. *Federal Trade Commission,* 264 Fed. 509 (1920).

2. Materials purchased may be of sufficiently high quality to maintain the quality of the product but not of a higher quality than is necessary. For example, a cheap quality of wood, thin sheets of metal, or cheap alloys may be used in the manufacture of certain parts of the product. The prescribing of close tolerances for the dimensions of parts which are purchased greatly increases the cost and may not be necessary.

3. The purchaser may be more certain of receiving the materials needed or ordered.

4. The size of the inventory of materials may be reduced if a limited variety of materials of standard quality is maintained.

5. The clerical expense of purchasing, receiving, and maintaining inventory records is reduced.

6. The operation of a standard cost accounting system is simplified. Cost can be more accurately determined in advance of production because the type of materials to be used is known.

7. The making of motion and time studies is facilitated. The operations and the motions to be performed in the manufacture of the product are more easily standardized when materials are purchased according to standard specifications.

8. The quantities to be purchased are more easily budgeted because fewer kinds of materials are likely to be used.

9. Inspection of incoming materials is simplified.

10. In some cases the purchaser may obtain a lower price because he avoids paying for a trade name or a brand article.

11. The standard quality of the product is more easily maintained when the same grade of materials is always used. Additional costs may be required for the manufacture of a standard product from nonstandardized materials.

How Much to Buy. The purchasing agent may attempt to buy large quantities when prices are low in order to profit from a rise in prices or to obtain the benefits of low materials cost. Purchases are made in anticipation of needs at an indefinite future time, without regard to immediate needs. This practice is known as "speculative buying."

Speculative buying is widely practiced during a period of rising prices. The policy may be justified not only because a speculative profit may be realized from the advance in prices but also because it may make continuous operation of the plant possible during periods of short supply. However, speculative transactions may result in losses instead of profits; and excessive purchases may cause additional expenses to be incurred for storage, handling, insurance, and interest. In some

cases, materials may decrease in value because of deterioration. Merchandise purchased on a speculative basis may become unusable as a result of changes in the design of the product. Many companies consider that, as an established policy, speculative buying is not sound.

The profits realized or the losses sustained from speculative buying may be entered in the accounting records and shown separately in the profit and loss statement. This result is accomplished by, first, recording the purchases in the general accounts and in the balance of stores records at cost and, second, charging purchases to operations at market prices prevailing when the materials are issued for use in production. The difference between cost and market price at the date of issuance is recorded as Gain or Loss on Purchases of Materials.

Hand-to-Mouth Buying. The policy of hand-to-mouth buying is the opposite of speculative buying. Inventory is kept as low as possible without interrupting current operations. The purpose is to avoid the costs incident to the carrying of large quantities of materials and the possible losses due to market declines. Many companies adopt this policy during periods of declining commodity prices.

Hand-to-mouth buying may result in the following advantages or economies:

1. Investment in inventories is lowered.
2. Less storage space is required.
3. Inventory losses are minimized in case the design of the product is changed.
4. Changes in the specifications of materials are facilitated in case new types of materials are offered in the market.
5. The purchaser has frequent contacts with vendors and more easily keeps informed of developments in the market.

The following objections may be made to the policy of hand-to-mouth buying:

1. Clerical expenses in placing orders, receiving and inspecting merchandise, and accounting for purchases are increased.
2. Prices on small quantities may be higher than they are on large amounts.
3. Service to customers may be delayed in case large sales orders are received.
4. Any interruption in the flow of incoming materials may result in delays in production.

For most companies the desirable policy is that purchases should be made in economical quantities and that inventories should not be excessive. However, the policy depends in part upon the material and

the conditions in the market. The amount to be purchased at any one time should be increased during periods of expanding business to provide for the increased rate of consumption of materials.

The policy of maintaining a reserve stock of key materials is intended to prevent an interruption of manufacturing operations because of the lack of a material which is essential to manufacture but whose cost is not a large percentage of the total cost of the product. Such materials may be purchased in quantity, not because the price may advance in the market but because the materials may not later be obtainable at any price. Possible causes of short supply may be labor difficulties, crop failures at home or abroad, government purchases or priorities, and restrictions on exports from foreign countries.

The difficulty with the policy of maintaining a large inventory of key materials is that many materials may be essential to continuous operations. The result may be an undue expansion of the investment in inventory.

Some commodities, such as tin or fiber containers, may be bought on a long-term basis. A contract of this kind may provide that for a stated period of years the vendor will supply on reasonable notice the full requirements of the purchaser, however large or small his needs may be. The contract relieves the buyer of the necessity for making any commitment for materials beyond the exact quantities he needs. He may order the materials on any time schedule according to the requirements of his business. Prices may be established at the beginning of each year for a period of twelve months. The price is varied to allow for changes in material and labor costs of the vendor. With this type of contract the customer is assured a constant cost of containers or other material purchased during the year. The advantage to the vendor is that he may undertake research or development work and may expand production facilities with reasonable assurance that the product can be sold at a profit.

Long-term purchase contracts may contain a clause which permits the price to be increased or decreased if market prices change prior to the date of the delivery of the merchandise. Such a contract is legal, provided that it indicates the conditions under which the price is to be increased and defines the standard or formula by which the amount of the increase will be determined. The increase in price should be automatic, and it should not require further discussion between the parties. A vague clause which provides for a change in the purchase price on the basis of time studies or a cost analysis cannot be enforced at law. In deciding a controversy between two parties who had made

a contract containing a tentative price schedule which was to be revised on the basis of a cost analysis, the court said:

> The cost analysis furnished only the basis for negotiation for a final revision of the prices — it did not provide an acceptable standard by which the court could give effect to the intention of the parties. . . . The prices stipulated were tentative and temporary, but they prevail until revised through the medium of supplemental contracts. The parties could not mutually agree upon terms of a supplemental contract, and we cannot make one for them.[2]

Records for Purchasing. The clerical section of the purchasing department compiles various types of information for use in placing orders and for following up orders placed. The data used in placing orders would include a file of catalogues and price quotations of vendors, a file of bids received on contracts, and a record of purchases made, classified by materials, vendors, and purchase-order numbers. Orders currently outstanding are controlled through a follow-up file.

The principal problem in the maintenance of records and files in the purchasing department is the arrangement of catalogues, quotations, and price lists received from vendors in a form which makes possible the quick and easy location of quotations on any material desired. Unless a systematic plan of filing is followed, obsolete catalogues and quotations will accumulate; and much time may be lost in searching for information when it is needed. The choice of a filing system depends upon the size of the department and the amount of material to be filed. The following methods are used:

1. Catalogues and price information may be filed alphabetically by name of vendor. One file may be maintained in bookcases for large catalogues and leaflets.

2. The alphabetical file may be supplemented by a commodity file. In the commodity file a folder is kept for each commodity. A sheet which is inserted in each folder lists the sources of supply, as contained in the catalogue file. The commodity file serves as a cross reference and is used in connection with the catalogue file.

3. The catalogue and sales literature are filed numerically. Folders are used for small, thin pieces of literature. Each catalogue or folder is given a number. A card index, with cards arranged alphabetically, is used to show the name and address of each vendor and the number of the catalogue of the vendor in the numerical file.

4. Information pertaining to vendors is filed in cases or cabinets as it is received and is located by reference to an alphabetical index. The

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[2] *Beech Aircraft Corporation* v. *Ross*, 155 Fed. (2d) 615 (1946).

index card indicates the case, drawer, and folder number in which the information is filed. For example, the file number 4–3–S4 might indicate:

4 Number of filing cabinet.
3 Number of drawer in cabinet number 4.
S Guide letter in drawer number 3.
4 Fourth catalogue behind guide S.

Adaptations of these methods are frequently found in practice. The essential requirement of any filing system is that the purchasing agent or the file clerk be able quickly to locate the catalogue of any vendor and the sources of supply for any commodity when the information is needed. The files should be reviewed regularly to eliminate obsolete information and to add supplementary information.

Qualifications of the Purchasing Agent. The discussion of the duties and the responsibilities of the purchasing agent indicates that he should be a person of broad business training, wide experience, and considerable business ability. He should be honest and able to resist flattery. He should have a knowledge of the products of the company and the methods used in manufacture. For buying certain types of materials and equipment, a knowledge of engineering would be helpful, although he may draw upon the training of other persons in the company for engineering advice. He should be open-minded, willing to deal fairly with vendors, and able to appraise values. He should be co-operative with other members in the organization. He should have a knowledge of markets, business conditions, office procedure, and the law of contracts and sales. He should possess executive capacity in the management of his own department. This tabulation of requirements is rather formidable.

QUESTIONS

1. What departments in a manufacturing enterprise should co-operate in determining quantities of materials to purchase?
2. Is purchasing a major or a minor function of a manufacturing business? Compare its importance in the following industries: meat packing, job printing, flour manufacture, brick manufacture, and jewelry manufacture.
3. When various departments and divisions use similar materials and supplies, what economies may be effected by centralized purchasing?
4. Explain how the decision concerning the quality of materials to be purchased may affect the work of product design, engineering, and sales.
5. What conditions determine whether purchase contracts should be made only when the supply reaches the reorder point or whether large quantities should be purchased when prices are believed to be low?

6. What costs and expenses are decreased when materials and supplies are purchased in large quantities? What costs and expenses are increased by purchases in large quantities?
7. Why is the reputation of the vendor for fairness and for quality important? If materials are purchased on the basis of specifications or commercial grade, does the reputation of the vendor affect the decision to place an order with him?
8. What is the advantage of placing purchase orders by indicating commercial grade?
9. Mention companies or enterprises which might follow the policy of reciprocal buying. Why do purchasing agents usually oppose such a policy?
10. What costs and expenses are increased by the policy of hand-to-mouth buying?
11. How may the purchasing agent decide whether a gift from a vendor is proper or improper?
12. What is an "escalator" clause? What is necessary to legal enforcement of such clauses?
13. What training and experience are desirable in preparation for a position as purchasing agent?

CASES

74. SCHEDULING OF PURCHASES

An automobile company purchases many of the parts used in the final assembly. In placing orders for delivery, the purchasing agent allows for the time required for paper work, transportation, and scheduling by the vendor as well as the manufacturing operations. Orders are commonly placed with vendors in advance of the requirements for assembly on the following schedule:

Transmission	12 months
Doors	10 months
Wheels and tires	9½ months
Rear axle	8 months
Fuel tank	6 months

The production schedule for the first six months of the year is as follows:

	Units
January	2,500
February	2,800
March	3,300
April	3,500
May	3,800
June	3,600

Required:

Set up purchasing schedule to meet production requirements.

75. CONTROL OF FUNCTIONS FROM MAIN OFFICE

A large retail enterprise has its main office at Chicago, with large stores in cities in different parts of the country. At Chicago, working directly under the

president, are the following heads of divisions: general manager, finance manager, personnel manager, advertising manager, controller, and purchasing agent. General policies for all stores are established at the main office in Chicago. Merchandise is purchased under long-term contracts with manufacturers for shipment direct from factories to local stores. Some merchandise is delivered to a central warehouse, from which it is obtained by local stores by requisition. At the head of each store is a store manager, who reports to the general manager in Chicago. Sales activities in each local store are handled by a merchandise manager, and under the merchandise manager are the managers of various selling departments. Each store also has a manager for each activity on a local basis, such as personnel manager, accountant, treasurer, and purchasing agent. These managers report to the local store manager, but they follow general policies established at the main office in Chicago. The local purchasing agent buys a limited number of items sold only in the local store.

Required:

Draw up an organization chart for the company. Show detailed organization for one store.

CHAPTER XXXIV

INVENTORY STANDARDS AND CONTROL

THE MATERIALS used in the manufacture of the product of industry amount from 50 to 55 per cent of total manufacturing cost. Because of its importance in determining total costs and profits, inventory should be carefully controlled by management.

Kinds of Inventory. The establishment of an effective control of inventory requires the setting-up of procedures for handling each of the kinds of inventory, which are as follows:

Materials inventory is the stock of items that become a part of the product manufactured. For example, the materials for the manufacture of a book include the paper, textiles, and cardboard of which the book is made. The materials for the production of canned food include the fruit or vegetables, sugar, and cans or other containers. Materials are sometimes referred to as "raw materials."

Purchased parts are fabricated items which are bought from other manufacturers in a finished or semifinished state. They may include such parts as motors, tires, carburetors, gears, connecting rods, wheels, and sprocket chains. Such parts are often included in the materials inventory, but a separate classification for purchased parts is desirable if the company sometimes purchases them and at other times manufactures them for itself. Parts which have been manufactured and placed in permanent storage in a storeroom are called "worked materials."

Supplies include those items which are used in manufacturing but which do not become a part of the product. Examples are lubricating oils, waste, and rags used for cleaning, stationery and forms used in the various manufacturing departments, sandpaper and other abrasives, and repair parts for machines and equipment. The supplies inventory, in cost accounting terminology, also includes those items which enter into the product in such small quantities that their measurement for

purposes of determining cost is not feasible. Examples are thread, glue, paint, and inexpensive items of hardware such as nails, tacks, and screws.

The stores inventory is a broad classification which includes materials, purchased parts, and supplies. In the accounting department a single account called Stores is often used to record all three inventories.

Goods-in-process inventory is the partially completed product in the factory in process of manufacture. When materials are issued from the storeroom to the first manufacturing department, they become a part of the goods-in-process inventory. The value of the inventory when the materials are issued consists only of the cost of the materials. Subsequent manufacturing operations increase the value by the cost of labor and manufacturing expense. The goods-in-process inventory is also referred to as the "factory float" or merely as the "float."

The *inventory of finished goods* consists of the manufactured product in the form in which it is sold to customers. The goods-in-process inventory becomes finished goods inventory when the product is completed in manufacture and is transferred to the finished goods storeroom or the shipping room.

The *inventory of tools, patterns, and dies,* in accounting terms, is a fixed asset and not a current asset, although the items in this inventory are of relatively short life. The control of this inventory is an essential part of business budgeting and planning. Both the initial purchases and the replacements made necessary by wear, breakage, and loss should be carefully controlled.

Purposes of Inventory Management. The objectives of the control of inventories include the following:

Minimum Investment. Effective inventory control should assure that stocks of materials are not excessive. Large inventories may increase various expenses, and the inventory may also be subject to deterioration and obsolescence.

Continuous Factory Operations. Production should not be delayed by a lack of materials of the proper quality.

Prevention of Waste. Waste of materials may result from carelessness in handling, dishonesty, or poor workmanship.

Information for Financial Management. Inventory control should yield information which may be used in financial planning. Such information includes the following: cost of materials used in production; supplies used by each department, both line and staff; inactive and obsolete materials in the storeroom; and value of the inventories for purposes of the balance sheet and the profit and loss statement.

Good inventory management requires that attention be given to the following phases of the problem:

The kinds of materials to be used in production should be determined, and specifications should be established. This phase of the problem has been previously discussed in connection with product design and purchasing.

Standards should be established for the quantity of materials to order for each item in stock. In determining the quantity to order, management should decide whether its policy is to be that of buying to meet the requirements of production, or buying from hand to mouth, or speculative buying. The last two policies were considered in connection with purchasing.

Control should be established over the receiving, inspecting, storing, issuing, and moving of materials. Inspection and materials handling have already been discussed. Storeroom activities will be considered in the following chapter.

Records should be established to assure the effective operation of the system of inventory control. The records should be periodically reviewed to check on the rate of purchase and consumption, the effectiveness of the established reorder point, and the size of the purchase order for each item.

Standard Quantities. The four standard quantities for inventory are as follows:

The *maximum* is the largest quantity of any material which should be on hand at any time. It is the upper limit for the inventory of any item.

The *minimum* is the smallest quantity of any item which should be on hand at any time. It is the quantity which is considered necessary for emergency or unusual demand. The supply may go below the minimum if material used is greatly increased or the delivery of materials purchased is delayed. The minimum is sometimes referred to as the "margin of safety."

The *reorder point* is the quantity on hand when a purchase order should be placed with a vendor for an additional supply or a production order should be issued to the factory for the manufacture of a product or finished part. The reorder point is established at that quantity which is believed to assure that the supply will not be exhausted before additional materials can be received.

The *quantity to order* is the economical quantity to purchase in the case of a material or purchased part. *The quantity to manufacture* is the economical quantity to manufacture in the case of a part or

a product which is manufactured for sale or for stock. When this quantity has been determined, all purchase orders placed with vendors or production orders issued to the factory are for the standard quantities. The standard quantity to order is revised when market or other business conditions change.

The relation of the inventory quantity standards to each other are as follows:

Reorder point + Quantity to order = Maximum.
Reorder point — Average consumption during the order period = Minimum.

Determining the Quantity to Order. One of the principal problems of inventory management is the determination of the economical quantity to order or to manufacture. The decision is affected by many factors, some of which relate to all commodities in the inventory and some of which relate to the individual items. The more important factors which should be considered in determining the quantity to purchase are as follows:

I. General factors affecting the entire inventory
  - General business conditions
    - Possible labor troubles of vendors
    - Shortages of supply in the markets
    - Transportation difficulties
    - The trend of prices upward or downward
  - Prospects and plans for the individual business
    - Advertising and sales promotion plans
    - Financial resources available for investment in inventory
    - Storage facilities and materials-handling equipment available for storing materials
    - Possible revisions in the design of the product
    - Plans and prospects of competitors.

II. Factors relating to individual commodities in the inventory
  - Clerical costs of placing the order
  - Space required in the storeroom
  - Possible deterioration in quality
  - Possible obsolescence due to changes in the design of the product or simplification and standardization of materials
  - Rate of consumption of the material
  - Freight and drayage on large and small quantities
  - Quantity discounts allowed by vendors which may result from manufacturing or other economies in the plant of the vendor.

When a company produces parts or materials for stock, many of the same considerations affect the economical quantity to manufacture. However, manufacturing quantities are especially affected by the cost

of adjusting the machine for varieties of styles or sizes and by the clerical expense required for the issuance of factory orders and for following their course from department to department until their completion and transfer to the finished goods storeroom. Labor costs are also increased when workers are required to make frequent changes from one order to another.

Some unit costs which affect the quantity to order increase with the size of the purchase order, and other costs decrease with the size of the order. Costs which tend to increase with the size of the order are:

Storage cost.
Interest on investment in inventory.
Insurance against fire and other hazards.
Possible spoilage or deterioration.
Possible obsolescence.

Unit costs which tend to decrease with the size of the purchase order are:

Invoice price per unit, because of quantity discounts.
Clerical cost of placing the order, follow-up, inspection, approving the order for payment, and accounting.
Freight and drayage.

Since the total cost of materials is the sum of the various elements of cost, the problem is that of determining the lowest total cost. Numerous formulas have been devised for computing the most economical size of the purchase order. One method is to compute for each item or each of several representative items the total cost for the year, on the assumption that orders are placed for varying quantities. To illustrate, if the total purchases for the year are $10,000, one order might be placed for $10,000, two orders might be placed at different times for $5,000 each, or 20 orders might be placed for $500 each. The costs with varying quantities might be as shown in Table 7. The margin of safety is omitted from this tabulation because it is constant, regardless of the size of the order. This table indicates that the lowest total cost is realized when four orders per year are placed for $2,500 each.

The method of determining quantities to order as explained in the preceding paragraphs can be used effectively when the rate of use of the material is fairly uniform throughout the year. If material consumption varies, or if the consumption is concentrated in a few months of the year, the purchases should be planned for delivery at or before the time when the material will be needed. In such cases the quantities to order cannot safely be based upon past usage. If the standard quan-

TABLE 7

COST OF MATERIALS WITH VARYING SIZES OF PURCHASE ORDERS

	NUMBER OF ORDERS PER YEAR					
	1	2	4	8	10	20
Size of each order.....	$10,000	$5,000	$2,500	$1,250.00	$ 1,000	$ 500
Average inventory of the item.....	5,000	2,500	1,250	625	500	250
Discount for quantity..	5%	5%	4%	3%	1%	None
Cost of merchandise....	$ 9,500	$9,500	$9,600	$9,700.00	$ 9,900	$10,000
Interest, insurance, and storage (10% of average inventory)..	$ 500	$ 250	$ 125	$ 62.50	$ 50	$ 25
Clerical, $5 per order..	$ 5	$ 10	$ 20	$ 40.00	$ 50	$ 100
Total cost for year.....	$10,005	$9,760	$9,745	$9,802.50	$10,000	$10,125

tities to order are not revised as conditions change, shortages of many materials will continuously develop. In periods of decreasing usage, inventories are likely to be too large.

A method of determining quantities to order under conditions of varying production is for the supervisor of inventory control or some other executive who is familiar with production plans to estimate the probable rate of usage during the next few weeks or months. This executive plans purchases and shipments to meet production requirements by authorizing each week the purchase orders currently to be placed. For his use, the person in charge of inventory records prepares a report for each item of materials in stock to show present inventory, weekly usage, and total usage since the beginning of the season or quarter. By reviewing this record, and by making allowance for future production plans, the executive can intelligently plan future purchases and deliveries to meet production requirements.[1]

Reorder Point. Usually, the reorder point is determined in advance of the letting of the purchase contract. Normally, the reorder point would be the quantity usually consumed in production during the period required for delivery by the vendor, plus a margin of safety. To illustrate, assume that 40 days are required for delivery and that the average usage for 40 days is 400 pounds. If the margin of safety is 50 pounds, the order for an additional supply should be placed when the quantity on hand has reached 450 pounds. The margin of safety is designed to provide for fluctuations in the rate of usage and for slight delays in the receipt of the merchandise ordered.

[1] R. L. Bowles, "Controlling Raw Materials to Meet Varying Production," *Factory Management and Maintenance*, Vol. CV, No. 1 (1947), pp. 94–96.

The established reorder point may be observed during periods when usage does not vary greatly from one month to another and stable conditions in the market afford an assurance of deliveries in the time allowed. If the rate of usage varies greatly, or if the market in which the goods are purchased becomes unsettled, the reorder point may be changed. Some companies, following the plan previously explained, provide that an executive who is familiar with production plans review each week the quantities on hand and the current rate of usage to determine the proper time for placing the purchase order.

The Balance of Stores Record. Most companies which handle many varieties of materials find a perpetual inventory record to be desirable. Such a record is called a "balance of stores" or a "stock record." A card record is kept for each size, style, or other variety of materials in stock. The record shows the following information for each item:

Quantity on order.
Quantity reserved for production orders planned ahead.
Quantity received into stock.
Quantity issued from the storeroom.
Quantity available for other orders.
Bin balance.

STOCK RECORD

PART NO 18-436 REORDER POINT 150 QUANTITY TO ORDER 200

DATE	REFERENCE NO	ORDERED	RESERVED	RECEIVED	ISSUED	AVAILABLE	BIN BALANCE
2/6/49	INVENTORY					200	200
2/8/49	P85		50			150	200
2/10/49	P83				80	70	120
2/10/49	V1250	200					
2/12/49	P85				50	70	70
2/20/49	V1250			200		270	270

FIG. 63. Balance of Stores Record

A form of the balance of stores record is shown in Figure 63. The method of maintaining the record may be observed by studying the entries made in it. When material is reserved for work planned for future production, the quantity is entered in the column headed Reserved. The amount is also deducted from the balance available. Quantities issued are entered in the Issued column and deducted from the Bin Balance. Receipts are entered in the Received column and added to the Bin Balance. Purchase orders are entered in the ordered

column as memoranda. The quantities on order are not added to the Bin Balance until they are received.

The form of the balance of stores record illustrated in Figure 63 shows quantities only. For cost accounting purposes the form may be enlarged to show cost prices as well as quantities. The form of such a record is shown in Figure 64. This record shows the quantities re-

STOCK RECORD

Part No 18-436 Maximum 350 Reorder Point 150

ORDERED		RECEIVED				RESERVED			ISSUED					BIN BALANCE		
DATE	QUANTITY	DATE	QUANTITY	UNIT PRICE	TOTAL	DATE	ORDER NO	QUANTITY	DATE	REQ NO	QUANTITY	UNIT PRICE	TOTAL	QUANTITY	UNIT VALUE	TOTAL
														200	010	2000
						2/8/49	P85	50								
									2/10/49	490	80	010	800	120	010	1200
2/10/49	200															
									2/12/49	495	50	010	500	70	010	700
		2/20/49	200	12	2400									200	012	2400

FIG. 64. Balance of Stores Record Showing Unit Costs

served for future orders, but it does not show the balance available. The balance shown in the last column to the right is the quantity in the bin. Columns may be added to show the quantities available for future orders, unless the additional columns make the form too cumbersome for easy operation. In most cases the available balance is easily computed. When goods on order are received, a line should be drawn through the figure in the Ordered column, since that information is no longer of value. For the same reason, a line should be drawn through the figure in the Reserved column when the materials are issued from the storeroom for work on the order.

Pricing of Materials Issued. When materials are issued from the storeroom on requisition, their cost is deducted from the inventory balance. Their cost is also entered in the cost accounting records as material cost of goods in process of manufacture. Supplies issued for use in a line or staff department are also deducted at cost from the inventory balance and are recorded as an expense of that department. The cost of the materials or supplies issued may be determined by any one of several methods.

The first-in, first-out method is based on the assumption that the materials first received are the first to be issued. The materials received and charged on each invoice are charged out from the inventory at the price stated on that invoice until the lot has been exhausted. Material issues are then assumed to be issued from the next lot received

at the invoice price of the second lot until that lot is exhausted. The units on hand at any time are assumed to be the units last purchased because all issues of materials have been made from the earlier issues. The first-in, first-out method is used in the balance of stores record shown in Figure 64.

The last-in, first-out method of pricing is based on the assumption that the last units received are the first to be issued. Materials issued from stock are charged out at the cost of the latest shipment received until that lot is exhausted. The next issues are then made from the next order preceding, provided the materials in that order were not previously issued. This method is designed to charge goods manufactured with the prevailing costs of materials instead of with costs which may have been paid for materials at a much earlier date.

The moving-average method requires that an average unit cost be computed for all units on hand when an order is received into stock. This average price is used to record issues of materials until a new shipment is received, when a new average price is computed. This process is repeated each time an additional shipment is received.

The effect of the method of charging materials depends upon the direction and the extent of changes in prices in the market. When prices are rising, the first-in, first-out method results in charging materials at lower prices than either of the other methods because the materials first purchased were bought at the lowest prices. The result is a lower figure for the cost of goods manufactured or a lower operating expense in the case of supplies. Likewise, this method results in a higher value of the materials in the inventory because the units on hand are assumed to be those last purchased. When prices are declining, the first-in, first-out method gives a higher cost of materials used, a higher cost of goods manufactured, and a lower profit. This method accentuates the effect of fluctuations in profits as prices rise and fall. The amount of the fluctuation depends upon the period of time that elapses between the purchase of the materials and their use in production. If a small inventory is carried and materials move rapidly into production, the effect of this method of pricing in comparison with other methods is not great. If the usual inventory constitutes several months' supply, the effect would be substantial.

The last-in, first-out method of pricing tends to keep the cost of materials abreast of current price trends. Materials are priced at a figure that reflects more closely the market conditions at the time they are used in production. Costs tend to advance as selling prices are increased and to decline as selling prices are decreased. The effect

is a smaller fluctuation in profit as a result of changes in business prosperity or depression.

The moving average has an effect upon profits and inventory valuation that is intermediate between the other two methods. A practical objection to the moving-average method is that it requires additional clerical work.

QUESTIONS

1. Indicate who should be responsible for each of the following phases of inventory management:
   a) Determining specifications of materials.
   b) Determining standard quantities to order.
   c) Controlling physical handling of incoming materials.
   d) Maintaining perpetual inventory records.
2. What is the relation of the reorder point, the quantity to order, and the maximum quantity of an item?
3. What is the margin of safety in inventory control?
4. How may allowance be made for seasonal variations in production in planning the reorder point and the quantity to order?
5. Why is the balance of stores record necessary to an effective control of the stores inventory?
6. What would determine whether the balance of stores record would show quantities only or both quantities and prices?
7. In a period of rising prices, what effect does the method of pricing stores issues have upon the cost of materials used in production and the book value of the inventory?
8. How does the method of pricing stores affect the cost of the product and the profits of the company during periods of rising prices? Explain also the effect during periods of price decline.
9. Give the arguments for and against each of the following methods of pricing stores issues:
   a) First-in, first-out (FIFO).
   b) Last-in, first-out (LIFO).
   c) Highest-in, first-out (HIFO).
   d) Moving average.
10. What would be the advantage of showing in the balance of stores record the quantities reserved for future orders?
11. Should the balance as shown in the balance of stores record be the quantity in the bin or the quantity available for future orders?

CASES

76. CHARTING OF INVENTORY REQUIREMENTS

A shirt manufacturer makes the product in four styles, designated as A, B, C, and D. The inventory of finished goods showed quantities of each style

on hand as follows: A, 100 dozen; B, 500 dozen; C, 30 dozen; and D, 800 dozen. The sales division estimates that the average sales per month, in dozens, during the next six months will be as follows: A, 50; B, 400; C, 10; and D, 200.

Required:

1. Prepare a bar chart to show the quantity of each style on hand.
2. Prepare a Gantt chart to show the quantity of each style on hand. In this chart the space for each month will represent the number that can be sold in one month.

77. CHARTING OF INVENTORY OF PARTS

The controller of a manufacturing company checked the inventory of finished parts used in final assembly and found the inventory to contain the following quantities: Part 1, 1,500; Part 2, 3,000; Part 3, 50; and Part 4, 2,000. The number of each part used in the assembly of one unit of product are: Part 1, 50; Part 2, 30; Part 3, 1; and Part 4, 75. The production schedule calls for 25 assemblies per week.

Required:

1. Draw up an ordinary bar chart to show the number of each part on hand.
2. Draw up a bar chart to show the number of assemblies covered by the inventory.
3. Draw up a Gantt chart to show the period of time the present stock of each item will last.

CHAPTER XXXV

STORING MATERIALS AND SUPPLIES

IF MATERIALS and supplies could be received in small quantities at the time they are needed, no storeroom or investment in stores inventory would be necessary. Losses from obsolescence, deterioration, and price declines would be reduced or eliminated; and the turnover of working capital would be increased. But this ideal situation usually is not possible, for the following reasons: [Necessity of stores] :

1. Materials are purchased in large quantities and consumed in smaller quantities. The amounts consumed from day to day are too small for economical purchasing.

2. Incoming shipments may be delayed by transportation tie-ups on lakes and rivers in winter, by traffic congestion, and by many other developments. A reserve supply in the storeroom is necessary to assure continuous production.

3. Many finished products are manufactured according to the specifications of customers. A variety of materials must be carried in stock in anticipation of customers' orders.

4. The materials purchased may be produced seasonally, but they are used in production throughout the year. This is true of agricultural production, which supplies many of the materials for industry.

5. Some materials, such as flour, lumber, tobacco, and hides, require seasoning before being processed or sold.

In some cases the production schedules of two or more companies may be so carefully planned and co-ordinated that the maintenance of an inventory of raw materials by the purchaser becomes unnecessary. For example, a fruit canning company may arrange for the delivery of both fruit and containers as they are needed in production. Both fruit and containers may go direct from truck or freight car to the production

line. Automobile and electrical appliance manufacturers make the same arrangements for delivery of motors and parts to the assembly plant. To provide for a margin of safety in the making of deliveries according to a definite schedule, the container manufacturer or other supplier may accumulate an inventory of his product in advance of delivery. To the extent that the supplier maintains an inventory of his finished product, the problem of inventory management is merely shifted from the purchaser to the vendor.

Inventories of materials are not maintained for highly perishable materials, which should be processed as soon as possible after they are received. Examples are most fresh fruits and vegetables, milk, and fish.

Essentials of Good Storage. The function of storeroom management is to receive, store, and issue materials and supplies at a minimum cost in labor and expense and to protect the items stored. Good storage should accomplish the following objectives:

Effective use of floor space and overhead space.
Ease in finding materials.
Ease in receiving and storing materials.
Ease in issuing materials.
Economical handling and moving materials.
Protection against deterioration.
Protection against damage and fire loss.
Prevention of waste and theft.
Prevention of accidents.
Keeping of inventories at a minimum.
Constant supply of needed materials.
Ease in taking inventory.

The methods of storeroom management designed to accomplish each of these objectives will be considered in the remainder of this chapter.

Effective Use of Space. Good layout is the first essential of the effective use of space. The phases of layout are, first, allocation of the proper amount of space to various uses and, second, effective arrangement. The allocation of space depends upon the size of the storeroom, the kinds of material to be stored, the types of shelves and bins, the height of the ceiling and extent to which vertical storing is possible, and the kinds of equipment used in handling materials. In a warehouse with a total floor area of 50,000 feet, the following allocation was found to be efficient:[1]

[1] C. R. Newpher, "25 Per Cent More Products Handled and Stored by 63 Per Cent Fewer People," *Factory Management and Maintenance*, Vol. CV, No. 1 (1947), pp. 90–93.

	Feet
Receiving	3,000
Inspection	2,000
Office and lavatories	3,600
Aisles	22,000
Storage shelves	19,400

An effective arrangement of areas in a storeroom which stores small parts for issue to manufacturing departments provides for receiving and inspecting materials at one end of the room and issuing at the other. The main aisle of the storeroom usually runs lengthwise, with cross aisles at right angles to the main aisle. The width of the aisles depends upon the kinds of material stored and the equipment necessary for moving materials. The main aisle may vary in width from five to ten feet or more. Cross aisles are not as wide as the main aisle. More storage space is available if the rows of shelves or bins extend to the side walls, although such an arrangement is somewhat less convenient and may increase the fire hazard. For economy in the use of space, rows of bins should be placed back to back. A possible storeroom layout is shown in Figure 65.

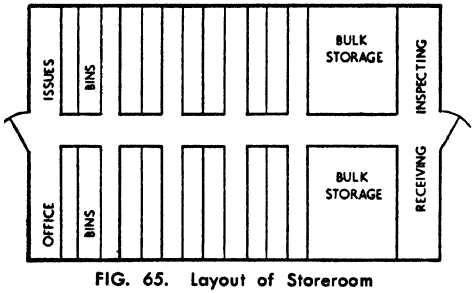


FIG. 65. Layout of Storeroom

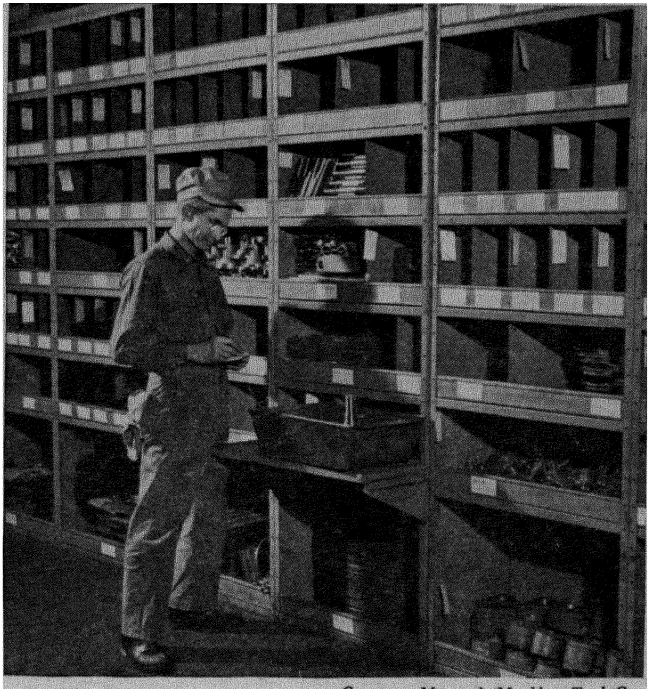
Another device for effective use of storage space is flexibility in the sizes of bins. Uniform sizes of bins and shelves would inevitably mean waste space. The use of standard shelving and dividers for bins provides for varying bin sizes, as shown in Figure 66.

Some items require drawers for economical storing, some require hooks or brackets, and some require racks of various types.

Modern materials-handling equipment has made it possible to stack materials to high levels and to utilize overhead space which was formerly wasted. By the use of lift trucks, material arranged on pallets can easily be lifted into position and removed when needed. In the piling of materials, care should be taken that the weight of the load does not damage articles at the bottom of the pile. The slipping of a package or the breaking of a carton at the bottom of the pile may cause the entire pile to fall. To spread the weight of the upper layers of materials, boards running crosswise of the pile are sometimes placed on the materials as the pile is built up. This method of spreading the weight is called *dunnage.*

Another precaution in the stacking of materials is that floor loads

should be kept within safe limits. At the top of the pile, sufficient space should be allowed to permit the up-ending of cartons when they are removed from the top. The materials should not be stacked so high as to interfere with the proper functioning of the automatic sprinkler system. Fire regulations prohibit stacking to the ceiling.



Courtesy Monarch Machine Tool Co.

FIG. 66. Storeroom Arrangement Showing Flexible Bin System
Note flexibility in distance between shelves and use of dividers.

Ease in Finding Materials. In a small storeroom the finding of materials when they are wanted may not appear to be a serious problem; but in a large storeroom, with perhaps 28,000 items, materials and parts may easily be misplaced, and additional material may be purchased unnecessarily. The finding of materials should not depend upon the memory of employees. The features of a well-developed plan for arranging stores are as follows:

A system of classification and identification for materials.
A system of identifying and marking storage spaces.
A system of arranging materials in the storeroom.

Four systems of classifying and identifying materials are used. They are the mnemonic, the numerical, the alphabetical, and some combination of the other three systems.

The word "mnemonic" means assisting or tending to assist the memory. The mnemonic system of classification is one which is especially designed for ease in remembering. The letters used in any symbol are associated with the general classification and name of materials thus designated, and the numbers are associated with the dimensions of the material or the size of the container. While every business may design its own set of symbols to suit its particular requirements, the first letter would usually be "S" to indicate stores; and "W" would indicate worked materials or manufactured parts. The second letter would indicate a general class of stores, such as "P" for paint. The third letter would indicate the class of paint, such as "D" for deck paint. The next letter would indicate the color, as "S" for slate. A numeral might be used to indicate the size of the container. Thus, the symbol S PD ¼ S would indicate a quart can of deck paint, slate color. A stores classification showing the general classes might be as follows:

CLASSIFIED STORES

S A	Office supplies
S B	Brass and brass products including pipe and fittings
S C	Coal, coke, and other fuels
S D	Wood and wood products
S E	Electrical supplies
S F	Fastenings, bolts, nuts, nails, screws, etc.
S G	Gaskets and packing
S H	Hangers, stands, boxes, bushings, pulleys, and clutches
S J	Gears made of all materials
S K	Chemicals and pigments
S L	Liquids, lubricants, oils, gasoline, and paints
S M	Machine and engine parts for boiler-power and water supply
S N	Metals not otherwise classified
S P	Pipe, pipefittings, and tubings made from cast iron, wrought iron, and steel
S R	Rubber scrap
S S	Steel, wrought or cast iron, and products made chiefly from same
S T	Tools, implements, and supplies
S U	Building materials, such as cement, quartz, sand, and brick
S V	Abrasive, emery wheels, grindstones, etc.
S W	Wearing apparel
S X	Stores not otherwise classified
S Y	Fibrous and textile materials
S Z	Special parts and supplies for equipment[2]

[2] L. P. Alford (ed.), *Cost and Production Handbook* (New York: Ronald Press Co., 1934), p. 1488. Used by permission. Same in L. P. Alford and J. R. Bangs, *Production Handbook* (New York: Ronald Press Co., 1948), p. 1351.

The mnemonic principle cannot be consistently followed in the classification because the letter which would be appropriate in designating a class of stores may have been used in another part of the classification. The letters "I," "O," and "Q" are usually not used because they may be mistaken for other letters or numbers.

The classification as illustrated is elaborated by the addition of other letters to indicate subdivisions of the main class. For example, one of the subdivisions of the classification S E Electrical supplies is S ES, indicating Sockets and Forks. This subdivision is further classified as follows:

SOCKETS AND FORKS

S ES B	Brass key sockets	S ES P	Porcelain key
	S ES 1B Small		S ES 1P Small
	S ES 2B Large		S ES 2P Large
S ES C	Brass keyless sockets	S ES R	Porcelain keyless
	S ES 1C Small		S ES 1R Small
	S ES 2C Large		S ES 2R Large
S ES H	Hood forks	S ES S	Porcelain pull
S ES K	Socket forks		S ES 1S Small
S ES M	Mica sockets		S ES 2S Large
		S ES T	Street hood socket

The principal advantage of the mnemonic system of classification is, as the name suggests, that the symbols are quickly learned and easily remembered. The system has greater flexibility than a numbering system because 23 letters are available as contrasted with 10 numerals or digits. A disadvantage is the necessity for substituting a different letter in case the names of two or more materials begin with the same letter. Furthermore, the designations of new items added to the inventory cannot be listed at the end of the classification but are inserted at a definite place in the list. The problem of adding a new designation for a material is similar to that of including a new word in the dictionary.

In the numerical system of classification and identification, numbers are consistently used to indicate both the principal classes of stores and the subdivisions. In the alphabetical system, letters are used to indicate all classes and groups without regard to the mnemonic feature. A familiar example of a system which combines the numerical and the alphabetical methods is the system of classifying books in a library.

A system that is built up without regard to the mnemonic feature may be easier to construct but more difficult to remember. If the items are grouped into classes, the designations for new items would be

added at fixed places in the list just as they are added in the mnemonic system.

A system of classification and identification may be used for the following purposes:

Indicating materials or supplies to be ordered.
Indicating materials or supplies to be withdrawn from the storeroom.
Indicating materials to be used in the manufacture of the product and in the planning of production.
Arranging stores in the storeroom.

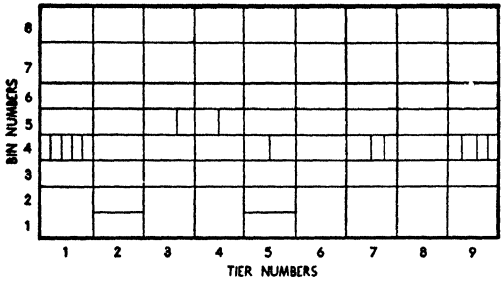


FIG. 67. Numbering System for Flexible Bins Showing Row of Bins

The row or aisle number is indicated at the end of the row.

The bins, shelves, or areas for bulk storage may be numbered by a system somewhat like the system used in numbering the seats in a theater or the rooms in a public building. Rows, tiers, and bins or shelves are designated by numbers. Thus, the designation 3–4–7 might mean row or aisle 3, tier 4, bin 7, as shown in Figure 67.

In the arrangement of stores in the storeroom, two methods are used. First, the stores may be arranged according to the system of classification. For example, if the mnemonic system of classification is used, stores designated as SAA would be in the first tier, first bins, in the row adjacent to the first aisle. Stores designated as SAB would be placed in the next bins. Stores would be similarly arranged throughout the storeroom, with stores designated as SZZ at the far end of the room. When stores are arranged by classification symbols, any item of stores can be located by its symbol, just as a book can be found in the stockroom in the library or an article can be found in the encyclopedia.

Several objections can be made to the arrangement of stores by classification symbols. The method is wasteful of space because room must be left at various places for the addition of new items. Unless space is left, the addition of a new type of stores will require the shifting of all stores farther down in the classification list. Another objection is that many parts and materials require special methods of storing. Heavy materials should be placed in bins near the floor, and light, bulky items should be stored in the higher locations. Extremely heavy items may at times be stored in the basement or even in the yard. Items

frequently requisitioned should be stored near the issue window. When the principle of storing according to the classification system is followed, exception must be made for some items.

The second method of arranging stores provides for arrangement by general classes but not strictly according to symbol numbers. When this system is used, new kinds of stores may be put into whatever bin or other space is available. An index is maintained in the storeroom office which gives the location of the item. This system, which is called the "index system," is the method most commonly used.

If the supply of any item in the storeroom is so large that not all of it can be stored in the usual location, the excess supply may be stored on top of a row of bins or located in some other place less accessible to the issue window. Notation should be made on the index card to indicate the location of the reserve supply, and a card should also be placed in the regular bin to indicate the location of the additional supply. However, any deviation from the established system of storing may prove costly. Temporary storage in aisles and odd places can soon disrupt a good system.

Ease in Receiving Stores. The storeroom manager may best plan for receiving incoming stores if he is advised of the kinds, quantities, and time of receipt. Incoming stores should be counted, weighed or measured, and checked against purchase orders and purchase invoices. Adequate space should be available for receiving and inspecting. Materials should be placed in permanent locations after inspection rather than in temporary locations in bulk storage or in aisles. Handling should be kept at a minimum. Time is saved when the stores can be placed in bins in original cartons or in containers in which they will subsequently be issued. Many types of materials and supplies can be stored on pallets or skids and moved by lift truck to permanent storage. Some items may be stored in tote boxes, which interlock when stacked to form a compact, rigid pile. Time can also be saved by making containers self-counting or self-measuring. Such a container is designed to hold a specified quantity, or has markings to indicate quantities.

Ease in Issuing. A possible procedure for the issuing of stores is as follows: The requisition is sent to an indexing clerk, who enters after each item listed the location, including the floor, row, tier, and bin number. An order filler takes the requisition, obtains a floor truck equipped with racks and trays, and proceeds from floor to floor or aisle to aisle until the order has been filled. He then pushes the truck to a checking area, where an assistant to the storeroom manager or a

group leader checks the material against the requisition. The truck is then taken to the proper department, as indicated by the requisition.[3]

The following arrangements and methods are designed to facilitate the issue of stores:

Aisles should be wide enough to permit easy handling of trucks or other equipment without wasting space.

In some storerooms, racks containing bar stock are placed parallel to each other but at a 135 degree angle to the main aisle to permit easy turning of trucks and also to make the contents of the racks visible and accessible.

Bar stock is stored with ends toward the aisle from which withdrawals are to be made.

Colors may be used to assist in the identification of certain types of stores. For example, a color code may be used to designate the various lengths of molding or other kinds of lumber. A spot of white on the end of a piece might indicate a length of 16 feet, yellow might indicate a length of 14 feet, and blue a length of 12 feet. Colors are also used to identify metal rods of various alloys or any other parts not otherwise readily identified.

Cartons are placed in shelves, so that the greatest number of units or packages can be seen and reached from the aisle.

Provision is made for moving heavy bulky items by crane, truck, or other special equipment. Figure 68 shows a truck used to store patterns mounted on skids.

Stores received in bulk and issued in standard quantities may be divided into packages of standard size when received. For example, rags for cleaning are received in bales and issued in five-pound lots. The smaller packages are prepared prior to storing.

Materials frequently requisitioned are stored near the issue window.

Heavy bulky stores used by only one department are placed near that department. Examples are coal, sand, and ore.

Small parts are counted by weight. Tables may be prepared to show the weight of a specified quantity of each item, such as 100. Any quantity needed can then be determined approximately by issuing multiples or fractions of 100. Special scales are also available for counting bulk materials by weight.

Any item of stores may be divided into a forward supply and a reserve supply. The forward supply is conveniently located, perhaps near

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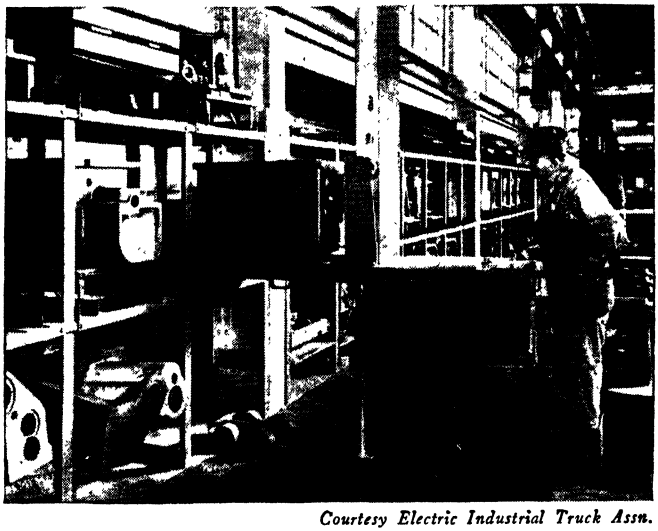
[3] G. V. Fletcher, "Better Storing Lowers Production Cost," *Factory Management and Maintenance,* Vol. CIV, No. 11 (1946), p. 110.

the issue window. It is replenished from the reserve supply when necessary.

Economical Handling and Moving. Many of the principles of materials handling which were discussed in relation to machinery and equipment apply to the handling of materials and supplies in the storeroom. Some types of stores require special types of equipment. Bulky materials of a noncorrosive nature may be moved in self-feeding, self-



Courtesy Electric Industrial Truck Assn.

FIG. 68. Truck Used for Storing and Issuing Materials on Skids

discharging flow conveyors. Examples are coal, flour, chemicals, wheat, and soybeans. Other types of equipment used for moving materials and supplies to and from storage include cranes, power trucks, hand trucks, gravity conveyors, powered conveyors, and chutes. To reduce the amount of materials handling, some companies equip hand trucks with racks and trays suitable for storage at the workplace. Materials that are withdrawn from stores are placed on the truck in position for use. The truck is then moved to the workplace and left there as a storage receptacle. Materials may also be stored in the storeroom in the containers in which they are later issued. See Figure 69.

To reduce the distance for moving materials and supplies after issuance, some companies have established two or more storerooms adjacent to different workplaces. Each storeroom is in charge of an attendant who is under the supervision of the general stores manager. This arrangement is satisfactory provided that the items kept at the various storerooms do not duplicate each other. If the same kind of

Issues are taken from the front. This method requires additional handling.

3. Circular packaged items, such as cans, or rolls of materials, are stored in gravity-feed racks. The racks resemble a trough and are slightly inclined toward the aisle. As containers are removed from the lower end of the rack, the remaining items roll toward the front to fill the space. Refills are made at the back and upper end of the rack.

4. Materials in cartons may be stored by the moving-division method. When the first shipment is received, it is stacked in cubical or rectangular fashion upon the floor. Issues are then made from the left side of the stack. When a second shipment is received, a new stack is made to the left of the first, with sufficient space between the two stacks to permit the storage of any additional shipment that may be received. Issues continue to be made from the left side of the first stack until the first shipment is exhausted. Thereafter, issues are made from the left side of the second stack. In this manner the stacks repeatedly move across the area from left to right. The method is illustrated in Figure 70.

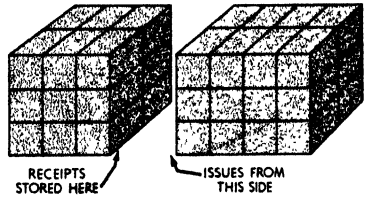


FIG. 70. Storage of Materials to Assure Old Stock Used First

Protection against Damage and Fire Loss. To prevent damage, materials and supplies should be stored with special reference to their requirements as to heat, cold, moisture, dryness, and cleanliness or protection from dust. Bar stock should be supported on racks to prevent bending or springing out of shape. Barrels should be stacked on end and not on the side. Brooms should be stored with the handle end down or should be suspended from hooks. Bags of cement should be protected from the weight of bags piled above them. In some cases, sufficient protection is afforded by placing boards between the layers of bags to distribute the weight. Fragile materials or parts are sometimes stored in boxed pallets or other containers. The containers rather than the materials carry the weight of the items piled above.

Many parts and materials should be stored and removed from racks with care to prevent the marring of polished surfaces. Parts easily damaged may require separate vertical compartments similar to the narrow compartments used for storing phonograph records. Finely polished gears are sometimes separately packed in wax-paper bags. Special types of cranes or other equipment for lifting and holding material securely may be required for heavy items.

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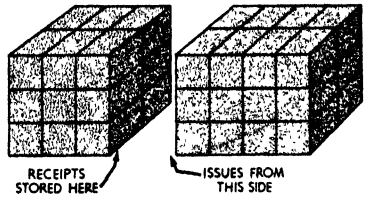

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To aid in preventing fire loss in the storeroom, the aisles should be wide and should be kept clear; bins should be made of steel instead of wood; and highly inflammable materials should be stored in a fire-resistant room with self-closing doors. As further protection against fire loss, fire extinguishers should be placed at convenient locations; and fire regulations should be strictly observed. At all times, good housekeeping is essential in eliminating fire hazards. Despite all precautions to prevent loss from fire, such losses may occur. The stores inventory should be covered by the proper types and amounts of insurance.

Prevention of Waste and Theft. Although the stores may be very valuable, waste in materials and supplies is frequently tolerated, when the mishandling of money is not permitted. Materials are stored in a careless manner, the storekeeper is not held accountable for breakage, and adequate precautions are not taken to prevent theft.

To reduce losses due to poor inventory management, the storekeeper or inventory takers should call the attention of the production planning department to any inactive items which might be used in production; and the person in charge of production planning should attempt to find a way to use them. If materials are obsolete, they should be sold as scrap to prevent complete loss and to make the storage space available. The waste of certain bulk items, such as paint, lubricating oil, and chemicals, may be reduced through purchase in containers of the proper size. Supplies of high unit value should be guarded from pilfering and theft by use of a locked room or closet. It is generally agreed that the balance of stores record should be kept by some one other than the storekeeper, perhaps by a clerk in the cost accounting department. The perpetual inventory record constitutes an independent check on the persons who receive, store, and issue materials and supplies.

Good storeroom management usually requires that a responsible person be placed in charge and that no unauthorized persons be permitted in the storeroom. Irresponsible persons can misplace or disarrange the materials or remove materials without signing the necessary requisitions. However, some companies have been experimenting with self-service in storerooms in a manner similar to that used by self-service grocery stores. The prinicpal advantage of the self-service method is the saving of man-hours that would otherwise be lost by employees in waiting their turn at storeroom windows. When issues are properly supervised and employees are required to sign for ma-

terials as they leave, losses are said to be no greater than the usual discrepancies caused by clerical errors.[4]

Protection against waste and theft also requires that some procedure be designed for assuring a return to the storeroom of materials and supplies withdrawn for use and not used. If it is anticipated that some materials will be returned, such as part of a roll of wire or a steel rod, a record of the withdrawal of the larger quantity should be kept in a temporary file until the unused portion is returned. The return of unused material that was withdrawn in the regular manner is the responsibility of the worker and the foreman. Excessive use of material should be checked by a scrutiny of the cost accounting reports of material costs.

Prevention of Accidents. In most industries the handling of materials is a chief cause of injuries. Among the common types of hazard and injury from materials handling are the following:

Incoming cars or truck — persons struck by train, automobile, or truck.

Unloading cars or trucks — hands or feet torn, pinched, or crushed; bruises; strains; falls; injury to health from dust, fumes, or chemicals.

Emptying and cleaning tank cars — suffocation or poisoning on entering tanks; burns from acid drips; falls from cars; explosion of inflammable gases; electric shock from extension cords.

Opening baled, crated, or barreled material — cuts and abrasions from sharp edges; nail wounds; strains from lifting; tool wounds.

Piling materials — injuries from falling materials; strains from lifting; falls; foot injuries.

Transporting materials — persons struck by trucks; hands pinched, torn, or bruised under or between articles; articles falling on feet; falls over loose articles.

Handling acids, caustics, volatiles.[5]

Unsafe handling methods include the following:

Handling heavy materials by hand.

Handling too heavy objects by hand truck.

Unmarked or narrow and crooked traffic aisles and material storage space.

Overloaded and carelessly loaded trucks or other carriers.

Poor maintenance, such as unsafe ladders, wobbly truck wheels, rickety truck bodies, worn or uneven floors, worn crane cables, and worn or broken tools.

Methods of preventing handling injuries are classified as follows:

Planning operations and methods to eliminate hazardous situations.

Substitution of mechanical handling for manual handling as far as practicable.

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[4] R. H. Wilson, "Self-Service Stockrooms," *Factory Management and Maintenance*, Vol. CIII, No. 3 (1945), pp. 122–27.

[5] Adapted from R. P. Blake, "Safety Subjects," *U.S. Department of Labor Bulletin* 67 (Washington, D.C.: U.S. Government Printing Office, 1944).

Careful selection and training of personnel.
Adequate and competent supervision.
Provision for suitable protective equipment.

Keeping Inventories at a Minimum. One objective of storeroom management is to keep the inventory as low as possible, consistent with continuous production. The avoidance of excessive inventories is not entirely the responsibility of the manager of the storeroom, but he may be of much assistance. He should be able to make suggestions pertaining to the following:

Finding substitutes for slowly moving items.
Eliminating needless varieties of materials and supplies.
Standardizing the items carried.
Avoiding duplication of purchase orders.
Avoiding purchase orders for items already adequately stocked.
Reclaiming idle materials made obsolete by changes in product design.

Constant Supply of Needed Materials and Supplies. Although good inventory management should keep stores at a minimum, the balances should not be permitted to fall so low that production is delayed for lack of materials. The policy of avoiding excess quantities requires that careful attention be given to inventory control to assure continuous supply. The balance of stores record is the principal reference; but, since it is only a book record, the co-operation of the storekeeper is necessary. Methods which aid in keeping physical inventories in agreement with book inventories are as follows:

1. Inspection of incoming shipments for quantity and quality.
2. Careful storing and issuing of materials and supplies to avoid damage in order that all items on hand may be of standard quality.
3. Strict observance of the requirement that stores are issued only on requisition; careful recording of excess supplies returned to the storeroom from the manufacturing departments.
4. Reporting to the balance of stores clerk when the supply of an item has reached the reorder point. One method by which the storekeeper may himself observe that the inventory of an item has reached the reorder point is to segregate an amount of an item equal to the predetermined reorder point. The reserve supply may be placed in a separate bin or carton or tied with a string. When the reserve supply is drawn upon, an order should be placed for the purchase of an additional supply.
5. Continuous or regular reporting to the balance of stores clerk of the quantity on hand. The exact method of reporting quantities on hand depends on the kinds and quantities of stores.

Some companies provide for a tag called a "bin tag" to be affixed to each bin or shelf and on which is kept a record of the quantity in the bin. The tag shows receipts, issues, and balance. At regular intervals the tags are sent to the balance of stores clerk for comparison of balances as shown by the two records. Another method is to require the person who issues stores from the storeroom to write on the requisition the quantity on hand as shown by the bin tag. When the balance of stores clerk enters the amount of the issue on the perpetual inventory record, he compares the quantity as shown on the requisition with his own record of the balance on hand.

Some companies consider the bin tag an unnecessary duplication of the balance of stores record. They rely upon periodical physical inventories for a verification of book inventory balances.

Ease in Taking Inventory. The number of units or the quantity of each item on hand should be determined by physical count at least two times each year. When a count is made, the book inventory as shown by the balance of stores record should be adjusted to agree with the inventory, in case there is a discrepancy. Two methods are used to determine the time for the count of the units on hand. First, the inventory checkers may start at one end of the storeroom and proceed to count the number of units in each bin or other storage space until all items have been inventoried. Second, they may count the number of units when the supply of an item has reached the reorder point. A list of such items would be given the inventory checkers for counting each day. By this method the count is made when the supply is at a low point. The counting, therefore, requires less time than would otherwise be necessary. The disadvantage of this method is that some slowly moving items may not be inventoried at any time during the year, unless special provision is made for them.

The following methods of storing and issuing are designed to facilitate the taking of the inventory:

1. Supplies and materials stored on shelves should be stacked with labels toward the aisle.

2. Cartons or bales of stores placed on the floor in open areas may be stacked in cubical or pyramid fashion. Cubical storing is preferable because the piles are more easily counted. The number of units in a pyramid may be computed by means of a formula; but the counting is more difficult, particularly after some units have been removed. The advantage of pyramid stacking is the greater stability of the stack. For some kinds of stores, pyramid stacking may be necessary.

3. Cubical storing, if possible, should be in decimal units. For example, if a pile is five or ten units high and five or ten units deep, and if this method is consistently followed, counting is greatly simplified. Although the number of piles cannot be kept at a fixed figure because of receipts and issues, the number in a pile can be kept at a constant figure except possibly for one broken pile.

4. Issues of materials and supplies should not be taken at random from various piles but should follow a definite plan. For example, issues may be drawn from the top and front of the first pile on the left. All the first pile on the left should be issued before any units are removed from the second pile. The units on hand can then be inventoried by counting the unbroken piles and the number of units in the broken pile on the left.

5. If any cartons are broken when stores are received and inspected, the cartons should be placed where they will be the first to be issued.

6. In the case of liquids kept in drums, such as turpentine, kerosene, and chemicals, a bin tag may be used to record withdrawals and the quantity remaining. To assure that the record of the bin tag is properly kept, the spigot may be locked and issues made only by a responsible person. Similar methods may be used for such bulk materials as rope, wire, and wirecloth.

QUESTIONS

1. What principles of layout of the factory apply to the layout of the storeroom?
2. How may shelving, bins, and general arrangement of the storeroom make for effective use of storage space?
3. How is flexibility in bin sizes made possible?
4. How have lift trucks reduced the labor required for handling materials in the storeroom and made possible further economies in floor space?
5. Explain how the system of classification may be used for the following purposes:
   a) Identification of stores when purchase orders are prepared.
   b) Arrangement of stores in the storeroom.
   c) Requisition of stores from the storeroom.
   d) Identification of materials and parts in designing the product and planning for its production.
6. How can the receiving of stores be planned to reduce labor and expense?
7. What use is made of color in the storing and issuing of materials and supplies?
8. How can small parts be counted by weight?
9. What types of equipment may be used in moving materials to and from the

storeroom? What kinds of materials may be moved by means of flow conveyors?

10. What methods of storage may be used to prevent deterioration in the quality of materials carried in stock?
11. How can the storeroom management aid in preventing losses from obsolescence due to changes in the design of the product or changes in the specifications of materials?
12. What answer might be made to the suggestion that the keeping of inventory records is an unnecessary expense because record keeping does not increase the value of the product?
13. What may be done by the storeroom manager to assist in keeping stores at as low a point as possible, consistent with continuous production?
14. How is a physical inventory taken when a balance of stores record is maintained?
15. How may quantities be checked easily between the dates for taking physical inventory?

CASES

78. USE OF STORAGE METHODS TO STABILIZE PRODUCTION

The Union Glass Works, Inc., at Alameda, California, makes glass containers used by fruit and vegetable canners and soft drink manufacturers. The company also makes corrugated boxes in which the containers are packed for shipment to the manufacturer. The paper cartons are made according to the specifications of the customer, who uses them to ship the filled containers to his own customers. Fiber shipping boxes carry the name and trademark of the canning company or other manufacturer.

The plant manager of the glass company has experienced considerable difficulty in stabilizing production because of the relatively low unit cost of the product and the high cost of storage. Customer demand is greatest during the spring and summer months, and customers prefer not to receive large deliveries in advance of their own production requirements. The container manufacturer has attempted to produce containers in anticipation of customer orders but has found this method inadvisable because of the high cost of storing packages of containers and of removing them when they were needed by customers. Breakage was also high when cartons of containers were piled to great heights by hand labor.

Production has usually been increased during the busy season by putting an additional production line into operation. When a line was started, it was operated twenty-four hours a day; and overtime work could therefore not be used as a method of increasing production. When the expansion of plant capacity seemed to be required because more production lines were needed, the plant superintendent authorized the plant engineer to make a study of the problem.

The plant engineer recommended to the superintendent that lift trucks and pallets be used to store the product. Cartons containing glass containers would be placed on pallets. The cartons would be interlaced to prevent tipping. The

lift trucks would be used to place one loaded pallet upon another in the storeroom and to remove them when the customer required delivery. Ceiling heights permitted stacking as high as might be desired. During the late spring and summer when no rain fell in the area, cartons could be stacked in the yard with no protection other than a canvas covering to prevent the accumulation of dust.

Questions:

1. What advantages would the company gain by the proposed plan of production for future delivery?
2. How can the management measure the advantages in terms of monetary savings?

79. NEED FOR MAINTENANCE STOREROOM

When the Woodring Pump Company was first organized, the plant was small; and a careful control of parts used for machine repair was considered unnecessary. When any part was needed, the plant superintendent or the foreman ordered it; and the necessary repairs were made by the employee who operated the machine, with the assistance of the foreman when it was needed. As the volume of work increased and repairs were made more frequently, foremen would often order two or three repair parts when only one was needed. The extra parts were stored in shelves in one corner of the shop, which gradually developed into a storeroom. When a machine was in need of repair, workmen would first look in the storeroom to see whether a repair part was available. If none could be located, an order would be placed for two or three parts; and the extras would be placed in reserve.

Foremen found this method to be unsatisfactory in several respects. A part would frequently be ordered when one was available but was overlooked because it was not quickly located. Reordering a part when one was on hand not only resulted in the purchase of parts not needed but also delayed production. More serious was the fact that no check was ever made on parts that might be needed quickly to prevent delays in production. Although the management trusted its workers, there was the suspicion that occasionally parts were taken by employees for personal use. On some occasions, defective parts removed from machines were placed in the storeroom by mistake. The defects could not be detected by visual inspection; and on several occasions, defective parts were used in making repair work. This caused further labor cost and additional delay.

The plant superintendent decided that the situation could be corrected only by the establishment of a separate storeroom for repair parts, which would be in charge of a responsible storekeeper. However, he was uncertain as to several details. One question was whether the storekeeper should be assigned any additional duties. In the beginning, when repair parts were being catalogued and arranged and inventory cards were being prepared, the full time of one person would be required. Later, the work would require no more than 60 to 75 per cent of the time of one person. The plant superintendent believed that the storeroom should be open at all times during work hours because the time of machine breakdowns could not be anticipated. If any other work was to be given the person in charge, it should be work which could be done at a desk in the storeroom.

Another question concerned the person to be chosen for the new position. Andrew Ramey, assistant storekeeper in the materials storeroom, was a high school graduate and also the graduate of a business college. He was familiar with all of the details of paper work required, and he was known to be neat and accurate in his work. He had had no experience in the shop itself and was not familiar with the names and numbers of parts. Frank Simmons was another possibility. Simmons was an excellent mechanic. He could tell at once the name of the part required for a repair, and he could identify a part by observation as well as by name. He had attended high school for one year but had no experience in storeroom work. The superintendent was inclined to favor Andrew Ramey for the new position.

Questions:

1. Should the storeroom be open at all times? Should the storekeeper be assigned some other work?
2. Who should be made storekeeper?

PART IX

Physical Control of Production

CHAPTER XXXVI

THE PROBLEM OF PRODUCTION PLANNING

PRODUCTION planning includes two major phases. The first phase concerns the planning of the total volume of production for the coming month, quarter, or other period of time. Each concern should estimate the total volume in order that plans may be made for purchasing raw materials, employing and training workers, financing the program, and making other general plans.

The second phase of production planning concerns the planning and control of detailed operations from week to week or day to day. This planning makes provision for the production of goods to meet the requirements of the orders of individual customers or for the production of specific items to build up the inventory in the storeroom. It prescribes the exact size, color, or other detailed specifications; indicates the number of items; and makes provision for the operations to be done at each workplace or machine. This type of planning constitutes the subject of the discussion in the present and succeeding chapters.

Development of Production Planning. Little planning was necessary during the handicraft stage of production. The master craftsman worked in his own shop and could readily determine the amount of work ahead. When a customer wished to place an order for future delivery, the craftsman estimated the time which would be required for work previously accepted and then indicated a date for completion. If the work ahead became too great, he could decline to accept additional orders. Rush orders were easily handled because the craftsman was familiar with the requirements of all of his customers and could shift from one job to another. The problem was not greatly complicated by the employment of apprentices and journeymen because all of them worked in the same shop under the supervision of the master craftsman.

When machine production was first introduced, the work in many industries was done in the home under a system known as "farming out." A capitalist supplied the materials and sometimes the machines. Work was delivered to the home, where various tasks were performed on a piece-rate basis. Completed work was collected by the capitalist and delivered to the next home, where the next operation was performed. This type of production required some planning, but the system was inefficient because time schedules could not be closely controlled.

When machines were brought together in one building, more detailed planning became necessary. The need for planning increased as the space occupied by the factory expanded and new departments were added. Another factor was the purchase of materials in wider markets and the sale of the product over a wider area. The integration of industry was also a significant development because each business became dependent upon others for parts and materials and in turn supplied parts or materials to other businesses.

Production planning was a part of the management work of Frederick W. Taylor. He found that incentive methods of wage payment were ineffective in achieving worker co-operation unless the worker had more work to do as soon as he finished any task. One of Taylor's functional foremen was a route clerk, who had the responsibility for routing the work from one machine to another. Another functional foreman was the instruction card clerk, who determined how the work was to be done and prepared the necessary instructions for the worker. The responsibilities of these two foremen have been enlarged to become the work of the planning or production control department.

What Planning Includes. The phases of production control are variously classified by different persons. However, planning may be regarded as including four steps, which are as follows:

Routing. This is the preliminary planning of where and how the work will be done. It provides answers to the questions of what product or variety of product will be manufactured and what quantity will be produced. It indicates the method by which the product will be made and prescribes the operations for making each part and each subassembly. Routing also includes the determination of the order in which the work will be done. Finally, routing includes determining where the work will be done. The departments that are expected to do the work and also the machines in each department are specified. In short, routing includes all of the preliminary planning up to the point where the time schedules are fixed.

Scheduling. This step fixes the time when the work will be done, that is, the date of completion or of delivery to customers. Starting dates and dates of transfer from one department to another are decided upon in order that completion dates may be met.

Dispatching. This means the execution of the plans as established in the work of routing and scheduling. It includes the preliminary work of preparation prior to the starting date, as well as the issuance of orders to the manufacturing departments. Before the factory begins work on the product, materials may be purchased, machines may be repaired or set up for the job, workers may be employed or trained, and machine tools may be manufactured or purchased. When work is started, orders and instructions are issued to workers and to various staff departments including the storeroom, materials handling, and inspection.

Follow-Up. This step includes checking up on the work as it progresses, comparing the progress with the original plans, and taking such corrective action as may be necessary or possible.

The details of the steps in production control vary with the company, the product, and the persons responsible for the planning. The procedure followed by one company is shown in the diagram in Figure 71.

An Illustration of Planning. The four steps in production planning may be illustrated by almost any type of activity, such as baking a cake, growing a vegetable garden, making an automobile trip, or building a house. A familiar example is the serving of meals in a cafeteria. The line of customers and their trays corresponds with an assembly line in a factory. Each tray contains a variety of foods chosen by the customer to suit his needs, his preferences, and his purse. The four steps in planning the service are as follows:

1. A complete meal is planned with choices for each course. The quantities of each type of food are determined, and the methods of cooking and serving each kind of food are planned. This is the work of routing.

2. The time for beginning each phase of the work is fixed. The complete meal should be ready when the doors are opened for service. It is therefore necessary to determine the hour of the day when each meal will be served and also the hour when service will be discontinued. Since some foods require a longer time for cooking than others, the hour when each type of food will be started in the oven or on the stove should be determined by working back from the time when the first customers are to be served. This is the work of scheduling.

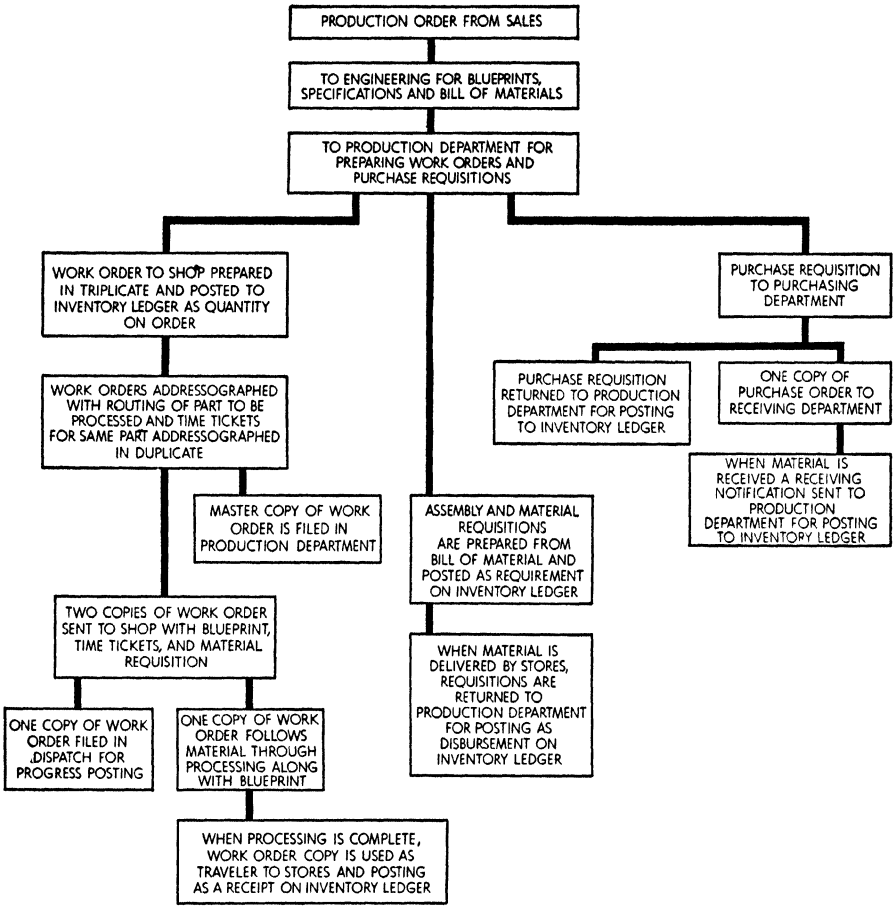

FIG. 71. Flow Chart of the Path of a Production Order

From Fred O. Orthey, "Production Control Based on Improved Inventory Records," *Factory Management and Maintenance,* Vol. CV, No. 12 (1947), pp. 98–99. Used by permission. Production department is synonymous with planning department.

3. The manager checks on the pantry to determine which foods are on hand and which should be purchased. Instructions are given to the kitchen and dining-room help as to the time for reporting for work. Food is purchased, prepared, cooked, and served according to schedule. This is the work of dispatching.

4. The serving of the meal may not proceed strictly according to plan. Some of the help may fail to report for work on time. Food may not be available in the market in the necessary quantities or at satisfactory prices. Shortages of some foods may develop because the choices made by customers may not follow the anticipated pattern or because an unusually large number of persons may ask to be served. Some of

the food may be rejected because it was not properly prepared. The manager must therefore be prepared to provide substitutions or to make other revisions of the original plan. This is the work of follow-up and corrective action.

The cafeteria is used merely to indicate the principal steps in the problem. In fact, production planning is usually much more complicated. To cite a specific example, a plant of the Western Electric Company manufactures over 2,000 different types of electric coils. The planning of the manufacture of a coil requires routing through 2 to 20 operations, and the sequence of the operations lacks uniformity. The weekly output may be 700 orders. The planning department usually schedules about 7,000 operations each week.[1] This means a large amount of detailed work.

Advantages of Production Planning. Production planning is intended to permit the use of machines for as large a percentage of the time as possible and to assure employees steady and continuous employment. When the product is routed through the plant in lots or batches, such as batches of shirts or trousers, the quantities are planned for the continuous operation of the workplaces and for other economies. The reservation of materials for work planned ahead or the planned purchase of needed materials should prevent the interruption of production due to a lack of materials. The planning of parts production may avoid interruption of work due to a shortage of parts on the assembly line.

The planning of production is desirable not only for the reduction of manufacturing costs and the maintenance of good employee relations but also for favorable relations with customers and vendors. Customers benefit from the orderly delivery of finished goods according to schedule. Vendors benefit because they can more effectively plan their own production. Rush purchase orders are avoided when production is planned, and the requirements for materials and purchased parts are anticipated. As explained in relation to inventory problems, the work of the purchaser may be so closely co-ordinated with that of the vendor that containers, parts, and some materials may move directly to the production line without first being put in the storeroom.

Relation to Other Management Problems. Production planning is affected by virtually all other activities of the enterprise because the primary objective of the business is the production and sale of goods at

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[1] Jack R. Dunn, "Automatic Dispatching Means Minimum Manpower," *Factory Management and Maintenance*, Vol. CVI, No. 5 (1948), p. 122.

a profit. It is affected by the location of the plant in relation to the sources of materials and manufactured parts and to the time required for deliveries. It may also affect the mode of transportation, which might be rail, water, or truck. Plant location also affects the choice of a type of building and therefore the plant layout. All these management policies affect the time required for the purchase and delivery of materials into stock and for transfer from one department to another.

Plant layout is directly related to production planning. The most significant feature of plant layout is the arrangement of workplaces by processes or by products. More detailed planning is required when the machines are arranged by processes. More time may be required for materials handling because distances between workplaces are greater. In a plant which is laid out by products, materials and parts may be moved into a production line; and the product may be advanced from one workplace to another according to a prearranged schedule. However, it may be necessary to plan for sizes, colors, and other varieties of the product made on one production line.

The kind of materials-handling equipment in the plant is also an important factor in production planning. Material dropped down a chute, put on a moving belt, or pushed along the line is immediately available at the next workplace. If the work is placed on a hand truck which is later moved by freight elevator to the next floor, allowance must be made for the time required in transportation in planning the load of work at the next workplace. Equally significant is the provision of general-purpose or special-purpose machines. General-purpose machines permit greater flexibility in planning and may make it possible to route work around a bottleneck operation. Machine breakdowns are less disrupting when machines can be used for more than one type of work.

Personnel policies affect production planning because they affect the efficiency of the workers and the speed of work. Important personnel policies are the training program, the employment and induction procedures, and service policies.

The policy of buying or making parts should be considered. During busy years or seasons, some companies buy many parts which they make for themselves at other times. A closely related policy is that of manufacturing for stock in the dull season in anticipation of later demand. When this policy is followed, the volume of production in the dull season is equal to the sales plus the amount put into stock. During the busy season the output is equal to the sales minus the

amount withdrawn from stock. The adoption of a policy of stabilized production is related to the policy of guaranteed employment or guaranteed annual wage.

Other significant management policies which affect production planning are plant expansion; improvement of working conditions; addition of new products; standardization of workplaces, tools, materials, and products; and overtime work.

Departments Affected by Production Planning. The planning department is a staff department, which means that it exercises functional control rather than line control. It has numerous contacts with many other departments. The line or manufacturing departments are directly concerned. The flow of work from one department to another is planned, and starting and completion dates of work are fixed by the planning department. The manufacturing departments report the progress of work to the planning department in order that it may check on the progress and recommend or take corrective action, if necessary. Planning affects the purchasing department, which places orders for materials to be delivered by the vendor in time for work to be done. The stores department receives the material upon delivery, stores it until it is needed, and issues it for use in production when requisitions are presented. The personnel department uses the production plans or the production budget for the preparation of a personnel budget. Employees are hired, trained, transferred, or laid off in accordance with the plans for production.

The maintenance department co-operates in the production program by periodically inspecting equipment, lubricating machinery, making regular and emergency repairs, and overhauling machinery. The toolroom stores, issues, and repairs machine and hand tools used in production. Its responsibility is to see that proper tools are available for each job.

Product design is closely related to planning. The design of the product prescribes the parts necessary to assembly. Close tolerances may greatly increase required machine time and therefore are a factor in the production plans. The work of inspection is related to production planning because the planning department notifies the inspection department when to inspect and receives reports from the inspector when the inspection is completed. Close inspection may result in the necessity for reworking the product or may require the placing of a new work order to replace the rejected parts.

Motion and time study reduce the time required for production and permit the setting of a standard time. Standard times are used in

scheduling the flow of work and in integrating the work of the various departments.

The sales division supplies customers with estimates of delivery dates which are dependent upon the work of production planning. After the order of a customer has been accepted, inquiries from the customer as to the progress of the order are referred to the planning department.

Production Control Methods. Production control systems are of three types — planning by line departments, systematic planning, and scientific planning.

Planning by Line Departments. This method of production control, which is also called "conventional control," represents the minimum of planning. Orders for work to be done are issued by the plant superintendent to the foreman of the first processing department, with no date of completion specified. The foreman plans all work within his department and assigns work to machines and men in whatever way seems best to him. When operations are completed in one department, the foreman has the work transferred to the next department and makes a report of its progress to the general foreman or the plant superintendent. If an order is delayed in production or a customer requests an early delivery, the sales division may report the fact to the plant superintendent, who will check on the status of the work and will attempt to have it completed in time to satisfy the customer. In some companies, expediters are employed to see that preference is given to rush orders. Although this method has produced satisfactory results in many small plants, it may prevent an orderly flow of work and thereby increase costs.

Systematic Planning by a Staff Department. With this method, plans for dates of completion of orders are made according to promises given to customers or to dates of delivery to the storeroom for the replenishment of stocks. Progress reports are made to the planning department upon the completion of work at each machine or in each department. The planning department constantly compares the progress of each order with planned completion dates, estimates the time required for subsequent operations, and takes corrective action when necessary.

Scientific or Detailed Planning. In complete or scientific control of production, all phases of production are planned by a staff department. While some systems omit one or more phases, complete production control would include authority over the following:

Plans for starting dates.
Plans for completion dates.
Plans for scheduling work at each step in production.
Assignment of work to machines and departments.
Authority to give precedence to delayed orders.
Control of specifications for the product and parts used in its manufacture.
Data on the results of motion and time studies.
Balance of stores record for inventory of materials.
Requisitions for the purchase of needed materials.
Tool design, purchase, and repair.

Centralized or Decentralized Planning. When planning is centralized, the planning department determines the order of work at each workplace. The worker reports to the planning department when he has finished a job and is then assigned to a new task. The foreman is relieved of responsibility for the order of work, and he is free to devote his time to general supervision. However, foremen sometimes object to being deprived of authority in connection with work assignments.

In decentralized planning, the central planning department schedules the work to the manufacturing department and determines the date when the work is to be started and completed in each department. The foreman assigns tasks to workers and to machines and sees that the dates prescribed by the central planning department are met. This arrangement permits over-all control of production but leaves considerable authority to the foreman. Many companies which formerly used centralized planning have found decentralized planning to be less expensive and more effective. The trend today is toward decentralized planning.

Effect of Method of Manufacture. Methods of production planning vary widely because methods of manufacture differ. Production methods are of two general types: first, the production of a variety of products for stock or for orders of customers and, second, mass production or quantity production of one product or a very few products for stock or for shipment directly to customers.

When a company produces a variety of products, several differences in methods of production are possible. The product may be made from a number of materials with standard parts. Examples are stoves, electric fans, radios, office appliances, and shoes. It may be made from a small number of materials in a variety of patterns or designs. Examples of this type of product are china, flat silver, costume jewelry, linoleum, tables, and metal furniture. It may be made from a large number of materials, with each job separately planned. Designs and specifications

used for one product may not be used for another. Examples are houses, bridges, ships, and custom-made clothing.

In mass-production industries, two types of operating methods affect the planning. First, some companies produce one product or a few products in quantity; and the customer is expected to purchase the

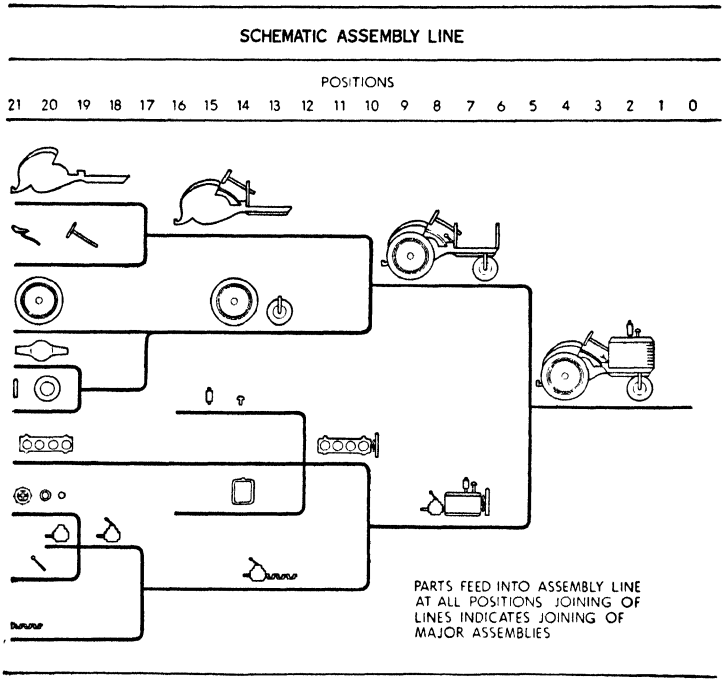

FIG. 72. Diagram of Lines for Assembly of a Product

Reproduced from *Schedugraph,* prepared by Remington Rand, Inc. Used by permission.

standard products. The specifications of the product are not changed to meet the preferences of individual customers. Examples are ice cream, cement, flour, bread, gasoline, salt, and various chemicals.

Second, some companies make the product in a limited number of designs. Although the customer is permitted in advance of production to choose the design he prefers, he must select one of the standard designs adopted by the manufacturer. Examples of these products are combination breakfasts in a restaurant, certain types of building materials, and automobiles.

Production planning also depends upon whether production is of the assembly or the continuous type. Continuous industries are further classified as synthetic or analytical.

The assembly industry may be compared with a river having numerous tributaries, with each tributary being fed by smaller streams. The main artery of the river corresponds with the main assembly line in a factory. The tributaries of the river correspond with production lines for the major parts of the product, and the streams feeding the tributaries correspond with the lines for producing parts which are assembled to make the major subassemblies. The mouth of the river corresponds with the end of the assembly line where final assembly is completed. The situation is shown graphically in Figure 72.

The system of production control should be adapted to the requirements of the individual company and its methods of production. No system can be prescribed to meet the needs of all businesses. When the production period is short, a simple system may be satisfactory. When it is long, a more detailed and elaborate system may be necessary. In continuous industries the planning of weekly or monthly output with regular follow-up of production records may be sufficient.

QUESTIONS

1. Explain the need for planning of production under the following systems of production:
   a) The handicraft system.
   b) The farming-out system.
   c) Factory production.
2. How is production planning affected by the decision to buy or to make a part?
3. Name the four steps in production planning, and indicate what is included under each step.
4. Illustrate the four steps of production planning by reference to the following activities:
   a) Making a vegetable garden.
   b) Operating a bus line.
   c) Making an automobile trip.
   d) Making a table.
5. Show the relation of the following activities to production planning:
   a) Design of the product.
   b) Establishment of specifications for the product.
   c) Manufacturing operations.
   d) Inspection.
   e) Reworking units to pass inspection.
   f) Shipment to the customer.
6. Show how production planning affects relations of the company to employees, to consumers, and to companies supplying materials or parts.

7. Show how production planning is affected by the following management policies:
   a) Plant location.
   b) Layout of the plant by processes or by products.
   c) Use of laborsaving machinery and methods.
   d) Stabilization of production.
8. What is conventional control of production planning? What are its advantages and its limitations?
9. What is systematic control of production?
10. What is included under complete or scientific control of production?
11. How is production planning affected by the number of types of materials used in production?
12. Distinguish between manufacturing by the analytical and by the synthetic method of production. Give examples, and explain how the problem of production planning differs in the two types of industries.
13. In planning a product made by the assembly of many parts, should the planning department start with the finished product and work backward to the parts and the materials; or should it start with the parts and the materials and work forward to planning the subassemblies and the finished product?
14. A company plans to organize a new department for production planning. The work of the new department will include assignment of work to manufacturing departments, scheduling of starting and completion dates for work planned, planning for the purchase of materials required for the work, and issuing of orders for the work to be done in the manufacturing departments. The department is placed under the supervision of the purchasing agent, who states that he has the time for the added work and responsibility. Is this a logical arrangement?

CASE

80. PLANNING FOR PRODUCTION[1]

Jackson and Harper manufacture office forms, such as order blanks, invoices, and cost sheets. Each order must be made to meet the specific requirements of the customer. The plant may handle as many as 1,200 orders each month. The plant is organized into five departments — preparatory, press, finishing, receiving and stores, and shipping.

Because of the large number of orders to be handled, considerable difficulty has been experienced in preventing an accumulation of work in process and in meeting promised delivery dates. The control department has designed a single form for production control, which is expected to simplify the procedure. The form consists of an original and a number of copies, in order that all interested departments may receive proper notification of plans and schedules.

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[1] Adapted by permission from *Factory Management and Maintenance,* Vol. CIX, No. 8 (1951), p. 107.

In planning for production, the first step will consist of assigning a production order number and typing a production order form. The production order will then be sent to the routing section where the operations necessary for production will be determined, and machines most suited to the work will be indicated. This information will be entered on the form. Next, the production order will be referred to the materials control section, which will calculate the amount of materials that will be needed. If the required materials are not in stock, they will be ordered; and delivery dates will be noted on the production order form. Then the order will be referred to the standards section, which will estimate the probable time required for production at each work station.

Starting and competion dates will now be determined, and the time for each operation will be scheduled. Orders will be listed on a machine-load bulletin board in the order in which they are to be run. A master schedule will also be kept to show starting and completion dates for each order. Each department is to be notified of work scheduled for the department by sending it a copy of the completed production order. Each department will maintain a bulletin board which will provide space for scheduling work at each machine.

Communication between the manufacturing departments and the production control department will be effected by telephone and by personal conferences. Written reports on the progress of work will not be required, but foremen and workers will be expected to maintain the schedules set. In cases of delay, foremen will be expected to determine the cause and correct the situation if possible.

Questions:

1. What manufacturing problems are peculiar to the production of business forms?
2. Why is scheduling especially important in this industry?
3. What is the advantage of the use of a simple form prepared in several copies?

CHAPTER XXXVII

ROUTING IN DIVERSIFIED PRODUCTION

THE discussion in this chapter and the next two chapters relates to production planning in diversified manufacturing, where each order is separately routed, scheduled, and dispatched. In a later chapter, planning in continuous-manufacturing or mass-production industries will be considered.

Organization for Production Planning. The planning department may consist of four sections, suggested by the four steps in production

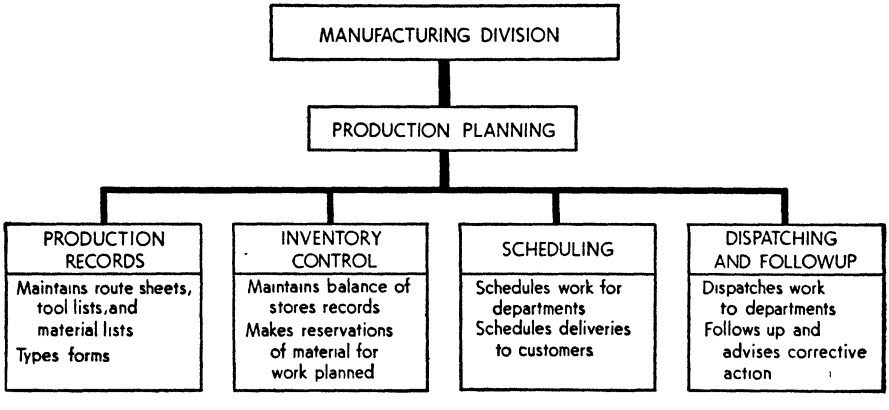

FIG. 73. Organization of Planning Department

planning. However, routing is so closely related to the design of the product that it is usually regarded as an engineering function. A possible organization of a planning department is shown in Figure 73. In this organization, routing is not included. This function is assumed to be a part of the work of the design engineer. The control of the balance of stores inventory records is placed under the manager of production planning. Production is concerned with quantities on hand, on order,

and reserved for work planned ahead. It is not especially concerned with unit cost or with the total value of the inventory. For this reason the inventory control function is usually included in the accounting department.

Phases of Routing. The work of routing consists of six phases or steps. These steps are not necessarily taken each time a production order is planned because the information may be available in the files as a result of the planning of a previous order. The phases of routing are as follows:

1. The parts necessary for the final assembly of the product and also the subassemblies are listed, and their specifications are stated.
2. The sequence in which the parts are to be manufactured and assembled is determined.
3. The materials necessary to the manufacture of each part and the quantities of each material are fixed.
4. The steps or operations necessary to the manufacture of each part are listed. The jigs, cutting tools, gauges, and fixtures which will be needed in the manufacture of the product are determined and listed.
5. Forms for use in dispatching are prepared and filed.
6. Provision is made for dividing the order into the proper batches, since the routing of all the material for a production order in one lot or batch may be uneconomical.

Parts Necessary for Assembly. To cite a simple illustration of what the first step involves, the parts necessary for the manufacture of a blackboard eraser would include a wood or fiber back and perhaps five strips of felt, three of which might be black and two white. The parts necessary for the manufacture of a knife might be one large blade, one small blade, a backspring, two strips of steel, two strips of bone, and two rivets. A pair of scissors would require two blades and one rivet.

More complicated products would require a consideration of the parts necessary for subassemblies. For example, a bicycle is composed of a frame, a front wheel, a rear wheel, a seat, a chain, handle bars and two mudguards. These parts are called "subassemblies" because each is composed of several parts. The wheel, for example, consists of a hub, a number of spokes, a rim, a tire, and an inner tube.

Sequence of Parts Completion. An ideal planning and production schedule might make it possible for all parts to reach the assembly line at the exact time they are needed. In most cases, however, this ideal cannot be realized because of delays in delivery of material, machine

breakdown, absence of employees, accidents, precedence given to special orders, and failure of employees to meet standards. In some cases the quantities of a part required on the production line are not sufficiently large to permit economical production. The better policy, therefore, may be to produce parts for reserve stock to be withdrawn from the storeroom as needed. The maintenance of a reserve bank of parts at each workplace along the line may be desirable to prevent delays and interruptions.

Materials Necessary. The kinds and quantities of materials which will be required in production should next be determined. If parts are produced and stored in advance of production, the parts are included in the list of materials. The list of parts and materials required for the production of an article is called a "bill of materials." If the product is complicated, such as a typewriter or a computing machine, the bill of materials may include several pages. A part of a bill of materials is shown in Figure 74.

BILL OF MATERIALS

NAME OF PRODUCT *SIMPLEX 6 CYL ENGINE* MODEL NO *72*
DRAWING NO *72560-4* NO OF SHEETS *16* SHEET NO. *1*

PART NO.	UNITS	PART OR MATERIAL
27213	2	BEARING
27335	4	BRACKET
11620	2	HINGE
45601	1	BASE
25219	1	CLUTCH
21702	6	SPARK PLUG
34822	16	BOLT
17109	6	BUSHING
46203	6	CONNECTING ROD
26523	4	HOOK
27117	6	SPRING
25613	4	BEARING
57314	2	RING
		ETC.

FIG. 74. Bill of Materials

From *Management Controller,* prepared by Remington Rand, Inc. Used by permission.

In many cases the bill of materials may be quite simple. Materials for the manufacture of glass bottles to order of the customer would include only the sand, some other chemicals, and coloring matter. Tin cans would require only the coated sheets, some solder, and possibly plastic coating. Candy would require chocolate, sugar, and a limited number of other ingredients. Printed forms require metal for the plates, paper of a designated quality, carbon paper, and shipping cartons.

Operations Necessary to Production. When the flow of work is planned, the job is first routed by departments and then to specific machines. The routing by departments indicates the general steps in production. The procedure is much the same in any business, although the names of the operations and departments will vary. The steps in various industries might be as follows:

Machine Shop Operations: Lathe, mill, shape, drill, grind, inspect, ship.

Printing Steps: Copy, composition, engraving, mats, make-up, client O.K., pressroom.

Foundry Operations: Patterns, cores, flasks, molding, cleaning, inspect, ship.

Advertising Steps: Copy, photo, layout, final copy, client O.K., art, paste-up, printing.

Textile Production: Grilling, combing, drawing, spinning, spooling, ship.

Job Shop Operations: Cut off, mill, drill, weld, plate, polish, assemble, deliver.

Publishing Operations: Editorial, composition, galley, author, illustrations, paging, author, press, bindery.[1]

NUMBER Y 1724 PART NAME COVER FOR WINDOW MODEL

MATERIAL FB-30 0078 X 48 X 120 STANDARD QUANTITY 200

DEPT. NO	OPERATION	HOURS PER 100 PARTS	MACHINE NO.	TOOL NO.	DATE	OPERATOR
	DRAW ABOVE MATERIAL FROM STOCKROOM A FOR DEPT NO 1 DRAW PARTS FROM STOCKROOM B FOR DEPT. NO 3-1-PD-2057					
1	SHEAR TO 2-7 16 X48	0450	310	10-915		
1	SHEAR TO 1.135	0.500	314	10-915		
1	NOTCH END	0 110	312	13-032		
1	CHANNEL FORM	0.200	376	K-5939		
2	GRIND EDGES	0.500	687	14-686		
3	WELD FILLER	0.500	744	12-144		
3	DRILL 2 HOLES	0.775	253	11-44		
3	TAP 2 HOLES DELIVER TO STOCKROOM C	0.575	253	8-461		

FIG. 75. Operation Ticket

From *Management Controller,* prepared by Remington Rand, Inc. Used by permission.

After each general step in production has been planned, the product is routed to specific workplaces and machines. The detailed operations are listed on an operation ticket which is sometimes used also as a shop travel card to accompany the material as it moves through the plant. The operation ticket shows the following information:

Part number and name.
Quantity to be manufactured.
Operation names and numbers.
Department and machine numbers.
Number or specification of tool to be used.
Estimated time required for each operation.

Space may be provided on the operation ticket for the insertion of the date when each operation is scheduled for beginning and completion. This information is entered later as a part of the work of scheduling. Space may also be provided for entering the number of the operator to whom the work is assigned when an order is dispatched. A form of the operation ticket is illustrated in Figure 75.

[1] Adapted from Wassell Organization, Inc., *How to Prevent Mishandling of Orders.*

The routing to machines may be a flexible arrangement, if many machines are general purpose. Sometimes, several sizes and types of milling machines or lathes, for example, may be available for doing certain kinds of finishing operations. A flat surface on a small casting may be finished by hammer and chisel, file, shaper, facing in a lathe, milling, surface grinding, or broaching.[2] Corrugated paper may be made on a machine that will process wide rolls of paper or narrow rolls, and textile fabrics may be made on wide or narrow looms. Corrugated paper boxes may be stapled by fully automatic machines or at manually operated machines. Chocolates may be hand-dipped, or the chocolate coating may be applied automatically by machine. The method and the machine used in any case will depend upon the exactness of the work required, the time allowed for the work, the work already scheduled for each workplace, and the price at which the product will be sold.

In some cases the routing to machines may be inflexible because the manufacturing processes have been built into the layout. For example, the manufacture of various types of jars and bottles, corrugated paper, or tin cans would usually be made on the same machines, with changes in molds or in machine setup. The manufacture of cubes of pressed sugar or small cakes of soap in wrappings bearing the name of the customer would likewise be done on the same line as other orders, with only a change in machine adjustment and a change in the roll of paper on the wrapping machine.

Preparation of Forms. Several forms are prepared as a part of the work of routing. The purposes of the forms are, first, to notify a department of the work to be done and, second, to provide a report of work completed. Where many persons are concerned with the work, it is often possible to include on one form the information which may be required by two or more departments. Copies of a form may be prepared in different colors for the use of various departments. For example, the operation ticket may be prepared in seven copies, as follows:

Color	Use
1. White	Master standard operation sheet for use by the engineering department.
2. Ecru	Central production order control form. This copy is placed in the master file in the production control department.

[2] Charles A. Koepke, *Plant Production Control* (New York: Wiley & Sons, Inc., 1941), p. 331.

Color	Use
3. Green	Departmental production order control form. One copy is prepared for each interested department. Each copy indicates the date the department is to start work on the job.
4. Buff	Traveling production order form. This copy is attached to the material. It is sent to the first department where work is started on the job and it travels with the material as work progresses.
5. Salmon	Material requisition form. This copy is sent to the first interested department which uses it to draw materials from stores when the job is started.
6. Blue	Parts requisition form. This copy is sent to the first interested department which uses it to draw parts from the storeroom when the work is started.
7. Pink	Cost department notification form. This copy is sent to the cost department which uses it to set up the cost record for work in process. The reverse side may be printed to provide space for job costs as the work is done.[3]

The copies of the operation ticket are prepared by the use of mimeograph or other duplicating equipment. All copies of the ticket are referred to the clerk in charge of the balance of stores records, who deducts the quantities required from the available balance. If the material is not available, he holds the forms until it becomes available. A similar procedure is followed for tools and fixtures. The forms are not sent to the departments concerned until materials, tools, and drawings are available and the work has been scheduled.

Other forms which may be prepared as a part of the work of routing include the following:

Material Requisition. This is a notice sent to the storeroom authorizing the issuance of specific material in stated quantities. It identifies the department to which the material is to be sent and indicates the number of the production order.

Move Ticket. This form identifies the material, indicates the quantity, and shows the production order number. It may indicate the sequence of operations, as well as the department to which the job is to be moved next. If a separate move ticket is prepared, the buff copy of the operation ticket, referred to as the "traveling production order form," would not be used.

Inspection Ticket. This form is used to notify the inspection department that the work is ready for inspection. It provides space for recording the number of good pieces, the number of pieces rejected, and the cause of rejection.

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[3] Remington Rand, Inc., *Management Controller*, p. 21.

Shipping Order. This is a notice issued to the shipping department to ship stated quantities of the finished product to a customer. Provision is made in the form for the recording of partial shipments.

Division of Work into Batches. When the work is routed from one workplace to another, economies may sometimes be effected by sending the material through the plant in batches instead of in a single lot. Examples are articles of clothing such as trousers or dresses, chapters of a book in a printing plant, the printed books in a bindery, and springs for automobile seats or beds. When material is moved in batches, the machines need not be reset for each batch; and a part of the material is forwarded to the next department when an operation is completed, instead of being held until the operation has been completed on all units in the order. The decision as to the most economical quantity in a batch is a part of the work of routing.

The size of the batch will be affected by the space required by the material and the amount of space available at each workplace. Another factor is the method of internal transportation and the cost of moving small batches. The investment in the inventory of work in process should also be considered. Costs may be increased by holding materials until the operation has been completed on all units. Since the product can be finished and shipped to the customer in shorter time if it is moved in batches, the urgency for getting the work completed would be another factor. The person in charge of routing should also take into consideration the amount of work already planned ahead for succeeding departments. If departments which perform later operations already have all of the work they can do, and if a transfer of the material in batches would only result in an accumulation of work in later departments, no saving would result from the division of work into batches.

The effect of the division of work into batches is shown in the chart in Figure 76. The chart shows that, if the work is routed in one batch, it cannot be completed until the end of June. If it is routed in two batches, it can be completed by the middle of May. The time required in production can be further reduced by dividing the work into a greater number of batches.

It should not be inferred that routing in diversified production always provides for the movement of material in batches. In some cases, as in bottle and tin can manufacture, the product moves in a continuous line. In other cases, as in the manufacture of printed forms or of industrial filters, the order moves from one machine to another as a single unit.

In some cases the work of the person in charge of routing includes the grouping of various customer orders into a single lot to make an economical lot or batch. For example, a candy company owning a factory and a chain of candy stores would plan production in the factory to permit the production of candy for several stores on a single factory order. A bottle company would group orders of customers for bottles to permit the production of one lot of bottles of the same size through one order on the factory. The arrangement would permit the economical operation of the mixing equipment and the tank furnace, provided the bottles are of the same size and color. They need not be the same shape because they are shaped in different molds that are supplied from the same tank furnace. A linoleum manufacturer would group orders from sales offices or distributors to permit a large run of linoleum of the same quality and the same pattern.

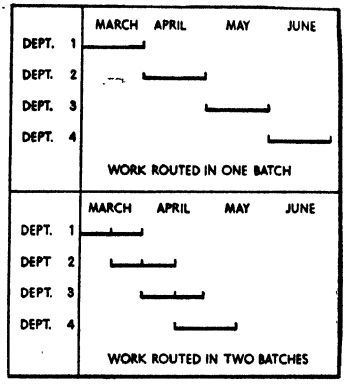


FIG. 76. Effect of Dividing Work into Batches

QUESTIONS

1. What activities which are not strictly production planning are sometimes placed under the control of the manager of production planning?
2. Is the determining of the parts necessary to a product the work of production planning or of product design?
3. Is the fixing of the sequence of parts completion an important phase of routing? How is this part of planning affected by plant layout?
4. What information is shown on the operation ticket?
5. How is production planning affected by the use of general-purpose or special-purpose machines?
6. Is flexibility in the use of machines most important in relation to routing or in follow-up and corrective action?
7. What forms may be prepared as a part of the work of routing?
8. What costs of manufacture are decreased by the production of large quantities, if it be assumed that some are shipped to the customer at once and that other units are placed in the storeroom to be held until further orders are received from customers?
9. What costs of production are increased by the production of large quantities, as stated in the preceding question?
10. How can the planning department determine the economical quantity to manufacture?
11. What consideration other than the time required in production will affect the decision to divide the order into batches?

CASES

81. ROUTING AND SCHEDULING IN BATCHES

A clerk in the production control department is required to route and schedule a lot of 500 units. The processing time for 500 units is as follows:

Department Number	*Time in Days*
1	3
2	6
3	5
4	18
5	6

Required:

Prepare charts similar to those shown in Figure 75 to indicate the time required for processing in one batch or five batches.

82. DIVISION OF WORK INTO BATCHES

In a bookbindery, unbound books as they are received from the printing presses are stitched and bound. Six operations are performed — trimming, glueing, stitching, forming, affixing backs, and lettering outside cover. The time required for processing 2,500 books of a certain size and type is estimated for various operations as follows:

Operation Number	*Time in Hours*
1	10
2	20
3	150
4	40
5	120
6	80

The work can be scheduled in one batch or in several batches. It would also be possible to assign two or more workers to any one operation if necessary to make deliveries at an early date.

Required:

1. Show by means of a Gantt chart the time that would be required if the order is scheduled in one batch.
2. Prepare a chart to show the time required in production if the work is scheduled in five batches.
3. Prepare a chart to show the schedule in five batches for operations 1, 2, 4, and 6. In operations 3 and 5 the work is divided into 10 batches, and it is scheduled for two workplaces.

CHAPTER XXXVIII

SCHEDULING IN DIVERSIFIED PRODUCTION

THE SECOND step in production planning is scheduling. This step is closely related to routing because routing cannot be completed without reference to the work previously scheduled for each department. Routing and scheduling are often done by one person, and the two steps are performed simultaneously on different production orders. The production planning department may find it necessary to reroute an earlier order to provide for later work. Both the routing and the scheduling may be changed in case of machine breakdown, delayed deliveries of materials, and other emergencies. Each of the first two steps affects the other, and both depend upon dispatching and corrective action.

Nature of Scheduling. Scheduling of work introduces the element of time. It may provide only for starting and completion dates; or it may provide for starting, completion, and transfer dates from department to department. Usually the date of completion or delivery to stock is first determined, and then the date when work is to be completed in any department is determined by working backward from the final completion date. For example, a publisher might schedule a book for publication on April 1. Preliminary steps could then be scheduled as follows:

Delivery to stock, in batches, beginning April 1.
In bindery, in batches, received in bindery February 15 to March 1.
In press, February 1 to February 28.
Correction of plates, set type for index, January 20 to January 31.
Page proof read by author, index prepared, December 15 to January 25.
Preparation of pages and page proof, December 10 to January 15.
Preparation of illustrations, November 1 to December 31.
Galley proof read by author, November 5 to December 31.
Type set, November 1 to December 15.
Editorial, October 1 to October 31.

It will be observed that some operations are planned to overlap in point of time. Galley proof is to be sent to the author before the setting of the type has been completed. Illustrations are to be made while the type is being set. The books are to be sent to the bindery and delivered to stock in batches. The situation is shown graphically in Figure 77.

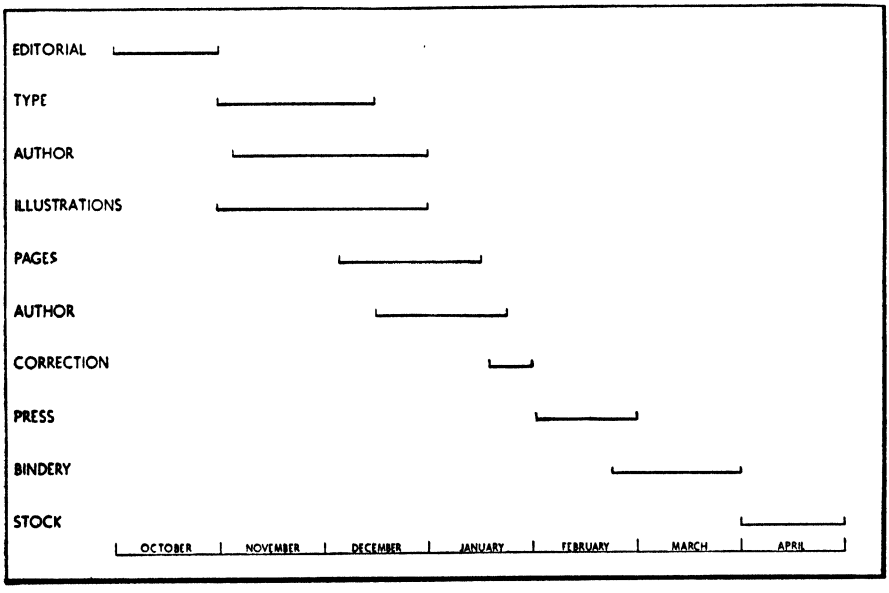


FIG. 77. Scheduling Production

The diagram in Figure 77 is prepared on the principle of the Gantt chart. The opening to the right (|___) of the vertical line indicates the date when an operation is scheduled to be started. The opening to the left (___|) indicates the date when an operation is scheduled to be completed. Horizontal spaces represent the time required to complete the processing of the work. The space for one week does not represent the same quantity values for different phases of the work. It may represent pages of manuscript read and marked by the editor, ems of type set by the typesetter, plates prepared, or number of books printed or bound in the designated period of time. The time required for transportation of materials is included in operation time.

Purposes of Scheduling. The inclusion of the time element in production planning serves a number of purposes for various persons inside and outside the company. Operating departments can use the information pertaining to the amount of work planned to schedule personnel, extra shifts, overtime, machine repair, and other work.

Foremen can determine for themselves whether their operations are on schedule. The purchasing department may make its plans for the purchase of supplies, tools, or equipment. The machine shop can know when special fixtures, molds, or tools, will be required. The planning department knows at each stage whether an order is on schedule and whether corrective action will be necessary. If a machine or department is becoming overloaded, the fact is known in time to permit rerouting of some of the work, declining additional customer orders, or making other plans.

Satisfactory relations with customers and vendors depend upon scheduling the work and then producing according to schedule. Deliveries may be promised to customers with the assurance that the goods can be delivered on time. A garment manufacturer, for example, who plans to make shirts or dresses for sale in a seasonal market requires assurance that textile, buttons, and thread of certain specifications will be available when they are needed. Scheduling permits the production plans of one manufacturer to be integrated with the plans of others.

Information Necessary for Scheduling. Before the element of time can be introduced into the planning of work, information should be available to indicate the operations necessary for the manufacture of the product as established by the product design engineer or the person in charge of routing. This information is shown in the operation ticket (Fig. 75, p. 585). The person who schedules the work needs to know the machine capacity and the number of hours a day or week that a machine can be expected to operate. If production depends upon the rate at which a worker can do the work and not upon the speed of machine operations, the standard time for various tasks as established by motion and time study should be available. The time required for the transportation of the material from one department to another is also a factor in some cases. The dates when purchased materials or parts will be available should be known, and a margin of safety is usually advisable. Since all planning is intended to assure that deliveries to stock or to customers will be made at a certain time, the dates when deliveries are wanted should be known.

In estimating machine capacity, the planning department first determines the number of hours per week the machines of each type may be expected to be in operation. The estimate is based upon the number of machines, the number of days per week the plant will be in operation, the number of shifts, and the estimated percentage of efficiency. To illustrate, the computation for No. 36 engine lathes might be made in the following manner:

Number of No. 36 lathes in the department	3
Number of labor shifts	2
Hours per shift	8
Number of days of plant operation per week	5
Total number of hours (multiply)	240
Estimated percentage of efficiency	75
Weekly capacity, hours in use	180

When the work previously planned for No. 36 lathes is converted into the number of hours required to complete the work assigned, the management can determine the length of time which will be required to complete new work and the extent to which the production program is in balance. For example, the results might be as follows:

	No. 36 Lathes	No 16 Lathes
Number of machines	3	4
Weekly capacity, hours in use	180	240
Average weekly load for next 18 weeks, work now scheduled	160	230
Surplus weekly capacity	20	10

A tabulation of this kind, when continued for the various machines and other workplaces, will indicate when the volume of work scheduled for a machine is nearing machine capacity. It will indicate to the management the need for additional equipment of certain types or possibly the desirability of revising production plans.

MACHINE WG 480 TYPE DRILL PRESS SIZE NO. 2

SCHEDULED MACHINE REQUIREMENTS

DATE	ORDER NO.	JANUARY		FEBRUARY		MARCH		APRIL	
		HRS.	CUM.	HRS.	CUM.	HRS.	CUM	HRS	CUM
12/6	186	60	60						
12/15	190	35	95						
12/28	198	45	140						
1/3	210			40	40				
1/6	215			52	92				
1/8	220					32	32		
MONTHLY CAPACITY (HOURS)			150		140		150		

FIG. 78. Monthly Machine-Requirement Record

The hours scheduled for each machine or workplace may be tabulated by means of a monthly or weekly machine-requirement record, as illustrated in Figure 78. The first step is the preparation of an operation card describing each operation as indicated on the operation ticket as shown in Figure 75. The operation cards are then sorted by machines, and the work is scheduled for a definite time of starting and completion. The information is recorded on the monthly machine-requirement record by order number and by month. After the information has been tabulated in this manner, the cards are re-sorted by job numbers and filed for future use in dispatching.

As the scheduled machine-hours are entered on the machine-requirement record, the hours are accumulated in the separate columns.

When the accumulated figure for each month or week reaches a predetermined percentage of the total available time for the month, a plastic signal is placed on the card in the monthly column to indicate that the machine is close to being overloaded and that no further orders should be scheduled for that period of time.[1]

It may be desirable that the work scheduled for each workplace be planned by days. This is done by means of a Gantt chart called a "machine-load chart." The machines are listed in the spaces on the left margin. The horizontal spaces indicate the days. Work scheduled for a machine is indicated by lines drawn on the chart for the number of days' work planned. The dates for which no work has been scheduled are indicated by breaks in the lines. These spaces will be filled in later as other work is scheduled. The method is illustrated in Figure 79.

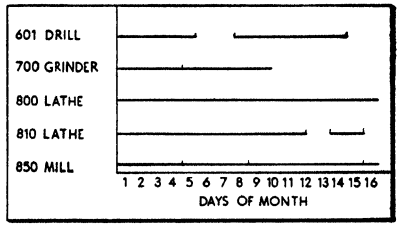


FIG. 79. Machine-Load Chart

Bulletin Boards for Showing Machine Loads. While a chart is a desirable method of showing work planned, it lacks flexibility. Changes in schedules made necessary by difficulties arising in production or in the procurement of materials are not easily made on the chart. To provide flexibility, several types of equipment have been devised.

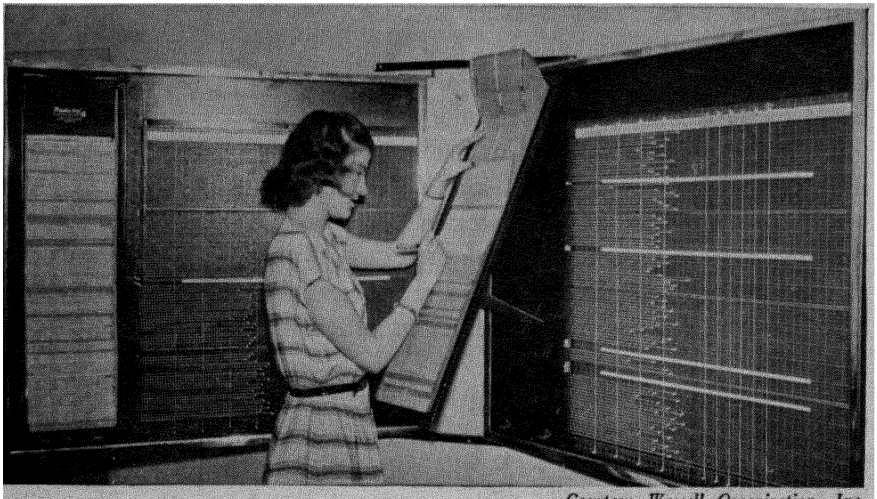
The earlier type of equipment for the scheduling of production and machine loads was a bulletin board with three spaces for posting operation tickets for work scheduled for each machine. Each space is equipped with a hook for holding the operation tickets. On the first hook is placed the ticket for the job now at the machine and in process. On the second hook is placed the operation ticket for work now in the department and waiting to be done. The tickets for other work scheduled are placed on the third hook.

The machine load for each machine may be shown graphically by means of a pegboard, as illustrated in Figure 80. The machines are listed in the spaces on the left column. Opposite the designation of each machine are two rows of holes which are used for the insertion of pegs to indicate the work scheduled. The board is operated on the principle of the Gantt chart, which means that the horizontal spaces represent the days of the month. When work is scheduled for a machine, a peg is inserted to indicate the starting date; and another peg is

[1] *Management Controller*, p. 41.

inserted to indicate the scheduled completion date. The board indicates the dates for which no work has been scheduled, as well as the dates of scheduled work. Operation tickets for the various jobs scheduled are filed in pockets on the left side of the board.

The total load scheduled for each machine is indicated by a transparent tape of flexible plastic which is drawn from an opening in the



Courtesy Wassell Organization, Inc.

FIG. 80. Machine-Load Bulletin Board

board adjacent to the machine number and is extended across the board over the number of horizontal columns that represent the days estimated as required for the work scheduled. When additional work is scheduled for the machine, the pegs for the previous order are left unmoved; and additional pegs are inserted to show the new work planned; the tape is then pulled farther to the right to indicate the additional period of scheduled time. In this manner the board is kept up to date and shows at all times the load of work planned for each machine.

Another variation of the bulletin board for scheduling work consists of a row of pockets opposite each machine number, in which are inserted the copies of operation tickets for jobs scheduled. The pockets are made of sturdy transparent material in which the edges of the tickets are inserted. The edge of each ticket, which is printed in a bright color, is trimmed or cut away according to the number of days or hours which will be required for the work. When it is inserted in the transparent pocket, it indicates the days or hours of scheduled work. Vacant spaces in the pockets represent the time for which no work has

been scheduled. The schedule can be revised by shifting the operation tickets in the pocket for each machine.

The method of scheduling machine loads by means of a bulletin board with a pocket for each machine is illustrated in Figure 81. The pockets overlap in such manner that only the edge can be seen. This visible arrangement reduces the space required for the equipment and

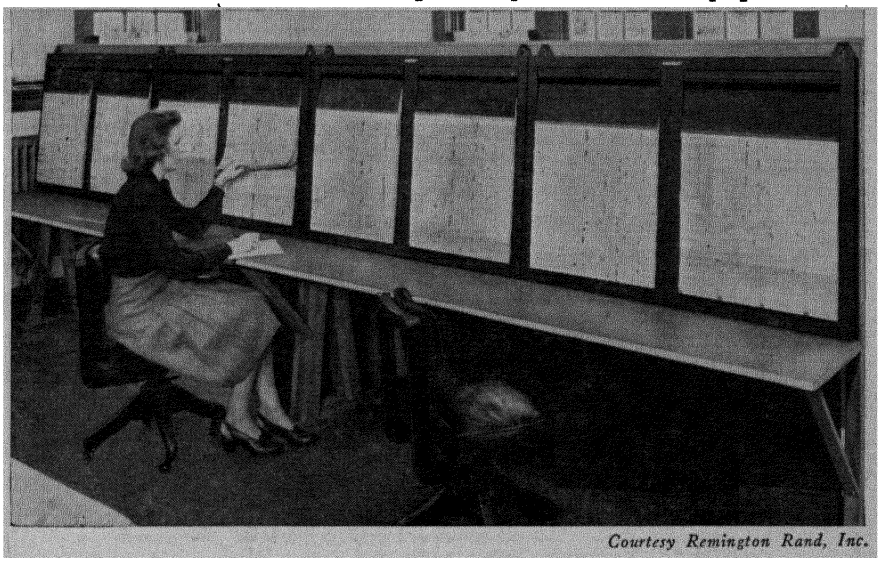


FIG. 81. Visible Filing System for Machine Loads

facilitates reference to the information. It also protects the operation ticket from exposure.

Scheduling the Production Order. When an order is to be scheduled, the parts list and the operation tickets are taken from the files. The parts list shows what parts are required for assembly, and the operation tickets show the operations necessary to the manufacture of each part. The person who is scheduling the work next finds out from the balance of stores clerk which parts are available in the storeroom and which parts must be manufactured. In scheduling the manufacture of any part, the clerk refers to the machine-load chart. If any machines to be used in the manufacture of the parts are already heavily loaded, he schedules the operations for the most heavily loaded machine first. The schedule is then projected through the subsequent operations to determine the finish date for that part.[2] He then estimates the time

[2] Douglas Haynes, "Production Control for Mixed Long and Short Runs," *Factory Management and Maintenance*, Vol. CVI, No. 6 (1948), pp. 110–12.

required for assembly operations and determines the date for the completion of the order.

The schedule date of completion is entered on a summary sheet of the various orders which are in process of manufacture or which have been scheduled for future production. This summary, which is called a *master schedule,* shows the order number, the description of the product, and the probable date of completion. The master schedule establishes the goal or the objective of the production planning department and the operating departments.

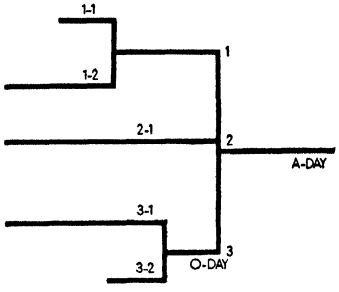


FIG. 82. Diagram of Sequence of Parts Completion

Working back from the date of completion, the person in charge of scheduling determines the date when each subassembly should be completed. He then works further back to determine the date when each component part should be completed, and then the date when each part should be started in production. The method is illustrated in Figure 82.

The dates for starting and completing the production of each part may be shown graphically by the use of a lead-time chart, as shown in Figure 83. The date set for the final assembly of the product is

LEAD-TIME CHART
(SHOWING OPERATIONS TO FOLLOW DUE DATES)

PART NO	NOVEMBER														
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1-1					1		0		A			0			
1-2			2		1		0		A			0			
2-1				4		3		2		1		0			A
3-1	4	3		2		1		0		A		0			
3-2				2		1		0		A		0			

FIG. 83. Lead-Time Chart Used in Scheduling

designated as A-day. Each part is scheduled for completion two days before it will be needed for assembly. The two-day interval will provide for delays and for transportation of materials for short distances. The date for which the completion of any part is scheduled is indicated in the chart as O-day. The dates for completing the various operations necessary to the manufacture of each part are indicated by the figures 1, 2, 3. For example, the figure 1 indicates that, after that date, one operation remains to be performed; and the figure 2 indicates that two

operations are to be performed. The figure 0 indicates that all operations have been completed.[3]

The scheduling of production may be illustrated by means of bulletin boards of various types. The spaces across the board represent work orders rather than machines. When the pegboard is used, pegs are inserted to indicate starting and completion dates in the various departments. The scheduling of production orders is also shown by means of a bulletin board with a pocket for tickets showing the operations necessary to the manufacture of each part or each product. The method of operation is the same as that of the bulletin board showing machine loads.

In addition to scheduling machine loads and flow of production orders, the planning department may schedule the delivery of materials into stock and also the production or purchase of tools and other equipment. If materials are to be purchased, the schedule might be made in a manner similar to the following:

Date when production is to be started.....April 15
Date when materials should be received, allowing 5 days for paper work and a margin of safety.....April 10
Date when material should be shipped by the vendor, allowing 5 days for transportation.....April 5
Date when contract should be placed with vendor, allowing 45 days for shipment.....February 19
Date when requisition should be placed with the purchasing department, allowing 5 days for paper work.....February 14

Centralized or Decentralized Scheduling. When scheduling is centralized, the planning department schedules the work of each machine, as well as the flow of work from one department to another. When scheduling is decentralized, the planning department schedules the final completion date and the dates for completion in each department. The foreman then assigns the work to individual workplaces and plans to meet the completion dates determined by the general program. The central production control department maintains data for work loads by departments. Each foreman may maintain charts or bulletin boards for machine loads and the flow of production orders within his department.

Adaptations of Scheduling Methods. The methods for scheduling work as developed in manufacturing enterprises may be adapted to many other types of activities. Any person may utilize his time more effectively if he schedules his work and allots his time between the various tasks. In an office the work of each typist or clerk may be

[3] Donald Peddie, "Lead-Time Chart Insures Close Scheduling," *Factory Management and Maintenance,* Vol. CV, No. 9 (1947), pp. 122–23.

scheduled in order that the supervisor may know the nature of the work being done by each person and the volume of work which is waiting at each desk. The scheduling may be done by using a sheet of analysis paper, with the names of the office staff listed in the left column. Spaces across the page represent the hours of the day or days of the month. Symbols may be used to indicate rush work, correspondence, duplicating, or other classes of work. By means of such a plan the supervisor may know at all times what persons may be shifted to other types of work in emergencies and what additional help may be needed.

QUESTIONS

1. What are the advantages of planning the starting and completion dates of work in each department?
2. Is the planning of completion dates in each department necessary to the planning of final completion dates for the product?
3. What information is necessary to the scheduling of work at each stage of production?
4. Explain how the bulletin board is used for showing machine loads. How is the bulletin board changed when additional work is scheduled for the machine?
5. Explain the use of the pegboard type of bulletin board for showing scheduled work.
6. Explain the use of the three-hook bulletin board in the scheduling of production.
7. Indicate the detailed steps in the scheduling of a production order for a customer.
8. Why does the clerk who schedules a production order begin with the most heavily loaded machine?
9. In the use of the lead-time chart, why may each part be scheduled for completion two days before it is needed in assembly? Would this always be desirable procedure?
10. After the date for starting work in production has been determined, how is the date for requisitioning the purchase of materials or parts determined?

CASES

83. METHOD OF PRODUCTION CONTROL FOR CAPS

Uniform caps are made for chauffeurs, bus drivers, gate watchmen, and various other groups. They are made to order by the Shaeffer Uniform Cap Company in a wide variety of styles and specifications. The company has designed a system to enable the production control department to follow the progress of each lot with a minimum of direction from the central office. When a production order is planned, a set of work orders is prepared in as

many copies as there are operations to be performed, plus an extra copy for the dispatcher himself. All copies of the work order, fastened by staples, are sent to the department in which the first operation is to be performed. When the worker has finished the first operation, he tears off the top copy of the work order and hands it to the assistant foreman. If the work is inspected before being moved, the inspector makes the proper notation, removes the copy of the work order, and gives it to the assistant foreman. These copies are picked up twice a day and sent to the dispatcher, who is thus enabled to follow the progress of the work and to take any corrective action that may be necessary.

Work orders do not follow a definite time schedule from one department to another. The dispatcher maintains a master schedule which indicates planned completion dates on the various orders. No corrective action is necessary so long as it appears that the order can be completed on the date required by the customer.

Required:

Evaluate the method of production control used by the company.

84. PREPARATION OF MACHINE-LOAD CHART

The manager of production planning asks an assistant to prepare a machine-load chart for three machines, using the following information:

Machine Number	Weekly Capacity	Scheduled Production by Weeks									
		1	2	3	4	5	6	7	8	9	10
1	80	75	80	60	45	40	30	15	15	10	10
2	100	90	90	75	50	40	40	25	20	20	10
3	120	80	80	60	60	40	20	20	20	10	5

Required:

Prepare the machine-load chart as requested by the plant manager.

85. COMPUTATION OF MACHINE CAPACITY

The plant manager requests the production planning department to determine the weekly capacity of the machines in a certain operating department. The following information is available:

Number of machines of this type	5
Labor shifts per day	1
Hours per shift	8
Days per week the plant is in operation	5½
Percentage of efficiency	80
Units of output per hour while in use	50

Required:

Compute the capacity of the machines of the kind indicated.

CHAPTER XXXIX

DISPATCHING AND FOLLOW-UP IN DIVERSIFIED PRODUCTION

ROUTING provides the plans for the flow of work, and scheduling introduces the time element. The next step is to put the plans into effect, to compare performance with the plans, and to take corrective action when necessary. Dispatching and follow-up include the following activities:

Preparation for the work.
Issuance of orders.
Reports of work done.
Comparison of the progress of the work with the original plans.
Rescheduling to provide for orders behind schedule or to make allowance for material shortages, machine breakdowns, and other emergencies.

Preparation. As soon as a production order is scheduled, steps should be taken to see that the materials will be available when they will be needed. The bill of materials is referred to the balance of stores clerk, who examines the inventory records to see if the necessary quantities of each material are on hand and available or on order. If the material is available, a notation is made in the Reserved column; and the quantity is deducted from the balance available. The bill of materials is initialed to indicate that the reservation has been made and is then returned to the planning department.

If the materials are not on hand, request may be made to the purchasing department for the procurement of the necessary quantities. However, the request may not be issued immediately if the work is planned for some weeks or months ahead. In some cases the material which is required for several production orders may be economically grouped in a single purchase order. The grouping is accomplished by means of a material-requirement record, as shown in Figure 84. The

date for the release of the purchase requisition is determined by the estimated time required for paper work, shipment by the vendor, and receipt in the storeroom. A similar procedure should be followed for purchased parts and machine tools.

MATERIAL 78-463

DATE	REFERENCE	JAN.	FEB.	MARCH	APRIL	MAY	JUNE	
11/18	NO. 418			120				
11/20	NO. 422			80				
11/30	NO. 435				200			
12/10	NO. 450				50			
12/21	NO. 260			100				
TOTAL				300	250			
NOW IN STOCK (NOT ALLOCATED)				80				
BALANCE ORDERED				220				
DATE 12/21								

FIG. 84. Material-Requirement Record

Issuance of Orders. The orders are conveyed on the forms which were prepared as a part of the work of routing. One form may carry instructions to all persons who will be concerned with the work, provide for the authorization to do the work, and make provision for the signatures to indicate that the work has been accomplished.[1] An illustration of a form used in planning and controlling production is the operation ticket shown in Figure 75 on page 585. Many companies have found that the use of one form for all dispatching operations greatly reduces paper work, eliminates confusion, and speeds up the flow of work. However, some companies use different forms for workers, inspectors, the storekeeper, and others. In any case, provision should be made for authorizing the following activities and providing for appropriate reports to the production planning department:

Issuance of Raw Materials or Parts. This order is conveyed by a requisition for materials as stated on the bill of materials.

Identification of the Materials or Product. A copy of the operation ticket may be used as an identification tag, as it shows all of the necessary information.

Work to Be Done. The operation ticket authorizes the worker to perform the stated machine or assembly operations. One form of operation ticket is often made to serve as a work order in each department. This is accomplished by duplicating several copies of the operation ticket in such a manner that certain information is omitted from each copy and only the information required by a department is included in the copy sent to it.

Inspection. A separate form may be used for the inspection order and inspection report, but many companies use a copy of the operation ticket for this purpose.

Moving the Materials. If the materials are heavy or bulky, special

[1] See Harold F. Kissel, "Single-Form Production Control," *Factory Management and Maintenance,* Vol. CVI, No. 2 (1948), p. 85.

handling by the internal transportation department may be necessary. In that case a special order is issued, and a report is made to the planning department when the material has been moved. The transportation is considered as a separate operation and is handled in the same manner as work at the machine.

Receiving the Finished Product. When the product has been completed, a report is made to the planning department that the goods have been received in the storeroom or the shipping room.

Following the Progress of the Work. Many plans have been devised for following the progress of the work and for showing present conditions in some graphical manner. Frequently, a bulletin board is used because it provides flexibility. The pegboard which is used for scheduling may be used for dispatching and for following the progress of the work. When work is started on an order, a transparent colored tape of flexible plastic is pulled out from the left side of the board; and the end of the tape is fastened under the starting date by means of a peg or tack. As the work progresses, the tape is pulled farther out to indicate the extent of the progress or the percentage of work done. For example, if the schedule for the first week calls for 400 units and the output is only 300, the tape is pulled three fourths of the way across the space for the first week. On another order, if the schedule calls for the production of 100 units and production is 110, the tape representing the progress of that order is pulled all the way across the space for the first week and one tenth of the way across the space for the next week. The first order is behind schedule, and the second is ahead of schedule. The method of operating the board is illustrated in Figure 85. The current date is indicated by a string drawn across the board from top to bottom. If all orders are on schedule, the tape for each order will extend to the string representing the current date. If no order is ahead of schedule, no tape will extend beyond the string.

When an order is behind schedule, a peg may be inserted to indicate the cause of the delay. Numbers on the heads of the pegs or the colors of the pegs may indicate the cause of the delay, according to an established code of numbers or colors. Causes of delayed schedules might be lack of materials, machine breakdown, lack of manpower, accident, or failure of a worker to meet standards. When steps have been taken to expedite an order, a peg with a distinctive color or numbered head may be inserted in the line to show that this action has been taken. This procedure will show at a glance that further attention to the order is not necessary.

On another type of bulletin board, as has been explained, the scheduled time is indicated by the width of the edge of the operation ticket which is inserted in the groove of one of a series of overlapping pockets. The tickets in one pocket extending the length of the board indicate all jobs to be done and also the time scheduled for each

FIG. 85. Bulletin Board for Showing Progress of Work

operation. The progress of an order, as indicated by reports from the shop, is shown by a colored signal which is moved across the board from left to right. For example, when the shop reports an operation completed on 500 of 1,000 parts of a job which was scheduled to require six days, the signal is moved to show three days' work completed. If such a report has been received after four days have been spent on the work, the job is one day behind schedule. The current date is indicated by a string as in the case of the pegboard. If the colored signal is to the left of the string, the order is behind schedule. If the signal is to the right, the order is ahead of schedule.

Recording Changes in Machine Loads. Some system of keeping machine loads up to date is necessary in order that the dispatcher may know whether work at each machine is proceeding according to plan and whether the machine will be available for the next order at the scheduled date. The usual method is to use a bulletin board which operates on the same principle as the board for recording progress on a job. On the machine-load board the machines are listed in the spaces to the left, and a line across the board indicates the work planned for the machine. Production at the machine is shown by a tape which is pulled from the left side. The distance across the board which is covered by the tape indicates the amount of work done.

When the board consists of a series of pockets, one pocket is used to show the work planned for each machine. A plastic signal is moved across the pocket to indicate the progress of the work, and a string drawn from the top is used to indicate the date. Work at the machine is indicated as behind schedule or ahead of schedule by the position of the signal in relation to the string.

Communication between Departments. Since the work of routing, scheduling, and dispatching is essentially that of correlating the work of the various line and staff departments, the planning department must be in frequent communication with various departments. For this purpose, some companies used a pneumatic tube system. Other companies use the telephone because it affords an opportunity for discussion of problems, but its limitation is that it does not provide a written record and may result in misunderstanding. The teletype has also been successfully used in dispatching. By means of this instrument, orders are automatically recorded on receiving machines in the departments to which messages are sent.

Follow-Up. The planning department follows up the orders given and must at times revise the schedules because of delays and also because of spoilage and defective work. Regular reports of progress are received and tabulated by the follow-up section. Some companies ask the foreman to prepare a "behind-schedule report" or a "fall-down report" as soon as he realizes that he cannot meet the schedule on an order. This report, which shows the order number and the cause of the delay, is sent to the follow-up section. The form of the report is shown in Figure 86.

In some companies the behind-schedule report originates in the planning department. Delayed orders are spotted by examining the files each day to determine which orders were scheduled to be moved to new locations on the preceding day. If a report of completion has

not been received, the order is listed as behind schedule and is described as critical. A report is then prepared which identifies the delayed order and indicates the operation number and the department or machine at which the material was last reported, the operation number and the machine at which the order is overdue, and the number of days overdue. Copies of the behind-schedule report are distributed to the foremen to notify them of the status of such orders. Each foreman reports to his division chief or other line supervisor concerning jobs listed as overdue in his department. This report indicates the status of each overdue order and the cause of the delay. A copy of the report of the foreman is sent to the follow-up section of the planning department.[2]

BEHIND SCHEDULE REPORT

TO PRODUCTION FOLLOW UP FROM DEPT 184

PRODUCTION ORDER NO. 116 PART NO. 185-358

SCHEDULED STARTING DATE 3/6 REPORT DATE 3/7

CHECK REASON:	REMARKS
NO MATERIAL	NEW #8 DRILL ORDERED 3/6
✓ NO TOOLS	
WORKER ABSENT	
RECEIVED LATE IN DEPARTMENT	
MACHINE OVERLOADED	
MACHINE BREAKDOWN	
INCORRECT ROUTING	
CHANGE IN SPECIFICATION	
OTHER REASON	

C. SMITH
FOREMAN

FIG. 86. Behind-Schedule Report

The follow-up section may prepare a weekly report summarizing the work load of each type of machine and the changes in machine load since the date of the last report. The report on machine loads is illustrated in Figure 87. The report is based on the assumption that the plant will be operated for two shifts of 40 hours each and that machines are expected to be in use 90 per cent of the time.

SUMMARY OF MACHINE LOADS 6/15

MACHINE	NUMBER OF MACHINES	HOURS AVAILABLE FOR WORK (2 SHIFTS)	LOAD 6/8	NEW HOURS	HOURS USED	LOAD 6/15	WEEKS AHEAD
RADIAL DRILL	6	432	1,680	420	430	1,670	3.8
MEDIUM PLANER	4	288	680	290	286	684	2 3
LARGE PLANER	5	360	1,150	380	360	1,170	3.2
SMALL LATHES	7	504	2,680	560	500	2,740	5.4

FIG. 87. Summary of Machine Loads

Some machines may become overloaded as a result of delays or interruptions or as a result of the rerouting of orders in adjusting production schedules. The situation is noted on the machine-load chart by means of a colored plastic signal or a peg of a certain color in the case of the pegboard. When the overloaded condition becomes known, appropriate corrective action may be taken by adjusting the schedules of certain

2 C. J. Peters, "Case Study of Production and Cost Control," *Bulletin of National Association of Cost Accountants*, Vol. XXVII, No. 18, Sec. I (1946).

orders, by authorizing extra shifts or overtime work, or by other appropriate action. If orders cannot be delivered on time, customers should be notified. In some cases, additional sales orders may be declined until the situation has been corrected.

When parts or finished products are manufactured for stock and placed in the storeroom, the report to the planning department indicates the number of seconds, or defective products, and the number of good pieces. If the total quantity of standard products completed is greater than the number originally scheduled or expected, the overage may be deducted from the number planned on the next order. If the total quantity of good production is less than the quantity needed for stock, the shortage may be added to the number planned on the next scheduled order. In some cases, additional shop orders may be released immediately to cover shortages. When a reorder is necessary, the number of the same parts or products originally scheduled for the next order may be included. A large number of units in the new order may be desirable to provide sufficient quantity for an economical run and to reduce the unit cost due to machine setup and paper work.

The follow-up section may prepare a report comparing the work done in each department with the amount of work scheduled. The section determines the number of hours originally allotted to the job from the work schedule and the number of hours taken from subsequent reports. The difference between these two is the number of hours of variance from the standard. If a job is still in process, the follow-up section may determine the standard number of pieces per hour and the actual number of pieces completed. This report would show the following information:

Part number and name.
Operation number.
Department or machine number.
Shift.
Number of pieces completed per hour.
Standard or scheduled number of pieces per hour.

Usually, this report is not prepared for every order but only for those for which performance appears to be unsatisfactory. The report may be of value to the scheduling section in planning future work because it indicates the reliability of standards previously established. It also indicates the orders in progress on which costs will be in excess of standard. Consequently, this report permits the management to take action to correct an undesirable trend in costs before the order is completed and before the final cost figures are available.

QUESTIONS

1. What are the phases of the work of dispatching?
2. Is preparation a part of dispatching, or is it a separate step?
3. What is the value of the material-requirement record?
4. What kinds of orders are issued in dispatching?
5. What forms are used in dispatching?
6. What reports are given to the production planning department to enable it to follow the progress of the work?
7. Explain how the peg bulletin board is used in dispatching.
8. How are machine-load data kept up to date as work is dispatched? Explain by reference to the use of the pegboard and transparent tape.
9. What methods of communication are used by the planning department in communicating with the manufacturing departments?
10. What use is made of the behind-schedule report? Where does the report originate?
11. What information is contained in the report on machine loads? What use is made of the report?
12. What may cause a machine to become overloaded?
13. What types of corrective action may be taken when a machine becomes overloaded?
14. What corrective action may be taken when the number of items rejected at inspection is larger than was originally expected? What action is taken in case the number of rejected items is less than expected?
15. What information concerning work dispatched and completed in production is needed by the foreman, the plant superintendent, and the production planning department?

CASES

86. SCHEDULING OF WORK IN A GARAGE

The service manager of a garage is responsible for interviewing motorists who bring their cars to be repaired and for making arrangements with them concerning the work to be done. He has designed a form with spaces for entering the name of the owner, the make of the automobile, the year model, the license number, and the time the owner will call for his car. The form also lists the various types of repair work to be done, and usually the service manager indicates the required work by placing a check mark in the appropriate space. Unusual types of needed repairs are noted in extra blank spaces at the bottom of the form.

The service manager finds that the customer asks two questions: "How much will it cost?" and "When can I get the car?" To permit an answer to the first question, the service manager has prepared an estimate of the probable time required for each kind of repair, with an upper and lower limit for certain types of work for which the required time is uncertain. The garage charges

the customer for the mechanic's time at the rate of $3.75 per hour. Parts are charged extra when they are used.

The manager has learned that a trade association of automobile dealers has prepared a booklet in which the various types of repair work are listed, along with a suggested charge for each repair. He finds that his own charges are usually less than those suggested in the booklet. He is contemplating a revision of his prices to conform with the suggested price list.

As for informing the customer when the car will be ready, the manager has devised a chart along the lines of the Gantt chart, with horizontal spaces marked to indicate the hours of the day. One line is to be used to record the work scheduled for each mechanic. When any work is assigned to a mechanic, the scheduled starting and completion times will be indicated by short vertical lines in the appropriate spaces. The number of the repair order will be written in just above the line. When a customer brings in his car for repair work, the manager will refer to his chart to determine when a mechanic will be available. In this way, he will be able to answer both questions of the customer.

Questions:

1. What are the advantages of the system devised by the service manager?
2. What difficulties might he encounter in operating the system?
3. Could the manager safely use the schedule of charges prepared by the trade association, or would he run the risk of violating the antitrust laws?

87. COMPARING QUOTAS WITH SALES MADE

An automobile dealer employs four salesmen, who are assigned quotas. The amount each salesman is expected to sell each week depends upon his experience with the company. During the six weeks beginning March 1, the sales of the four men, together with information as to quotas, were as follows:

Week	Jones (4)	Carnes (2)	Mullins (3)	Day (3)	Total (12)
1	5	1	2	2	10
2	5	2	2	3	12
3	4	3	3	3	13
4	6	2	3	3	14
5	3	2	3	2	10
6	4	2	3	1	10
Total	27	12	16	14	69

Required:

1. Prepare an ordinary bar chart to show the sales made by each salesman.
2. Prepare a chart by the Gantt method, comparing actual sales of each salesman with his quota. The chart should indicate the weekly accomplishment of each salesman, the cumulative record for the six weeks, and the total weekly sales in comparison with the quotas.

CHAPTER XL

PRODUCTION PLANNING IN CONTINUOUS MANUFACTURING

THE SYSTEM of production planning as described in preceding chapters is used in industries which manufacture and sell a variety of products. A company which manufactures a relatively small number of standardized products or a single product in continuous manufacturing cannot use such a system to advantage because too much clerical work is required. Although the four steps of routing, scheduling, dispatching, and follow-up are necessary, the methods of planning should be adapted to the production requirements.

Characteristics of Continuous Production. A distinguishing characteristic of continuous production is that the product is always made by the same operations at the same series of workplaces. The parts are transferred from one department or workplace to another in a continuous flow or in small batches. Work is continued in succeeding departments as the material is received, even though preceding operations have not been completed on the entire quantity. Parts or materials are transferred for succeeding operations or for assembly without being placed in the storeroom for later withdrawal by requisition.

It should not be inferred that all industries manufacturing by continuous and concurrent operations are exactly alike. As explained in connection with the discussion of plant layout, such industries may be either analytical or synthetic. In analytic industries, such as meat packing or oil refining, the work is planned to provide for the fanning-out of work in process from the point at which the materials are put into production. In synthetic industries the work is planned to provide for the orderly assembly of parts produced on converging production lines which terminate when the finished product emerges in the last department.

Manufacturing enterprises in continuous-production industries may be organized on more than one basis. Some companies set up separate production lines for each principal product and plan separately for each line. An example is a bakery which may have separate production lines for bread, cakes, and other products. Some companies make more than one product on one line by changing machine tools or by adjusting the machine. For example, a linoleum manufacturer may make the product in various colors and designs by using different stencils and different colors in the materials. The greatest economy in production is achieved in such cases by operating the line as long as possible without change.

In assembly industries, which operate on the principle of continuous production, the products are not necessarily all alike but may be produced in a number of varieties. For example, automobiles sold under a single trade name may differ in color, types of upholstery, body style, and combinations of accessories. The principal requirements for continuous production in an assembly industry are that the parts are interchangeable, the varieties or sizes of any part are made on the same equipment, and all varieties of the product are moved by the same mode of transportation in the assembly line.

Routing. Routing in a continuous industry is closely related to product design and plant layout. Since the same processes are continuously repeated, the production centers are laid out to perform the operations effectively and to facilitate the transportation of the materials. The routing is completed before the plant is laid out, and the production line is not changed as long as the product remains the same and more efficient equipment is not devised. Examples are plants for canning fruits, manufacturing soap, refining sugar, and packing meat.

In the continuous manufacture of a product that consists of a number of parts and subassemblies, such as computing machines or electric fans, the plan for routing the product is also built into the layout. The routing of a product that is made of several parts requires attention to the production of the various parts as well as their assembly. After the layout has been arranged to provide for the flow of work, the materials may be started in production in the first department and then moved through to final assembly without deviation. In a machine industry, routing includes the following steps:

1. Determine the parts necessary for the assembly of one machine and the number of each part in one machine.
2. Establish specifications for each part, and prepare drawings and blueprints.

3. Determine the type and quantity of materials necessary for the production of the parts.

4. Determine the most economical way to procure each part. Parts may be made in the plant or bought in finished or rough form.

5. Establish the operations to be performed for the manufacture of each part, such as stamp, cut, weld, drill, and ream.

6. Determine what tools and machines are necessary and what new equipment should be purchased.

7. Plan the layout for most economical production.

Preparation for Production. When a new model is to be introduced, the various activities in preparation for production should be scheduled for completion by the date when assembly is to begin. In the automobile industry the preparatory work includes the following activities:

Engineering and testing.
Manufacture or purchase of tools and dies.
Purchase and installation of machinery and equipment.
Purchase of finished parts and assemblies.
Purchase of crude materials.
Purchase of fabrics.
Purchase of special materials.

Since the time required for completion of the various phases of preparatory work is not the same, some activities should be started at an earlier date than others. In scheduling the deliveries of materials and purchased parts, allowance should be made for the fact that the volume of production may be small when car assembly begins. The volume may be expected to increase gradually as various difficulties in production are overcome and the departments gain momentum. A possible schedule of the basic preliminary work is shown in Figure 88.

Scheduling Production with Demand. The first question which should be decided in scheduling production is whether the rate of output is to be stabilized from month to month or whether it is to be varied according to fluctuations in the volume of sales. If production can be maintained at about the same rate throughout the year, the company will benefit in many ways. Turnover of labor would be decreased because the labor force can be retained throughout the year. Lower labor turnover decreases the cost of employing, training, and inducting workers, and lowers costs in other ways. Moreover, industry is becoming increasingly conscious of its obligations to labor for stabilized employment as well as to stockholders for profits and dividends.

A further advantage of scheduling production with demand is that

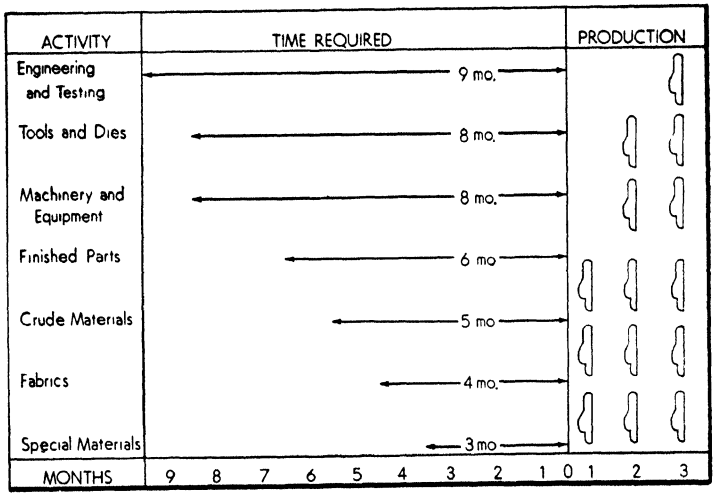


FIG. 88. Scheduling Preparation for Production
Adapted from *Automotive War Production,* Vol. III, No. 10 (1944).

machinery and equipment would be more effectively utilized. Provision need not be made for peak demand but only for the average monthly output. The need for a smaller amount of equipment would be reflected in decreased building space, heating and lighting costs, and other costs of production.

Production cannot always be stabilized to meet a varying sales volume. The following factors may require a varying rate of production:

1. If the product is bulky, an excessive amount of storage space would be required. This is true, for example, of boxes and various other types of containers, cheap furniture, and automobiles.

2. Style changes, as in textiles and clothing, are difficult to forecast. Stabilized production might result in heavy inventory losses.

3. Raw materials may be perishable. For this reason, such industries as fruit and vegetable canning and oyster processing cannot be stabilized.

4. The product may be made according to the specifications of the customer, as in various steel products and custom-made clothing.

5. The finished product may be subject to physical deterioration, as certain food products.

6. The product may be heavy or otherwise difficult to store — for example, cement, brick, and other building materials.

Many companies which do not produce uniform quantities from month to month do not vary production with fluctuations in sales

volume. The increase in sales in the busy months is met partly by increasing the rate of output and partly by drawing upon the storeroom for stock produced during preceding months of lower sales volume.

Scheduling Monthly Deliveries to Customers. In scheduling monthly and weekly production, the first step is to estimate the monthly shipments to customers and the monthly deliveries to stock. These two estimates are not necessarily the same. In estimating consumer demand, the percentage of customers who will order a certain style of body or a certain kind of upholstery, in the case of automobiles, should be determined in order that purchase and production programs may be controlled. The desired production of the finished product might be as shown in Figure 89. This estimate is in terms of product and not in monetary terms. The estimates embodied in the production program are based upon such factors as the following:

PRODUCTION PROGRAM

MONTH	MODEL NO. 10		MODEL NO. 20		MODEL NO. 30	
	THIS MONTH	CUM	THIS MONTH	CUM	THIS MONTH	CUM.
JANUARY	5,000	5,000	10,000	10,000	7,000	7,000
FEBRUARY	6,000	11,000	12,000	22,000	8,000	15,000
MARCH	6,500	17,500	13,000	25,000	10,000	25,000
APRIL	6,500	24,000	13,000	38,000	12,000	37,000

RECOMMENDED _____ DATE _____
PRODUCTION MANAGER

APPROVED _____ DATE _____

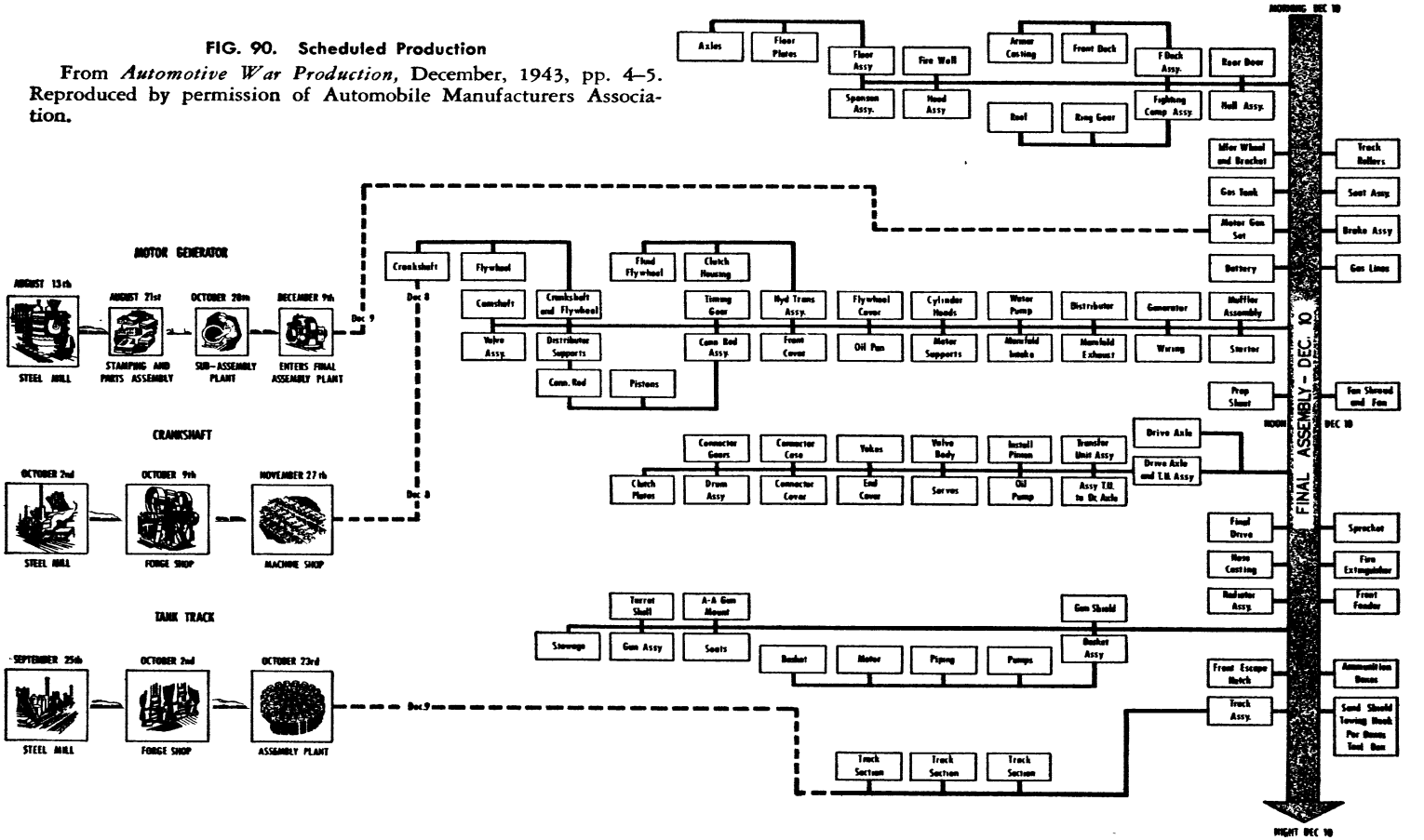
FIG. 89. Estimate of Production

1. Market conditions
   - Conditions in the materials markets
   - Plans of competitors
   - Trend in business conditions
   - Reports of salesmen or other sales outlets
2. Conditions within the business
   - Analysis of sales last year and other years
   - Advertising plans
   - New sales outlets to be opened
   - Changes in design of product
   - Labor conditions affecting production
   - Financial plans for raising new capital

Scheduling the Production of Parts and Assemblies. The weekly or monthly schedules of production of parts and assemblies are prepared by computing backward from the monthly production schedules. A chart showing the flow of production from one department to another may be prepared as shown in Figure 90. This chart shows that, if tanks are to be completed on the assembly line on December 10, the steel for the motor-generator should be in the steel mill on August 13. Steel for the crankshaft should be in the steel mill on October 2, and steel for the tank track should be in the steel mill on September 25.

FIG. 90. Scheduled Production

From *Automotive War Production,* December, 1943, pp. 4–5. Reproduced by permission of Automobile Manufacturers Association.



The flow of the materials for each of the various parts is timed throughout each of the succeeding departments. If production of 400 tanks is planned for December, the motor generators for that number of units should be processed by the steel mill in August. The steel for the crankshafts for December production need not be processed in the steel mill until October.

The Factory Float. The factory float is the amount of inventory in process of production at any one time. It includes materials being processed, materials being transferred from one workplace to another, and materials in temporary storage at any place in the factory awaiting fabrication or transfer. In accounting, the float is usually referred to as "goods-in-process inventory."

The amount of the float may be stated in terms of a certain number of days or weeks of production. For example, if steel which is put into production on August 13 does not emerge as finished product until December 10, it is in process 119 days (including Sundays and holidays). By the time the steel is completed in production, other steel equivalent to production for 119 days has been put into process. If production amounts to 50 units per day and 100 pounds of steel are required for each assembly, the float would total $50 \times 100 \times 119$, or 595,000 pounds.

One objective of production planning is to keep the float as low as possible. If the float is greater than necessary for continuous production, the result is idle capital, possible deterioration, obsolescence of parts in case of changes in design, and crowding of workplaces. However, some banks of materials at various workplaces may be necessary to avoid delays in production due to accidents and other interruptions. The float is reduced by effective plant layout; regular servicing of machines; effective methods of employee selection, training, and motivation; and other management policies. Detailed factors affecting the amount of the float are as follows:

Labor turnover.
Absences and general employee efficiency.
Sunday and holiday work.
Balance in plant layout, preventing delays.
Straight line layout.
Short moves from one workplace to another.
Type of materials-handling equipment.
Condition of machinery and equipment.
Effective control of materials inventory.

Scheduling Daily Runs. As production nears the assembly stage,

the scheduling of production becomes more detailed. In the automobile industry the distributor, in response to requests of customers, may be permitted to specify color, body style, upholstery, and certain accessories. In each case the customer is required to choose from a limited number of varieties offered by the manufacturer. A car may be made in 5 colors, 2 kinds of upholstery, 3 body styles, and 3 combinations of accessories. These combinations make possible 90 varieties ($5 \times 2 \times 3 \times 3$). Since the varieties cannot conveniently be carried in stock, the most economical plan is to schedule production in order that automobiles will leave the production line with the proper specifications. The scheduling is done by means of a daily run sheet, as shown in Figure 91.

DAILY RUN SHEET

DATE _____

DISTRIBUTOR	COLOR	BODY STYLE	UPHOLSTERY	ACCESSORIES
W.C RICE, DALLAS	BLUE	# 1	# 2	# 1
R.W. SMITH, PEORIA	GREEN	1	2	2
G C. ARTHUR,TOLEDO	BLACK	2	1	1
ETC.				

APPROVED _____
PRODUCTION MANAGER

FIG. 91. Daily Run Sheet

Copies of the daily run sheet are distributed to the head of each production line which feeds into the main assembly line. The sheet is used to determine the order in which fenders, wheels, bodies, and other parts are forwarded in the line. The time required for any part to be fabricated before reaching the main assembly line is known, and the progress of any car along the line can be definitely determined from the schedule.

The manner of scheduling after the daily run sheet has been prepared may be seen by reference to Figure 92. This chart does not show the schedule of any one manufacturer but is a composite chart based upon the experience of a number of companies. The chart shows that a car which is to be finished at 2:20 P.M. on Friday will start on the final assembly line at 1:00 P.M. on the same day. The rear assembly will be started on Monday at 8:00 A.M., while the gear assembly will be started at Monday noon. Other assemblies are timed to start in a similar manner. However, the production of each part need not be timed as precisely as the chart seems to indicate because many parts are interchangeable and will fit into the assembly of any automobile along the line. Such parts are planned only in the necessary quantities. They may be stored in bins at each station, or they may be moved by overhead conveyor.

In some industries the time required for production is much shorter than in the automobile industry. In most companies, however, sched-

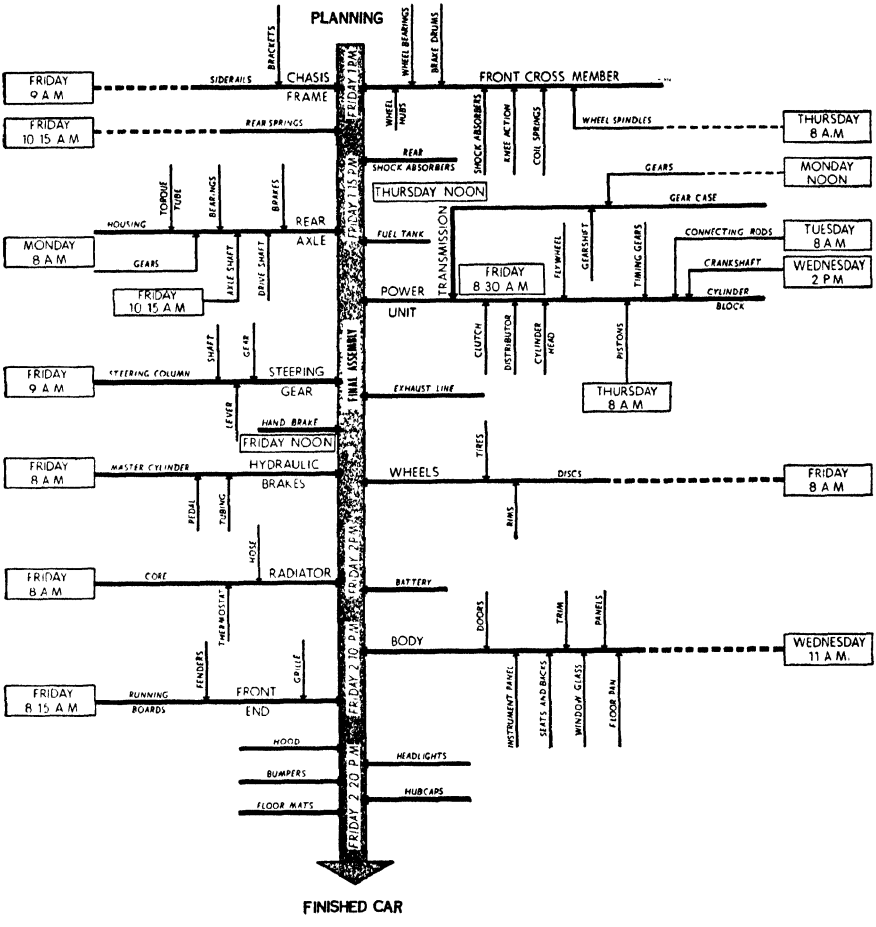


FIG. 92. Timing of Automobile Production

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uling consists of both long-range and short-run planning. In the baking industry, for example, long-range planning requires that machinery, equipment, storage space, shipping facilities, and inventories of materials be planned for the estimated volume of production. Daily runs of various products are then planned in order that quantities of the product may be balanced with daily and weekly fluctuations in demand. The flow of work should be planned each day in order that employees may report for work as the product moves forward from one stage of production to another. The problem differs from that in the automobile industry principally in the time required for the production cycle. Moreover, the production line is cleared at the end of each day's production and is started from the head of the line on the following

day. Methods of production differ in that the product is the result of synthetic processes rather than fabrication and assembly.

Dispatching. Dispatching in continuous manufacturing does not require attention to each order. Work flows from one workplace to another without move orders, operation tickets, or material requisitions. In the early stages of production, work is dispatched to meet the total requirements of the monthly or weekly production schedules. In the later stages of production and assembly, the parts are channeled into the production line; and they proceed from one workplace to another with no detailed orders except the daily run sheet.

As in intermittent manufacturing, the first step in dispatching is preparation. This step includes the authorization of work and the making of contracts for purchases, as previously described. The preparation work includes engineering, testing, and the purchase of materials, parts, and equipment.

The initial schedules of production are prepared many months in advance in order to permit long-run planning for production. The schedules are revised as final production dates near, and weekly production schedules are then released to plants and departments. As each car is dispatched from the head of the line, it is identified by a tag attached to the chassis. The tag indicates the name and address of the distributor or dealer, the color, body style, and other specifications. Except in cases of accident, machine breakdown, or other interruption, the car advances without further direction from the planning department through the stages of assembly, inspection, and shipment.

Follow-Up. Dispatching is followed by periodical reports of accomplishment, comparison, and corrective action when necessary. The reports may show the results of all phases of the purchasing and production program. The report of the purchasing agent would show contracts authorized to be placed and contracts actually made. It would show for each month the materials which were scheduled for delivery into stock and the actual deliveries. Any delays in the deliveries of materials are promptly reported to the planning department, and the production program is revised when necessary.

The production of each plant or each department is reported weekly, and the volume of production is compared with the schedule. This report might be prepared in the form shown in Figure 93. This type of report shows the amount of the float or work-in-process inventory at the beginning of the week, the work placed in production, the work completed, the scrap, and the balance in process at the end of the week. Standards are available to the management for determining the success

of each manager regarding the amount of work started, the amount completed, the scrap, and the balance in process.

Another report which may be prepared is a monthly report comparing actual production with scheduled production. This report is illustrated in Figure 94.

WEELY PRODUCTION REPORT

DEPARTMENT 18 FOREMAN J. SMITH

WEEK BEGINNING	IN PROCESS FIRST OF WEEK	PLACED IN PRODUCTION	COMPLETED	SCRAP	IN PROCESS END OF WEEK
2-2	500	600	540	10	550
2-9	550	650	660	5	535
2-16	535	640	645	8	522
2-23	522	635	630	4	523

FIG. 93. Weekly Production Report

MONTHLY PRODUCTION REPORT

DATE

MODEL	APRIL		MAY		JUNE		TOTAL	
	ACTUAL	SCHEDULED	ACTUAL	SCHEDULED	ACTUAL	SCHEDULED	ACTUAL	SCHEDULED
X-445	41	40	45	40	39	40	125	120
X-448	80	85	85	85	90	85	255	255
X-541	30	35	33	35	35	35	98	105

FIG. 94. Monthly Production Report

The reports and charts presented in the present chapter should be regarded only as illustrative. They are designed to indicate the general nature of such reports and the types of information needed by management for the control of production.

QUESTIONS

1. Under what conditions is the method of continuous production used in the manufacture of a product which is made by the assembly of a number of parts separately processed?
2. What are the four principal steps in production planning required in continuous-production industries? How do the steps differ from the steps in diversified production?
3. How does preparation for production in continuous manufacturing differ from preparation in diversified manufacturing?
4. What are the advantages in scheduling production at a uniform rate throughout the year regardless of fluctuations in sales of the product?
5. What additional costs are incurred in scheduling production at a uniform rate?
6. What is the relation of monthly volume of production to monthly sales when production is stabilized in a seasonal industry?
7. What information is needed for a reliable estimate of the number of units of product which will be sold each month?

8. Explain how the estimate of production of parts and assemblies is made from the estimate of the number of units of finished product to be completed.
9. Why should the factory float be kept as low as possible without delaying production?
10. What is the relation of the factory float to production planning?
11. How does the existence of the factory float affect the method and the cost of changing the design of the product?
12. What is the daily run sheet? What use is made of it?
13. What control over production is exercised after parts are started on the production line?
14. What daily or monthly reports are needed for follow-up and corrective action in continuous-production industries?

CASES

88. USE OF LABOR POOL

The Holt Appliance Company regularly employs about 800 men and women. Its manufacturing operations consist of various machining operations, painting, assembling, and testing. Some of the departments have been troubled with excessive absenteeism, and the foremen have had difficulty in making substitutions for employees who fail to report for work. After discussion of the problem at a conference between the plant superintendent, the foremen, and the personnel manager, it has been decided that a labor pool would be established under the supervision of a pool manager who would report to the plant superintendent.

According to the plan, a pool of 25 persons of varied experience would be available on call from any foreman to replace absentees in any department and to meet other emergencies. In employing workers for the pool, the employment department would seek to find persons who could do any one of several types of work. However, the pool manager would attempt to learn the qualifications of each person in the pool and to send the same persons continuously to any one department for a given type of work as far as that was possible. It was agreed that foremen would be required to give initial instruction in some cases, but it was hoped that members of the pool would in time be able to develop facility in several kinds of work.

To keep the members of the pool occupied when they were not on call from an operating department, the production planning department was asked to assign certain types of special work which was not required to meet a close schedule. Such work would include handling goods returned by customers, packing shipments for export, maintenance, and production of parts for stock in anticipation of future orders.

Members of the pool would have first preference in transfers to operating departments for filling vacancies or newly created jobs. They would be paid a guaranteed hourly rate when working under the pool manager and would be paid for substitute work at the going rate for that type of work. An advantage

to persons working under the direction of the pool manager would be that they could learn a variety of types of work and could shift to new positions to break monotony.

Questions:

1. What would be the advantages of the proposed plan?
2. Would workers like to be members of the pool?
3. What does the proposed plan indicate concerning the simplification of tasks in industry?

89. FILLING ORDERS OF CUSTOMERS IN A MAIL-ORDER HOUSE

The first delivery of mail at a large mail-order house is received at 5 o'clock in the morning. The mail is immediately weighed to determine the probable number of customers' orders. This estimate is possible because the company has learned that, on the average, each pound of first-class mail brings a certain number of orders. By means of similar relationships the company can estimate the probable number of pounds of mail and orders to be received in each of the two later deliveries for the day. This information enables the company to assign the proper number of clerical workers to handle the work at the various stations along the route of the order.

In the mail department, letters are opened; the cash is removed and recorded; and orders are classified by method of payment, such as cash, C.O.D., and time. Orders are sent to the order-reading department, where orders are read and any special requests, such as time of delivery, are noted. The method of shipment, which might be parcel post, freight, express, or truck, is determined. Orders are classified as "singles" if all merchandise is ordered from a single department or as "multiples" if the merchandise comes from more than one department. Next, in the index department the name-and-address stencil of a customer is removed from the file, and package labels are prepared. A customer record, on which is entered the date and value of the order, is kept. This record is used for keeping mailing lists up to date.

In the entry department the description and price of the merchandise are checked, and a separate sheet is prepared for each item on a multiple order. Each order is then scheduled to be delivered to the packing and shipping department at a certain time in the day. The time is stenciled on each order and also on each entry sheet. The purpose of the scheduling is to enable all items of merchandise on any one order to arrive at the packing station at the same time. The entry sheets are then sorted by merchandise departments, and they are forwarded to the appropriate department or section of the storeroom. The customers' orders are sent to the packing department.

In the merchandise departments, which together constitute the stockroom, the merchandise as specified on the entry sheets is taken from the bins, inspected, and placed on a moving belt at a time which assures delivery to the packing department at the scheduled time. Moving belts on each floor carry the merchandise to a gravity chute which terminates in the packing room. By means of the customer's order and the entry sheets accompanying the merchandise, the clerk in the packing room assembles the merchandise for each order, wraps

it, and prepares it for mailing. If any item is out of stock, the entry sheet for that item is also sent to the packing room, where a refund check, or a notice that the missing item will be sent later, is prepared for inclusion in the customer's shipment.

Required:

1. Explain the purpose of each step in filling orders.
2. Compare the method of filling orders with production planning in diversified production.

PART X

Financial Control of Production

CHAPTER XLI

CONTROL THROUGH THE BUDGET

THE budget is a co-ordinated financial plan for a business enterprise. It includes estimates of sales, production, purchases, labor costs, expenses, and financial operations. Its purpose is to plan, co-ordinate, and control the activities of various divisions and departments of the business.

The budget may be partial or complete. A partial budget is a financial plan for one or a few activities. For example, the partial budget might provide for advertising expense, product research, a production program, or plans for the expansion of plant facilities, without including expense budgets for each department. When budgets are first introduced in a business, the expenses of a few departments may be budgeted on a trial basis. As foremen and their assistants come to know the advantages of operating on a budget, the plan may be gradually extended to other departments. When the budget is confined to a limited number of departments, it is a partial budget.

A complete budget is a financial plan for all the activities, including sales and finance. It is an estimate of both income and expenses. It provides for the expansion of plant facilities and the procuring of funds through bank loans or the sale of corporate securities, and it consists of separate departmental budgets and a master budget. The master budget summarizes and consolidates the data included in the departmental budgets.

The budget estimates are stated in dollars and cents. In some cases, supplementary estimates are prepared in other terms. Estimates of sales and production are usually made in terms of units of product. Purchases may be estimated in units of material, as well as in monetary terms. The labor budget may indicate the number of workers required in addition to labor cost.

Relation of the Budget to Management. The budget is a significant device or tool of management. When the budget estimates are formulated, a general view must be taken of all of the activities of the business for the purpose of maintaining balance. When funds are granted or denied for any purpose, the decision is then made that a particular activity is or is not necessary. The increase or the decrease in the budget allowance of a department means that the activities of that department will be expanded or curtailed. Since the budget may include expense allowances for all departments of the business, it reflects the views of management concerning the value of each activity and the success of each executive.

The budget emphasizes the idea that expenditures for any purpose should be justified by increased income, decreased expenses in another category, increased tangible or intangible assets, or other business or social advantages. The business budget reflects management plans and also serves as an important check on management decisions.

The budget permits the management to give careful consideration to future economic developments and to choose in orderly fashion the course of action to be followed. Also, it enables the management to take advantage of favorable developments and to prepare for unfavorable developments. For example, if the prospect is for an increase in the volume of business, the company may plan to expand facilities, increase purchase commitments, employ and train more workers, or add new lines of products. If a recession appears imminent, the company might plan to reduce inventories, decrease purchases, postpone the expansion of facilities, and change its employment policies. However, the company might wish to offset unfavorable tendencies by increasing its advertising appropriation, introducing a new product, or initiating some other program for increasing sales. Since the budget makes possible the selection of the most desirable course of action, both unwarranted optimism and undue pessimism may be avoided.

The budget establishes a standard of accomplishment for the various departments, and each department is expected to reach established goals of production and sales with the funds allotted for the purpose. The budget permits each executive to determine for himself whether his performance is satisfactory. If he can produce the quantities of product required by the budget with the allotted funds, he knows he is meeting the standard for his department. In this manner the budget is a means of raising the level of performance throughout the organization. It provides a basis for comparison and corrective action.

The budget is designed to achieve the co-operation of various de-

partments and to co-ordinate their activities. The plans of the sales, finance, purchasing, personnel, and manufacturing departments must be co-ordinated to assure a successful enterprise. One department cannot succeed without reference to the plans of the others. If the budget is properly planned and executed, the entire program will be operated as a unit.

Static or Flexible Budget. The static budget is a financial plan which is considered to be fixed and not subject to variation. It is prepared on a monthly, quarterly, or yearly basis. New estimates are made each year because the budget is based upon data which relate to a specific or definite period of time.

The flexible budget provides several estimates of expenses for each manufacturing department and other departments for varying volumes of sales and production. The first estimate establishes a standard of expense on the assumption that the volume of production will be normal. Other estimates of expenses are made for a volume of production which is 10, 20, or 30 per cent below normal. An estimate may also be made for a volume of production which is 10 or 20 per cent above normal. Normal production is stated in number of units produced in order that its meaning may be definite. When the foreman knows the current volume of production in any month, he can easily determine the budget figures which apply. Some expense allowances are changed as the volume of production increases or decreases, while other expense allowances do not change with variations in production.

The flexible budget has a marked advantage over the static budget during periods of business uncertainty. It makes a revision of the expense budgets unnecessary when sales and production programs are changed. It is a means of separating budgeting and forecasting. Flexible budgets need not be revised from year to year, unless the prices of supplies or wage rates for labor in a department are changed.

Length of the Budget Period. The budget is usually made for one year in advance, although it may be made for a shorter or longer period. In some cases, partial budgets of plant expansion and finance are made for five or ten years or even longer. The budget should cover at least a seasonal cycle, including an off season and a busy season, in order that plans may be made to supply the increased sales demand in the busy season. If goods are produced to the order of customers, the budget period may be relatively short unless customers' orders can be anticipated with a fair degree of certainty. Some companies continuously project the budget twelve months in advance. At the end of each month the current month is dropped from the estimates and the corre-

sponding month next year is added. In this manner the planning always permits each department to make advance commitments for advertising, purchases, and other contracts.

Organization for Budgeting. The responsibility for the preparation of the budget estimates and for the operation of the budget varies according to the size and the circumstances of the individual company. The chief executive or general manager should assume ultimate responsibility for the estimates, although he need not attend to the details. He should be well informed of every activity of the company and should know the functions of every department and the qualifications of the various executives. He should be able to co-ordinate the conflicting interests of the various departments. Only the chief executive is in a position to deny requests for increases in expense allowances or for additional plant facilities.

Some executive directly responsible to the chief executive is usually placed in charge of the procedure for the development and the enforcement of the budget. This executive is usually the controller or the treasurer; but he may hold a position especially created for the budgetary work, such as budget supervisor, budget director, or controller of the budget. The essential requirement is that the person who administers the budget be co-ordinate in rank with the major functional executives and also have the support of the chief executive.

The budget officer may be assisted by a budget committee composed of executives who are thoroughly familiar with conditions throughout the operating departments. The budget committee is usually composed of the heads of the major divisions.

The entire organization should take an interest in the preparation of the budget and in the responsibility for its execution. This favorable condition cannot be created as soon as the budget program is initiated, but it is the result of long and successful experience with its administration. A gradual introduction of a budgeting program is frequently advised in order that general participation and interest may be developed.

Preparation of the Budget. The preparation of the budget is supervised by the budget officer, with the aid of the budget committee. Before any estimates are made, the budget committee should meet for a discussion of past performance of the business, prospects during the ensuing year, and changes in the policies of the business. The head of each major department then prepares and submits to the chief budgetary officer the proposed budget for his department. The budget officer may combine and summarize the estimates to show the total result.

He then transmits them to the budget committee, together with information to assist the committee in evaluating the proposed program. When the estimates have been revised or approved by the committee, they become the budget for the ensuing period; and they are transmitted by the budgetary officer to the various departments for their guidance. Any revisions which later become necessary are recommended by the budget officer and the budget committee.

The manner in which the proposed budget is to be assembled for submission to the budget committee is prescribed by the chief budgetary officer. The expense estimates for each department should be classified by the nature of the expense, such as wages, supplies, communication, repairs and maintenance, and taxes. Each department should submit its estimates in terms of dollars and cents. In addition, some departments should submit estimates in terms of physical units, such as units of product to be sold, units produced, and volume of purchases. The labor budget should show labor costs in dollars and also the number of persons to be employed.

The various estimates are closely related to each other and should be integrated to form a consistent, balanced program. For example, the sales estimate is limited by the amount of the product which can be manufactured; and the amount to be manufactured depends upon the amount which can be sold at a profit. Both the sales and the production budgets may depend upon the funds available for financing and the amount of materials which can be purchased. Expenses vary with the rate of production, although they may not increase or decrease in proportion to changes in the volume of output.

The Sales Budget. Financial planning usually begins with the estimate of sales because all of the other estimates depend upon the amount of goods that can be sold. The company would usually determine the amount that can be sold, with allowance for planned increases or decreases in the amount of goods in the inventory. The planned production determines the requirements for personnel, the purchasing program, and the manufacturing expenses. Selling and general administrative expenses usually are budgeted on the basis of sales rather than production.

During periods of acute materials shortages, the budget would be formulated with reference to the amount of materials and parts that can be purchased because the shortages may limit production, which in turn limits sales. In any case the budget committee should scrutinize the estimates as a whole to see that they reflect current conditions.

The sales estimate can be accurately prepared only after a careful

study has been made of conditions within and without the business. The information which should be available is as follows:

Sales for Two or More Years Preceding. The sales information should be available in the same form as the sales estimate. For example, if the volume of sales of two or more products is to be estimated, sales information for the various products in prior periods should be available. The sales data should include information for two or more years for the purpose of determining consumer trends and seasonal or cyclical fluctuations. Such trends may be particularly significant for new products or products whose consumer appeal is increasing or decreasing.

Changes in Business Policy. The sales budget is affected by such changes as lines of product to be added or discontinued, changes in design, and the amount of the advertising appropriation. Any change which affects the volume of goods produced will also affect the amount which can be sold. Production is affected by construction or expansion programs, the installation of an incentive wage system, the number of labor shifts, and various other business policies.

Changes within the Industry. One company may lose business to, or gain from, its competitors. One industry may also expand at the expense of another. Examples may be found in the transportation, frozen food, and other industries. In estimating its sales volume, each business should consider the policies of competitor companies in the same industry and in competitive industries.

Changes in the Market Area. The market is affected by such factors as crop prospects and by prosperity or depression in industries which provide employment for customers. If the product is sold to business enterprises rather than to individual consumers, the prosperity of companies in consumer industries should be considered.

Responsibility for submitting the sales budget to the budget director rests with the sales manager, although he does not necessarily make the first sales estimate. It is usually desirable for the persons who will be responsible for the execution of the budget to assist in making the estimates.

The following procedures for making sales estimates are possible:

1. The sales manager, with the assistance of his research staff, may draw up the sales estimate on the basis of available statistical and economic data. The total sales estimate is assigned as sales quotas to territories, branch sales offices, or individual salesmen. This procedure has the advantage of being based on reliable and perhaps complete statistical information. It is not entirely satisfactory because of the

manner in which sales quotas are passed down the line to the various branches of the sales department and to salesmen.

2. Each salesman may be asked to estimate the sales which he believes he can make in his territory. The district sales manager may revise the estimates, which are then submitted to the general sales manager. The estimates for the various districts are combined to determine the total estimated sales. This procedure has the advantage of placing responsibility for execution of the budget upon the district sales managers and the individual salesman. However, sales estimates made in this manner are likely to be unreliable because the salesmen are not in a position to appraise the prospects of the company and the effects of changes in general business conditions. Some salesmen may set quotas for themselves which are overly optimistic, while others will set quotas which they are certain they can meet with a substantial margin to spare.

3. The estimates may be made in the general sales office and submitted to district sales managers for comment. They are revised in the light of suggestions from men in the field.

Regardless of the manner in which the sales estimate is made, it is closely scrutinized by the chief budgetary officer and the budget committee. The final estimate should reflect the best opinion of what can and will be accomplished during the budget period. In some companies, particularly the smaller companies, an unsupervised estimate made by the sales office might be unreliable because it is overly optimistic.

Manufacturing Budgets. The manufacturing departments prepare the following budgets:

Production budget
Purchases budget
Plant and equipment budget
Maintenance budget
Labor budget
Manufacturing expense budgets
Research budget

The production budget has been considered in connection with production planning. Since the sales budget shows the quantities to be sold, the principal problem in the preparation of the production budget is to distribute the required production over the months of the year. The company may vary production with sales, or it may attempt to stabilize production by producing in the dull months in anticipation of increased sales in the busy season. This problem has been discussed elsewhere and does not require further treatment at this time.

Purchases Budget. This budget is the plan for the purchase of materials required by the production budget. The purchases estimates

are therefore directly dependent upon the estimates contained in the production budget. On the basis of estimates as contained in the purchases budget, the purchasing agent may make the purchase contracts. In some companies, however, the purchases are made on the basis of inventory records and the established reorder points. When purchases are made in this manner, the purchases budget is useful principally as a means of financial planning.

Plant and Equipment Budget. This budget shows the additions to be made to the plant, the new equipment to be purchased during the budget period, and also the units to be scrapped or sold. When the expansion or replacement of plant facilities is planned through the budget, the management is usually required to survey carefully all requirements and to make the expenditures where they will be most beneficial to the company. Since the plant and equipment budget shows changes in the investments in fixed or capital assets, the funds authorized for expenditure in this budget do not represent current expenses. The assets acquired are called "fixed assets" and are retained and used in the business during more than one fiscal year. Large capital expenditures are usually planned over a number of years; and commitments are made after consideration of the long-range trend of business, costs, and money-market conditions. Decision must also be made, in many companies, to buy or to make certain types of equipment.

Maintenance Budget. The maintenance of buildings and equipment is very important because neglect can mean greatly increased expenses in the future. In slack times, maintenance may be neglected because of the pressure to economize. In busy times, maintenance may be neglected because materials and labor are high in price and perhaps difficult to purchase and because repairs might slow production. However, repairs should not be neglected in either good times or poor times. The budget should provide the funds for various types of maintenance work, such as the following:

1. Periodic repair or service jobs, including lubrication.
2. Preventive inspection to assure that equipment is functioning properly and to determine when repairs are needed.
3. Repair jobs, the need for which is discovered by preventive inspection.
4. Repair jobs made after machinery or equipment has failed to function. Emergency jobs should be held to a minimum by preventive inspection. They are usually limited to superficial repairs.[1]

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[1] For discussion of maintenance work, see Donald T. Ward, "The Management of Maintenance," *Factory Management and Maintenance,* Plant Operation Library No. 112, July, 1948.

Labor Budget. The budget of labor requirements is based upon the production budget, which shows the number of units of product to be manufactured each month. The amount of labor needed for production depends upon, first, the volume of production and, second, the policy of retaining or laying off men in the slack season. The labor budget is prepared separately for each department, and it shows the number of employees needed each month and the labor cost in dollars. The personnel department uses the labor budget to determine the number of persons to employ. It makes a computation similar to the following:

DEPARTMENT NO. 10

BENCH ASSEMBLERS

Number on payroll at beginning of month	40
Estimated separations:	
Quits	2
Discharges	1
Transfers and promotions	1
Retirements	0
On leave	1
Other causes	0
Total separations	5
Net	35
Required for production program	42
Difference to be met by transfer or hiring	7

Manufacturing Expense Budgets. Manufacturing expenses are budgeted in separate estimates for each department. If flexible budgets are prepared, the estimates will show the amount of each expense at stated percentages of normal production, which might be 100, 90, 80, 70, and 60 per cent. The amount of each expense at varying levels of production depends in part upon the nature of the expense, which might be variable, semivariable, or fixed. Variable expenses increase or decrease directly in proportion with changes in output; semivariable expenses vary with changes in output but not in corresponding percentages. Fixed expenses do not change with variations in the volume of production so long as additional plant facilities are not necessary. This classification must be accepted with some degree of caution, however, for few expenses fall clearly within any one of the three classes. The difficulty of classifying expenses into three groups can be seen from the following list of expenses of the manufacturing departments:

Foreman's salary
Assistant foremen's salaries
Supplies
Power
Salaries of clerks and helpers
Defective work
Overtime bonus
Depreciation of building

Light
Workmen's compensation insurance
Heating
Telephone and telegraph
Salaries of inspectors
Property taxes
Fire insurance
Boiler explosion insurance
Depreciation of equipment

The effect of varying rates of production upon expenses depends in part upon the policy of the management in dealing with the prospect of increasing or declining business. For example, a proposed increase in sales volume might be met by purchasing certain parts usually manufactured, adding a labor shift, increasing production by overtime work, providing additional facilities for production, or increasing efficiency by the mechanization of certain tasks. Each of these policies will affect expenses in a different manner.

Research Budget. The research budget was discussed in Chapter XIV (p. 245). It is one of the most difficult to control because the results are indefinite and long delayed. The budget should indicate the amounts to be spent on each major research project; and the amounts should be further classified as salaries, supplies, equipment, taxes, depreciation, building costs, and other expenses.

Advertising Expense Budget. The advertising budget and the sales budget are closely related because increased advertising expense should result in increased sales. The problem in the budgeting of advertising expense is to determine the most profitable relationship between advertising and sales. An increase in advertising expenses beyond a certain point becomes unprofitable. The total amount to be spent for advertising is subject to control by the budget committee.

The advertising expense budget is prepared by the advertising manager, who is usually under the supervision of the general sales manager. His recommendation as to the method of spending the advertising allowance and the media to be used is usually approved by the budget committee because the final responsibility for results rests upon him.

Selling Expense Budget. This budget includes all selling expenses other than advertising. The budget would usually include such expenses as the following:

Salesmen's salaries.
Salesmen's commissions and bonuses.
Traveling expenses of salesmen (including entertainment of customers).
Sales office expenses.
Cost of samples.
Freight-out.
Trucking and delivery expense.

Freight-in on returned sales.
Warehousing and storage, subdivided as:
Heat, light, and power.
Depreciation, taxes, and insurance.
Labor.
Clerical.

The selling expense budget, like the advertising expense budget, raises the problem of determining the most profitable expenditure. Some items of selling expense can be increased with profit to the company; but, beyond a certain point, additional expenditures are not justified by the increase in sales. The selling expense budget is prepared by the sales manager and revised or approved by the budget committee.

Administrative Expense Budget. This budget is prepared by the controller or possibly the office manager, depending upon the nature of the organization. It includes the estimates for the expenses of the accounting, statistical, credit and collection, and general administrative offices. Bad debts expense is also included under this heading. The general administrative expenses do not vary in proportion to changes in the volume of sales. Because of the familiarity of the controller or office manager with operating methods and statistical reports, the administrative expense budget is usually subjected to little revision by the budget committee.

Cash Budget. From the other budgets, together with certain supplementary information, an estimate of cash receipts and cash disbursements is prepared. To the balance of cash and marketable securities on hand at the beginning of any month are added the cash receipts and cash sales, accounts and notes receivable, dividend and interest income, proceeds of long-term financing, sales of property, and other sources. In this estimate, allowance is made for the time allowed customers in making payment on credit sales and also for cash discounts. In the estimate of cash disbursements, allowance is made for the variations between the expenses for each month and the cash disbursements. For example, bad debts and depreciation, although expenses, are excluded from the estimates of cash disbursements. Insurance, taxes, and royalties appear in the monthly expense estimates but are not paid on a monthly basis. The monthly forecast of cash might be prepared as follows:

MONTHLY CASH FORECAST

Balance at beginning of month (cash and marketable securities)	.....
Receipts:	
Cash sales	.....

Collections of accounts receivable	.....	
Collections of notes receivable	.....	
Sales of properties	.....	
Total		.....
Total Balance and Receipts		.....
Disbursements:		
Expenses	.....	
Income taxes	.....	
Plant facilities	.....	
Interest	.....	
Dividends	.....	
Other	.....	
Total		.....
Balance at end (including marketable securities)		.....
Additional requirements:		
Cash required, to be borrowed from banks	.....	
Available for payment of bank loans and other purposes	.....	

Estimated Financial Statements. The budgets thus far described make it possible to prepare an estimated profit and loss statement for the coming year and an estimated balance sheet showing the financial position at the end of the year. The estimated statements are prepared with the aid of a device known to accountants as a "work sheet." In the first two money columns are entered the ledger account balances as of the beginning of the year. The summarized budgets for the year are then entered as a series of adjustments. For example, the amount of sales on account is entered as an increase in Accounts Receivable and an increase in Sales. The collections of accounts receivable are entered as an increase in Cash and a decrease in Accounts Receivable. Expenses paid in cash, as shown in the expense and the cash budgets, are entered as Expenses and as a decrease in Cash. This procedure, which is familiar to all accountants, is continued until the information shown in all the budgets has been entered. From the estimated financial statements prepared in this manner, the budget committee can see the total effects of the proposed program.

Operating the Budget. The preparation of the budget is the first important step in the budgetary program. The success of the program requires careful follow-up and enforcement. The accounting department should establish an account classification corresponding to the form of the budget estimates. An account should be opened for each budget allotment, and all expenditures should be classified and entered to show the total expenditure under each classification. Monthly reports should be prepared by the accounting department to show for each income or expense item (1) the amount for the current month, (2) the amount for the same month last year, (3) the budget estimate, and (4) the amount for the current month over or under the budget.

Such reports should be prepared soon after the close of each month; and copies should be furnished to department heads, foremen, and other persons in the management.

All significant variations from the budget should be investigated to determine the cause. Some variations may be due to salary or wage changes authorized by the management or to changes in the cost of supplies in the market. Others may be caused by inefficiency. All executives, including the foremen, should be given some incentive to encourage them to meet the budget estimates. The reward might consist of a word of praise, a letter of commendation, a higher merit rating, or a monetary bonus. The budget will fail if executives learn that no recognition is awarded for meeting the estimate and no penalty is given for exceeding it.

Advantages of a Budget. When properly operated, the budget should improve management methods in many respects. Executives give careful attention to various possible courses of action and choose the course which will result in the greatest benefit. Errors in management are discovered and corrected.

The program of various departments is kept in balance. Expansion and increased expenditures are authorized for departments which can use the additional funds to best advantage. Departments which are overexpanded may be curtailed, and executives who are not properly placed may be transferred or given training to improve. The activities of the business, such as finance, purchasing, production, and sales, are properly co-ordinated. Co-operation between departments is encouraged.

The executives acquire a greater knowledge of the business and of other persons within the company. Information is made available for the rating of foremen and other executives. A proper method of approach to business problems is developed within the organization. Executives learn to give careful study to any situation before rendering a decision.

Limitations of the Budget. Budgets have not always been regarded as successful. The failure of budget programs has usually been due to poor management. The difficulty has been that too much was expected in too short a time with too little attention by executives throughout the organization. Not much can be expected when the department heads prepare the budget by taking last year's figures and changing them a little to make them look reasonable and when the current year's reports are merely prepared and filed away. The budget should not be regarded as a time-consuming device or as just another

report. It should be regarded by all executives as essential to the success of the enterprise. The full benefits should not be expected immediately. The value of the budget will increase with experience.

QUESTIONS

1. In what respect is the budget a financial standard?
2. How is the budget used to maintain balance between the various departments?
3. Which departments or activities are frequently budgeted even though a complete budget is not prepared?
4. What budgets are prepared in terms other than dollars and cents?
5. It has been said that the flexible budget makes possible the separation of business forecasting and financial planning. Explain how this is possible.
6. Why is the year a common period for business budgeting? What budgets may be prepared for a longer period of time?
7. Should the chief executive assume responsibility for the final approval of the budget, or should this responsibility be placed on the controller?
8. What is the advantage of the budget committee?
9. Which is the first estimate to be made? What information should be available for making the estimate of sales?
10. What is the relation of the number of units to be sold to the number of units to be produced?
11. What is the relation of the purchases budget to the production budget?
12. What is the relation of the plant and equipment budget to the production budget?
13. What use is made of the labor budget?
14. What is included in the estimate of manufacturing expenses?
15. Does the amount to be spent for advertising depend upon the amount of the sales, or do the sales depend upon the amount to be spent for advertising?
16. What are general administrative expenses? Who is responsible for the budget of administrative expenses?
17. How does the cash receipts budget differ from the sales budget?
18. How does the cash disbursements budget differ from the expense budgets?
19. How can an estimated profit and loss statement be prepared from the various budgets?
20. What is a master budget?

CASES

90. BUDGETING MANUFACTURING COSTS

A shirt manufacturing company makes two product lines, which are designated as dress shirts and fancy shirts. Budget plans are made by conferences

between top executives, including the vice-presidents in charge of manufacturing, sales, finance, merchandising, and purchasing. For the six months beginning on September 1, the budget committee has estimated that the company can make and sell 12,400 dozen dress shirts and 10,000 dozen fancy shirts.

The cost of materials and supplies for dress shirts is estimated to be $1.00 per shirt, and the cost for fancies is estimated at $1.25. Workers are paid on piece rates, which total 75 cents per shirt for either type of shirt. Manufacturing expenses are estimated to be one third of labor cost, or 25 cents per shirt. Selling and general administrative expenses are estimated at $80,000 for the period of six months.

The dress shirts are sold to retailers for $2.50 each and the fancies at $3.50.

Required:

Prepare a statement to show the estimated results for the six-month period.

91. DESIRABILITY OF A BUDGET

Ritchey and Mansfield operate a plumbing and heating contracting business. They install equipment in residences, office buildings, apartments, and other structures on contract. They maintain a storeroom of heating and plumbing supplies which averages about $50,000. Some supplies are purchased for each contract, and some are drawn from the regular stock. Last year, their contracts totaled $325,000. Materials and supplies cost $140,000 for the year. The average number of employees on the payroll was 25, and labor cost was $120,000. Expenses, not including salaries of the partners, were $31,000.

The partners have never prepared a budget. Plans are made from one month to the next, and bank loans are arranged as they are needed. Repayments of loans are made when money is available, and renewals of loans are arranged if funds are not available for payment. Mr. Ritchey believes that substantial economies could be realized by the use of a budget of income, expenses, and costs and also cash receipts and disbursements. Mr. Mansfield is unable to see any advantages of a budget in a business of this kind. He thinks that the firm must take business when it can get it and that planning would be too uncertain to be of any value.

Required:

Explain the advantages of a budget in this kind of business.

CHAPTER XLII

CONTROL THROUGH COSTS

COST accounting is one of the major techniques for managerial control of business. It furnishes some of the most significant information for the formulation of business policy. The discussion of cost information in the present chapter is designed to show the way that cost is determined and also the uses that may be made of the cost figures. It is not intended to indicate the detailed methods of organizing and operating a cost accounting system.

Purposes of Determining Cost. Cost information is not to be regarded as mere historical data. The purposes of determining costs have been classified under four main heads, as follows:[1]

Determine the Value of the Inventory. This information is necessary to the preparation of the balance sheet and the profit and loss statement. Although this is an important purpose of cost determination, it should not be regarded as the main purpose.

Determine the Selling Price of the Product. Cost information is used in determining selling prices when a company must bid on a contract without knowing what the bids of others will be. Cost information also affords a valuable check on the determination of the selling price of one size or grade of a line of products in relation to the prices of other sizes or grades in the same line. However, the product must usually be priced in relation to prices asked by competitors for similar products in the market. A manufacturer cannot ordinarily fix his selling price by computing his cost and adding what he regards as a fair margin of profit.

Eliminate Unprofitable Items. When management finds from its cost data that certain products are being sold at a loss or at a small

[1] Perry Mason, "Some Fundamentals of Cost Accounting," *Bulletin of National Association of Cost Accountants*, Vol. XXVI, No. 15 (1945).

margin of profit, it may be able to discontinue their production and to concentrate on the profitable items. Even though the unprofitable items may be continued in order to retain the profitable business, management is in a position to put its major sales effort behind the profitable items. The same considerations apply to unprofitable sales territories or branch offices.

Increase Efficiency. Cost information is designed to inform management of the departments or the manufacturing processes where costs are excessive and to permit the proper steps to be taken to eliminate waste and to increase efficiency. It should provide the data to permit management to determine whether material costs are excessive because too much material was used or the purchase price was too high; whether labor costs are out of line because the worker spent too much time on the job; or whether processing costs in the manufacture of any product are more than they should have been.

Kinds of Cost Systems. Cost systems are of several kinds because the needs of businesses and industries differ. The two principal types of cost systems are, first, the process cost system which is used in continuous-production or mass-production industries and, second, the job-order or production-order cost system which is used in diversified industries.

The process cost system is used to determine the cost of operating each department or each process in manufacture. The average cost at each stage of production is then determined by dividing the cost of operating the department by the number of units produced. Total average cost per unit is determined by adding the average costs at the various stages of production or the average costs in each department. For example, raw suger is refined by a series of steps, which start with removing molasses, reducing the crystals to syrup for purifying, filtering, crystalizing, cleansing, drying, and packaging. Because the sugar flows continuously from one operation to the next, costs can be figured only by dividing the cost of each operation by the number of pounds processed. Similar methods of computing costs are used in such industries as food processing, bread baking, and soapmaking.

The production-order cost system is designed to determine the cost of each unit or each lot of product manufactured. This system is usually preferred to process cost accounting, provided that separate costs can be determined without too much clerical expense. The method is especially suited to companies making products of large dollar cost to the specific order of customers. Examples of such products are bridges, buildings, industrial filters, and ships. It is also used

by manufacturers who make a large quantity of items of relatively low unit cost to the order of the customer, such as books, shirts, dresses, glass or tin containers, and machine parts. In some cases, production-order cost accounting is used to determine the cost of items manufactured for stock. The discussion throughout the remainder of the present chapter will relate specifically to the production-order cost system.

Production-order cost systems are not all operated in the same manner. The types of such systems are as follows:

1. A *historical cost system* shows the actual costs during the present or the preceding month or year.

2. A *standard cost system* shows the cost of the product according to a predetermined standard and the amount by which actual cost differs from the standard. The standard costs may be recorded in the accounting records; or the actual or historical costs may be recorded in the accounts, and the standard cost may be used only for comparative purposes. Standard costs are sometimes called "predetermined costs."

3. An *estimated cost system* shows the costs as estimated by management and the amount by which the actual historical cost varies from the estimate. Estimated costs are usually recorded in the accounting records. Estimated cost differs from standard cost in that the estimated cost is what management thinks the cost actually will be, while the standard cost is what the cost would be if all waste could be eliminated and no mistakes were made by workers or management.

Elements of Manufacturing Cost. The manufacturing cost of any product is the sum of three elements — materials, labor, and manufacturing expenses.

Material cost is the cost of purchased items entering into the product and becoming a part of it, such as the lumber in a table or the steel in a rail. Materials are to be contrasted with supplies, which are used in the factory but do not become a part of the product.

Labor cost is the amount paid workers whose time is spent in fabricating, transporting, painting, finishing, polishing, assembling, or otherwise working directly on the product. The time spent on a task can be clocked, and the amount of the labor cost to be charged to the product can be definitely determined. Material cost plus labor cost equals total prime cost or direct cost.

Manufacturing expenses include those costs which are not incurred for the benefit of any one production order or unit of product. They are incurred for the benefit of the entire factory or possibly for the benefit of some one department. Because manufacturing expenses can-

not be identified with any one production order or any specific units of the product, they must be prorated as a cost of the various units manufactured. Manufacturing expenses were listed in the preceding chapter in the discussion of the budget.

Determining Material and Labor Cost. The cost of material and labor to be included in the cost of a production order is not particularly difficult to determine. When materials are requisitioned from the storeroom, the number of the production order is indicated on the requisition. After the cost has been entered by the balance of stores clerk, the requisition is forwarded to the cost accounting department, where the amount is entered on a cost summary, or cost sheet, which is kept for each production order. The quantity of material used in production is definitely known; and the unit cost of the materials may be determined from the balance of stores record by the first-in, first-out method, by the last-in, first-out method, or by the moving-average method.

Labor cost is determined from a labor time ticket, which is prepared in the department where the work is done. The ticket shows the time the work was started, the time when the work was completed, and the elapsed time. The payroll section of the cost accounting department determines the labor cost by multiplying the time taken by the labor rate per hour, or by multiplying the number of pieces by the rate per piece. The principal difficulty in determining labor cost is in deciding the method of entering such items as social security taxes for direct labor, bonus paid for overtime and holiday work, paid vacations, provision for pensions and retirement, and payments for idle time due to delays in production. Although such items are theoretically a part of direct labor cost, many companies treat them as manufacturing expenses. The method of charging them to expense is easier and simpler because manufacturing expenses are not charged to any product but are allocated over the various products. Such expenses as payments made during vacations cannot readily be charged against any one product or the order of any one customer.

Purposes of Manufacturing Expense Accounting. A large part of the difficulty in cost accounting arises in dealing with manufacturing expenses. This fact can be seen from the objectives in accounting for manufacturing expenses. One objective is to determine the total of each class of manufacturing expenses, such as supplies, indirect labor, supervision, depreciation of machinery and equipment, property insurance, and heat, light, and power. This information is valuable to the

management in comparing expenses from month to month or from year to year. It is also used in the preparation of the profit and loss statement.

Cost accounting reports should also show the amount of expense incurred by each department, both line and staff. This information is necessary in order that each department may be held accountable for its expenses. The classification of expenses by departments is also necessary to the operation of a budget. In cost accounting, the two types of departments are usually called "manufacturing departments" and "service departments."

Another purpose of expense accounting is to determine the cost of service rendered by each service department. Such departments as standards and methods, personnel, safety, repairs and maintenance, production control, inspection, and power do not manufacture the product directly. They assist in its manufacture by rendering a service to the manufacturing departments. After the cost of operating such a department has been determined, the cost of the service rendered to each manufacturing department is computed. The total cost of operating each manufacturing department is the sum of the expenses incurred within the department and the apportioned charges. For example, the cost of operating the assembly department is the sum of the expenses incurred in the department plus the costs of the services rendered to it by the various staff or service departments.

Cost accounting should determine the amount of expenses of each manufacturing department that should be charged against each unit or each batch of the product passing through the department. Since the expenses of the department are incurred for the benefit of all units of product fabricated in the department, the amounts must in some manner be apportioned to the various units. This is the most difficult problem in cost determination.

The Allocation of Service Department Expenses. After the expenses of the service departments have been determined for any month or other period of time, they are allocated or apportioned to the manufacturing departments on some basis which is a measure of the actual cost of service rendered. For example, the total power cost may be apportioned on the basis of the amount of power consumed as determined by meter. Factory lunchroom expense in excess of income from meals is apportioned on the basis of the number of employees in a department. Repair and maintenance expenses are apportioned on the basis of actual cost of the repairs as determined by the cost of the materials or parts used and the wages paid to repairmen. In case no

other basis for apportionment is available, the expenses of a service department are apportioned on the basis of number of employees or the number of labor hours in the manufacturing departments.

The allocation of service department expenses to manufacturing departments is complicated by the fact that some service departments render services to each other. For example, employees from the power plant use the facilities of the plant cafeteria; and the plant cafeteria uses heat, light, and power from the power plant. The total expenses of each service department include a part of the expenses of the others. This problem is handled in one of three ways, as follows:

1. Disregard the cost of any service rendered by one service department to another, and apportion the total expenses of each service department directly to the manufacturing departments.

2. Distribute first the expenses of a service department which renders service to the greatest number of service departments and receives the least service from the others. Part of the expenses of such a department would be charged to manufacturing departments, and part would be charged to other service departments. From the remaining service departments, select the one which has served the greatest number of others and has received the fewest services; and distribute the expenses in the same way. Proceed in this manner until the expenses of all service departments have been distributed. The expenses of the last service department will be distributed entirely to the manufacturing departments, since no expenses are charged back to the service departments whose expenses have been distributed.

3. Proceed as by the second method with the difference that, when the expenses of the second service department are distributed, some of the expenses may be carried back to the first department, provided it was benefited by services rendered. When the expenses of the third service department are distributed, some of the expenses may be carried back to the first two departments, provided they received services from the third department. When the expenses of all service departments have been distributed, the procedure will have to be repeated because new undistributed balances for the various service departments have been created. This process is continued as many times as necessary to reduce service departmental balances to small amounts. Any remaining balances are then carried directly to the manufacturing departments, and any service rendered by one service department to another is disregarded.

Allocation of Expenses to the Product. The total direct and apportioned expenses of a manufacturing department are allocated to the

product manufactured in that department. This apportionment may be made in any one of several ways, such as the following:

Labor Costs. The total manufacturing expenses of a department are divided by the total labor cost to determine a ratio or a percentage. This percentage is applied to the labor cost of a production order to determine the expense to charge as a part of the cost of the order. For example, if the expenses of a department total $15,000 and the labor cost is $20,000, the expenses amount to 75 per cent of the labor cost. If on a given production order the labor cost is $80, the manufacturing expense would be $60.

Labor Hours. The manufacturing expense is divided by the number of labor hours to determine the cost per hour. The number of labor hours spent on any production order multiplied by cost per hour gives the total manufacturing expense to be charged against the order.

Machine-Hours. The expenses of each department are apportioned to the various machines or workplaces to determine the cost of operating a machine for a month. The cost for the month divided by the number of hours equals the cost of operating the machine for one hour. The number of hours the machine is operated in work on a production order multiplied by the cost per hour equals the total expense to be charged against the order. Because the workplaces may consist of benches or other spaces rather than machines, this method is sometimes called the "production-center method."

Material Cost. The total material cost is divided by the manufacturing expenses to determine the percentage. The material cost on any production order multiplied by the expense ratio equals the expense to be charged against the order. This method has very limited application.

Prime Costs. The total of the labor and material costs is divided by the manufacturing expenses to determine the ratio which is used in charging expense to each production order. When this method is used, a separate rate is usually not computed for each department, but one over-all rate is computed for the entire plant.

Unit Cost. The total expense of a department divided by the number of units produced equals the expense per unit. The number of units in a production order multiplied by the expense per unit equals the expense to be charged.

The most accurate method of allocating manufacturing expenses is the machine-hour method because it results in charging the expenses to the product solely on the basis of processing time and the costs incident to time. Other methods indirectly allow for time, but the amount of the expense charged to any product is affected by other factors.

For example, the labor-hour method is related to time but is not directly related to processing costs because it does not allow for the cost of operating the machine. The labor-cost method results in a charge which is dependent upon the number of hours of labor, but the expense charge is also affected by the wage rate of the worker. However, the labor-cost method is often used because it requires less clerical expense than most other methods.

Seasonal Variation in Production. If all the expenses in any month are apportioned to the product manufactured during the month, the cost per unit will vary because expenses do not vary directly with volume. A unit cost which varies from one month to another because of varying rates of production is not usually considered a true cost. The effect of seasonal variations upon cost is eliminated by computing the cost over a longer period, such as a year. The total manufacturing expense for the year is apportioned to the units produced during the year by one of the methods previously explained.

Predetermined Expense Rate. The most accurate method of computing the overhead expense to charge as a part of the cost of a production order might be to wait until the end of the year when the total expense and the total production would be known. However, management cannot wait until the end of the year to know the cost. Therefore, the expense and the production are usually estimated in advance; and a predetermined expense rate is computed at the beginning of the year. This rate is used throughout the year to determine the proper amount of expense as each order is completed.

When a predetermined expense rate is used, the amount of expense apportioned to all production orders probably will not exactly equal the actual expense. If the actual expense exceeds the amount apportioned, the difference is the underapplied expense. This is usually regarded as the cost of idle time or as a loss due to the low volume of production. However, some accountants recommend that the underapplied expense be apportioned to all production orders completed during the year by computing a supplementary rate of expense apportionment.

If the expense entered as a cost on the various production orders exceeds the actual expense, the difference is the overapplied expense. Since the cost is overstated in comparison with actual expenses, the difference is usually treated as a deduction from the total cost of goods manufactured. However, it would be possible to recompute the cost of the various production orders.

Normal Rate of Output. In the preceding paragraphs, it has been assumed that the predetermined expense rate is computed on a basis which was intended to apportion the total expense over the production for a year. This method of computing costs would cause the cost per unit to fluctuate with changes in the volume of production from one year to another. To illustrate, assume that a company manufactures only one product. The production, the manufacturing expense, and the manufacturing expense per unit over a period of five years have been as follows:

Year	Number of Units Produced	Manufacturing Expense	Manufacturing Expense per Unit
1	50,000	$ 760,000	$15.20
2	60,000	780,000	13.00
3	90,000	810,000	9.00
4	70,000	784,000	11.20
5	50,000	760,000	15.20
Total	320,000	$3,894,000	$12.11

If the material and labor cost remain unchanged at $20 per unit, the total cost each year would be as follows:

Year	Material and Labor Cost	Expense (per unit)	Total Unit Cost
1	$20.00	$15.20	$35.20
2	20.00	13.00	33.20
3	20.00	9.00	29.00
4	20.00	11.20	31.20
5	20.00	15.20	35.20
Average	$20.00	$12.11	$32.11

This illustration shows that the unit cost decreases with an increase in the rate of production and increases with a decrease in the rate of production. Cost figures which fluctuate in this manner may be misleading to the management. Therefore, the cost per unit may be figured on what is considered to be a normal or an average rate of output. In the illustration given, the average manufacturing expense per unit might be assumed to be $12.11; and the total cost per unit each year might be considered to be $32.11. Over the five-year period the total expense charged on all orders would equal the actual expense, although in some years the expense would be overapplied and in other years it would be underapplied.

The normal rate is determined by selecting some year which is considered normal or average. The manufacturing expense per unit in that

year is used as the expense per unit each year. If expense is distributed by the labor-cost method, the normal rate is computed by determining the ratio of manufacturing expense to labor cost in the normal year.

The unit cost of the product as determined by the methods described should be regarded as estimated rather than as exact. Such a unit cost can be of much value to management, provided that its limitations are recognized.

Standard Cost. Management should have a standard for judging whether costs are low or excessive. Costs in a prior month or year do not constitute a satisfactory standard because they may mean no more than a comparison of efficiency this year with efficiency last year or a comparison of inefficiency with inefficiency. A standard cost would indicate the following:

For materials:

The standard quantity of materials to be used in the manufacture of the product, provided there is no waste. The excess of materials used is called a "material quantity variance."

The price of the materials, provided the proper grade of materials is available and purchases are made in the most economical quantities. The excess in price paid for materials is called a "material cost variation."

For labor:

The standard amount of labor consumed in the manufacture of the product, provided that labor meets the standards set by the time-study man and that there are no interruptions or delays. The excess of time required is called a "labor efficiency variance."

The wage rate, provided the worker assigned to the job has just the qualifications required. The labor cost would be excessive if a highly skilled worker were assigned to a job which a lower-paid worker could do. The excess labor cost is called "labor cost variance."

For manufacturing expense:

The standard expense to be charged to each job. Manufacturing expense would exceed the standard if the worker required more machine time than was considered necessary. The excess cost of machine time is called "manufacturing-expense efficiency variation."

The total expense of a department, as stated in the budget. Any expense in excess of the budget is called "manufacturing-expense budget variation."

The number of hours a department is expected to be engaged in production during a year or perhaps a month. This standard is important because the expense charged to production depends upon the number of hours the machines are in production. If a department fails to meet the standard hours in production, its expenses should be considered as a loss from idle time rather than as a cost of the product. The cost of idle time is called "manufacturing-expense capacity variation."

Standard costs may be used merely as statistical data for comparative purposes, or they may be entered in the accounting records. If the

standards are used in cost determination, the cost of the product is recorded at standard; and any excess cost is entered in the accounts as a variance. The cost reports should show the total of each variance. The reasons for the variances should be determined, and responsibility for them should be fixed. The cost reports afford a basis for action by management.

Interest Not a Part of Cost. The unit cost as determined by the usual methods of cost accounting does not include interest paid on money borrowed or interest on the capital invested in buildings, machinery and equipment, inventories, or other assets. The question of the inclusion or exclusion of interest has been the subject of much controversy among accountants and management engineers. It is generally agreed that, even though interest is not included in the cost data, allowance should be made for interest in making many management decisions, such as the proposed purchase of a machine to replace hand labor, the purchase of an automatic machine to replace manually operated equipment, or the building of an addition to the plant. Allowance for interest can be made in each case, provided the person using the data knows that no interest has been included in cost.

Differential Cost. By differential cost is meant the increase in cost which will result from an increase in production. To illustrate the significance of differential cost, assume that a manufacturer receives an offer to purchase 1,000 units of his product for $2.50 per unit. The prospective purchaser is a chain store or mail-order house whose sales are made under private brand or trade name and do not affect the other sales of the manufacturer. The cost accountant prepares a cost summary which shows a unit cost of $3.00. The statement is as follows.

Materials ($1.00 per unit)	$ 5,000
Labor ($1.00 per unit)	5,000
Expense	5,000
Total cost of 5,000 units	$15,000
Unit cost	$3.00

This statement indicates that cost is in excess of the proposed sales price of the additional 1,000 units. The accountant is requested to show what the costs would have been if the additional 1,000 units had been produced. This statement shows a unit cost of $2.85, as follows.

Materials ($1.00 per unit)	$ 6,000
Labor ($1.00 per unit)	6,000
Expense	5,100
Total cost of 6,000 units	$17,100
Unit cost	2.85

The cost per unit is still in excess of the proposed selling price, and it therefore seems that the manufacturer should reject the offer. However, total costs are increased only by $2,100, while income is increased by $2,500. On the basis of differential cost rather than average unit cost, the proposed sale appears to afford a profit. Before the decision is made to make and sell the additional 1,000 units at $2.50 per unit, the manufacturer should consider the possible effect on the market, his ability to finance the additional production, and the possibility of legal liability under the Robinson-Patman Act, which prohibits discrimination between customers.

Total Cost. The total cost of all units produced may sometimes be as significant as unit cost. To illustrate, assume that the manufacturer mentioned in the preceding illustration produced 6,000 units at a total cost of $17,100, with material, labor, and manufacturing expense costs as previously indicated. Selling and administrative expenses amounted to $6,000. He sold the product for $3.80 per unit, which resulted in a net loss. His profit and loss statement was as follows:

Sales (6,000 units at $3.80)		$22,800
Cost of goods sold:		
Materials ($1.00 per unit)	$6,000	
Labor ($1.00 per unit)	6,000	
Manufacturing expense	5,100	17,100
Gross profit		$ 5,700
Selling and administrative expenses		6,000
Loss		$ 300

In order to avoid a loss, the manufacturer increased his selling price to $4.00. However, the higher price caused his sales to decrease to 5,000 units, with results as follows:

Sales (5,000 units at $4.00)		$20,000
Cost of goods sold:		
Materials ($1.00 per unit)	$5,000	
Labor ($1.00 per unit)	5,000	
Manufacturing expense	5,000	15,000
Gross profit		$ 5,000
Selling and administrative expenses		5,700
Loss		$ 700

The manufacturer has increased his loss by increasing his selling price. This illustration is not intended to show that an increase in selling prices is always poor policy. It indicates only that other factors besides unit cost should be considered.

Replacement Cost. In time of rising prices for materials and labor, replacement cost is a factor in sales policies. Suppose, for example, that a company has in stock 5,000 units which cost $15,000 to manufacture. If the prices of materials and wages paid to employees have increased to such an extent that the cost of replacing the goods would be $20,000, this fact should be considered in pricing.

Opportunity Cost. The management might like to know what profit was sacrificed or lost by using the semifinished products at certain stages for further processing instead of selling them. Stated in another way, management might wish to know what the final product would have cost if the semifinished product had been transferred to a later department at the prices prevailing in the market for such products.

To illustrate the meaning of opportunity cost, assume that a meat-packing plant produces dressed meats, which are used in making cured and canned meat products, at a cost of $5,000. The company could have sold the dressed meats without further processing for $5,500. In determining the profit from subsequent operations, the cost of the material might be considered to be $5,000. However, if the final profit is only $400, the last department is operated at a loss, when opportunity costs are considered. Other examples of opportunity costs are the use of a building in business when it could be rented, the devoting of the owner's time to a business when he could be earning a salary, and the use of materials by a steel company for the manufacture of fabricated products when the steel could be sold in the market. Opportunity costs do not appear in the cost reports, but they affect the decisions of management.

QUESTIONS

1. Does the cost of production per unit determine the selling price? How would the management know how much profit to add?
2. If the selling price of a product as determined by competitive conditions in the market is less than cost, what alternatives are open to management?
3. Distinguish between "historical cost," "standard cost," and "estimated cost."
4. What information does management need concerning material cost, labor cost, and manufacturing expenses as a cost?
5. Manufacturing expenses are sometimes called "burden." Is this an appropriate name for this element of cost?
6. How can the expenses of such departments as employment, employee training, purchasing, and building maintenance be included as a part of the cost of the product when many different kinds of commodities are manufactured?
7. When the total expenses of a manufacturing department have been deter-

mined, how can the expenses per unit of product or for any production order be determined?

8. It has been said that the cost of a production order cannot be accurately determined but can only be estimated. Show why this is true.
9. What is meant by a predetermined expense rate? Why is it usually necessary?
10. What is meant by "underapplied expense"?
11. What is meant by a normal rate of output? How is it used in cost determination?
12. What uses are made of standard cost?
13. A manufacturer is considering the purchase of a new machine to replace an old one now in use. He has the money to pay for the new machine in cash. Should interest be included as part of the cost per unit in the computations of cost with the old and the new machine?
14. What is meant by "differential cost"? Under what conditions is differential cost important?
15. What is meant by "replacement cost"? Should a manufacturer disregard replacement cost in estimating the amount to be bid on a contract?
16. What is meant by "opportunity cost"? Is it important to management?

CASES

92. USE OF COST INFORMATION

A company that confines its business to the publication of college texts on business subjects is considering the suitability of a text that would be used only for advanced courses in a few institutions. The sales manager has submitted an estimated sales volume of 2,000 copies over a period of four years at $4.00 per copy. Sales after four years are considered problematical because of possible competing books that might be published during the period.

The controller has submitted a cost estimate, which shows that the cost of producing and selling the new book would be $9,450. Costs include the following items: editorial work, preparation of drawings and charts by the art department, advertising, sample copies to instructors and professional magazines for review, contract price paid to a printing company for printing and binding, royalties to the author, a prorata amount of the cost of maintaining branch sales offices, a prorata share of the home office expense including rent and executive salaries, and a prorata amount of the traveling expenses and other expenses of salesmen who visit schools and colleges in promoting the sales of all books published by the company.

The sales manager has questioned the inclusion of some of the cost items for purposes of deciding whether to accept a manuscript for publication. He believes that an item of expense that would be incurred regardless of whether any one manuscript would be accepted should not be included in the cost. He would include only those costs and expenses that are incurred as a result of the publication of the manuscript.

The cost estimate has been revised by the sales manager to include only the contract price of printing and binding, royalties, the cost of the copies for free distribution, and advertising. These costs total $7,200, and he thinks the manuscript should be accepted.

The controller objects to the revised cost statement. He says that any cost computation that excludes any element of cost is incomplete and misleading. He believes that the company should decline to publish the manuscript.

Questions:

1. Should all elements of cost be included?
2. Should the company publish the manuscript?

93. PLACE OF THE COST ANALYST IN THE ORGANIZATION

The management of a metal and fiber container manufacturing company found that the profit ratio was declining because of the increasing cost of materials. The controller obtained permission from the president for the employment of a cost accountant in his division, to be given the title of cost analyst. The duty of the cost analyst was to study cost ratios and point out to the foreman of any department the reason for any cost that was out of line. It would then be the responsibility of the foreman to take appropriate action.

The cost analyst found that, under instructions from foremen, workmen in the slitting department were using sheets of metal carrying a heavier coating of tin than was necessary for the manufacture of certain types of cans. For example, sheets that had been purchased for the manufacture of cans for peaches were used in making oil cans or paint cans. The cost was increased because the sheets carrying a heavier coating of tin cost more per square foot. The waste in each sheet was also increased because the sheets had been designed for the cutting of a different size of can.

The cost analyst reported his findings to the foreman of the slitting department for action. The foreman stated that he was under pressure from the plant superintendent to get out the work and that he had to use such material as was available. Furthermore, he politely informed the cost analyst that he took orders from no one other than his own superior officer, the plant superintendent.

The cost analyst reported this situation to the controller and asked for further instructions. The controller was sure that the situation called for corrective action, but he could see no advantage in talking to the foreman himself. He decided to transmit the information to the president of the company for such action as the president might wish to take.

Questions:

1. What was wrong with the original plan for finding and eliminating excessive costs?
2. Was the controller right in taking the matter to the president?
3. Might the situation have been handled by the controller and the plant superintendent?
4. Did this situation indicate that the planning and purchasing programs should be revised?

INDEX

INDEX

A

Ability to pay, 349
Absenteeism, 103
Accident costs, 485
Accident frequency rate, 496
Accident investigation, 494
Accident prevention, 107
Accident proneness, 492
Accident severity rate, 497
Accidents
  allowance for, in time study, 329
  causes of, 488
  definition of, 485
  prevention of, 488, 493, 559
  reporting of, 494
Accumulative timing, in time study, 320
Accuracy, standards of, 82, 255
Administrative expense budget, 637
Advertising expense budget, 636
Aggressive interview, 445
Air
  cooling of, 219
  filtering of, 221
  heating of, 218
  movement of, 222
Air-conditioning systems, 219
Allowances, in time study, 328
Alphabetical filing, 531
Alternating current, 175
American Can Company
  organization of, 50
  research program of, 241
American Management Association, 26
American Society of Mechanical Engineers, 76, 241
American Society for Testing Materials, 241
American Standards Association, 268, 495, 527
Analytical processes, 190, 611
Annual improvement factor, 350
Annual reports to employees, 109
Annual wage, 359
Application, letter of, 444
Application blank, 443
Applied research, 238
Apprentice training, 475
Aptitude tests, 449
Area Development Division, 133
Arithmetic average, in time study, 325
Assemblies, scheduling of, 538, 615
Assembly industry, 190, 579
Authority
  centralized, 66
  delegation of, 61, 77
  levels, 48
  local, 41
Autocratic leadership, 9, 73
Automatic inspection, 279
Automobile, assembly of, 618
Average time, 325

B

Badges, for employees, 112
Balance
  in layout, 183
  in organization, 65
Balance of stores record, 541
Bargaining, collective, 431
Bargaining strength, 344
Barth, Carl G., 21
Batches, division of work into,
Bedaux plan, 366
Behind-schedule report, 607
Belonging, sense of, 108
Bias, in rating, 407
Bill of materials, 584
Bin balance, 541
Bin tag, 561
Bins, arrangement of, 548
Blocks, glass, 210
Bloomfield, Meyer, 21
Bonus, Christmas, 380
Bow-type roof, 149
Boyle, James M., 25
Brick, paving, 261
Brick building, 145
Brick floors, 148
Bricklaying, 14
Broadcasting systems, 227
Budget
  advantages of, 639
  limitations of, 639
  operation of, 638
  preparation of, 630
  research, 245
Budget officer, 630
Budget period, 629
Budgeting
  organization for, 630
  purposes of, 627
  relation to management, 629

Building
appearance of, 151
construction of, 145
maintenance of, 153
multistory, 143
relation to air conditioning, 149, 223
relation to layout, 142, 189
relation to lighting, 149, 209
relation to operating costs, 141, 143
single-story, 142
standard design of, 142
Building construction, trend in, 152
Building costs, 127
Building plan, 141
Buildings, number of, 144
Built-in safety, 151
Bulletin board, in dispatching, 604
Bumper, height of, 267
By-products, 127

C

Cafeteria
planning in, 571
plant, 505
Caliper, in inspection tests, 283
Cantor, Nathaniel, 511
Carbon dioxide, in air, 222
Cash forecast, 636
Catalogues, filing of, 531
Central tendency, 406
Centralized planning, 576
Centralized purchasing, 523
Charter, industrial relations, 428
Charts, use of, in inspection, 280
Checkoff, 432
Chemical composition, inspection for, 286
Chiseler, 111
Christmas bonus, 380
Civic values in plant location, 128
Classification, systems of, 549
Clerical aptitude test, 450
Climate, in plant location, 127
Closed shop, 432
Clothing, relation to accidents, 489
Clubs, employee, 503
Collective bargaining, 431
Color
effects of, 214
in design, 251
inspection for, 287
of light, 207
purposes of, 213
relation to lighting, 207
of walls, 210, 214
Color distinction, 287, 450
Color schemes, 213
Commercial standards, 264
Committees, use of, 50
Commodity Standards Division, 264
Commodity theory of wages, 243
Communication, 61, 92, 107, 197, 393
Company housing, 131
Company stores, 506
Company town, 131
Company union, 30
Comparator, in inspection tests, 285
Complaint, definition of, 93
Complete budget, 627
Concrete floors, 148
Conflict, labor-management, 426
Consultant in management, 25
Consumer complaints, prevention of, 275
Consumers' ideas, in design, 253
Containers, research in, 238
Continuous manufacturing, 612
Continuous-process industries, 190
Continuous production, 611
Continuous-run method of time study, 319
Contracts, long-term, 530
Control
functional, 50
line, 50
Control charts, 280
Control group, 29
Conversational interview, 445
Co-operation, labor-management, 428
Co-operative store, 506
Co-ordination, in organization, 67, 89
Corporation, organization of, 40
Corporations, research by, 239
Correction factor, 328
Cost
differential, 652
elements of, 644
estimated, 133, 644
historical, 644
opportunity, 654
process, 643
relation of, to price, 633
replacement, 654
standard, 651
total, 653
Cost information, use of, 644
Cost-of-living wages, 347
Cost of materials handling, 165
Cost systems, 643
Cost and time clerk, 55
Cost of unemployment, 176
Counseling, of employees, 510
Craft distinctions, 360
Credit unions, 510
Criteria, wage, 345
Cubical storing, 562
Cycle method, in time study, 320

D

Daily run sheet, 618
Daily runs, scheduling of, 617
Day rate
  advantages of, 356
  disadvantages of, 357
  measured, 358
Decentralization
  of industry, 129
  of organization, 41, 130
Decentralized planning, 576
Decentralized purchasing, 523
Decentralized scheduling, 599
Defective work, allowance for, in time study, 329
Defects, correction of, 276
Degrees
  in job evaluation, 388
  in merit rating, 400
Delay, allowance for, in time study, 329
Delegation of authority, 61, 77
Deliveries, scheduling of, 615
Democratic leadership, 74
Demotion, 464
Dennison, Henry S., 21, 24
Depreciation of machines, 172
Design of product
  features of, 249
  phases of, 249
  problems of, 250
  in a small company, 256
Development research, 238
Dexterity test, 450
Differential cost, 652
Diffusion of light, 207
Dimensions
  inspection for, 283
  standards of, 255
  variances in, 255
Direct current, 175
Direct leadership, 73
Direct lighting, 211
Discharge of employees, 465
Discipline, 466
Dispatching, 571, 602, 620
Dissatisfaction, 93
Distance judging, 450
Diversity of product, 262
Dunnage, 548

E

Economic changes, 134, 140
Edison, Thomas A., 267
Efficiency men, 27
Efficiency wage, 374
Effort rating, 328
Element times, 318, 325
Elements of a task, 298
Emerson, Harrington, 21, 23
Emerson efficiency wage, 374
Employees
  comfort of, 150
  counseling of, 510
  education of, 109
  handbooks for, 421
  opinion surveys of, 113
  publications for, 504
  questionnaire for, 113
  rating of; *see* Merit rating
  selection of, 27, 440
  services for, 500
  training of, 27
Employers' liability, 486
Employment agencies, 441
Employment department, 24
Employment procedure, 440
Engineering
  departments of, 91
  emphasis on, 28
Equipment, inspection of, 489
Equipment budget, 634
Escalator clause, 530
Estimated cost, 133
Estimated financial statements, 133, 638
Examination, physical, 452
Exception principle, 76
Exceptional observations in time study, 324
Executive capacities, use of, 64
Executives, training of, 80
Expansion of plant, 143
Expendable pallets, 171
Expense
  allocation of, 646
  applied, 649
  manufacturing, 635, 644
Experimental group, use of, 30
Eyestrain, 206

F

Factor-comparison method, 386
Factory board, 51
Factory float, 617
Factory layout; *see* Layout
Fair Labor Standards Act, 32
Farming out, 570
Fatigue
  allowance for, in time study, 329
  relation of color to, 214
  relation of monotony to, 230
Fatigue study
  by Gilbreth, 16, 230
  by Taylor, 8, 230
  by Western Electric Company, 29, 232
Federal Trade Commission Act, 32
Federated Engineering Societies, 264
Feiss, Richard A., 21, 471

Filing systems, 531
Filtering of air, 221
Financial aids
  to employees, 502, 508
  in plant location, 127
Financial plan, 627
Financial rewards, 83
Financial standards, 82
Financial statements
  estimated, 133, 638
  relation to plant location, 133
Fire hazard, 146
Fire loss, 557
First-class worker, Taylor's, 6, 10
First-in, first-out method of pricing, 542
Flat roof, 149
Flexible budget, 629
Float, factory, 617
Floor inspection, 282
Floors, types of, 148
Flow process chart, 192
Fluorescent lighting, 213
Follow-up, in production control, 606, 620
Foot-candle, 207
Foremanship, functional, 52
Foremen
  co-operation by, 89
  part of management, 87
  rating of, 404
  recognition of worker by, 111
  relation to personnel department, 92, 416
  relation to production control, 576
  responsibility of, 44, 88
  training of, 94, 478
  unions of, 97, 435
  work of, 44, 87
Formal questioning interview, 446
Forms, in production control, 586
Foundry
  air conditioning in, 222
  operations of, 584
Front line of management, 87
Front-line personnel man, 94
Fully automatic machine, 160
Fulton, Robert, 239
Functional control, 50
Functional foremanship, 52
Functional organization, 11, 52
Functional theory of wages, 344
Functions, organization by, 41

G

Gage, 284
Gang boss, 53
Gantt, Henry L.,
  attitude toward labor, 18
  contribution to cost accounting, 19
  on employee training, 472
Gantt, Henry L. — *Cont.*
  method of wage payment, 18, 373
Gantt chart, 19
Gantt task and bonus plan, 18, 373
Gases, in air, 222
General Electric Company, 76
General lighting, 211
General Motors Corporation, 245
General-purpose machines, 162
Gifts, acceptance of, 526
Gilbreth, Frank B.,
  fatigue study by, 16, 230
  motion study by, 14, 296
  study of bricklaying by, 14, 296
Gilbreth, Lillian M., 13, 16, 63, 296, 301
Glare, 206
Glass blocks, 210
Glass gage, 284
Glory chart, 460
"Go-and-no-go" gage, 278, 284
Grading interview, 446
Graphic rating scale, 402
Grievance
  definition of, 93
  handling of, 93
Group hospitalization, 502
Group life insurance, 502
Group piece rates, 367
Group solidarity, 110
Guaranteed annual wage, 359

H

Halo effect, 406
Halsey plan, 362
Handbooks, for employees, 421
Handling of materials, 165, 183
Hand-to-mouth buying, 529
Hardwood floors, 148
Harmonious relations, importance of, 427
Hathaway, H. K., 21, 330
Hawthorne experiment, 29, 111
Heating systems, 218
Historical costs, 644
Hobbing machine, 160, 296
Hopkins, Ernest M., 21
Horizontal co-ordination, 67
Hoxie, Robert F., 24
Humidity, 220

I

Illumination; *see* Lighting
Improvement factor, 350
Incandescent lighting, 212
Incentive wage systems, 371
Indirect leadership, 73
Indirect lighting, 211
Individual worth, 108
Individuals, research by, 239

Induction to job, 453
Industrial consultant, 25
Industrial relations charter, 428
Industrial relations department, 415
Industrial relations manager, 422
Information
  action based on, 83
  to employees, 61, 92, 107, 197, 393
Informer, 112
Insecurity
  of employer, 434
  of labor unions, 430
  of workers, 106, 433
Inspection
  of equipment, 489
  method of, 278
  purposes of, 275
  size of sample in, 280
  type of test in, 283
  by whom made, 278
Inspection ticket, 587
Inspector, 53, 278
Instruct, how to, 478
Instruction card clerk, 55
Insurance
  group life, 502
  surgical, 502
Intensity of light, 207
Interchangeability of parts, 275
Interest as a cost, 652
Internal faults, 287
Interruptions, allowance for, 328
Interview
  counseling, 510
  employment, 444
  exit, 466
  preliminary, 443
  types of, 445
Inventory
  kinds of, 535
  management of, 536
  quantity to manufacture, 537
  quantity to order, 529, 537
  taking of, 561
Investigation, personal, 447

J

Jethro, 77
Job analysis, 384
Job classification, 386
Job description, 384
Job differentials, 392
Job evaluation, 383
Job ranking, 385
Job shop operations, 585
Job specifications, 385
Jobs, key, 386
Johnston, Eric, 378
Junior board, McCormick Company, 51

K

Key jobs, 386
Key man in production, 92
Key materials, 530

L

Labor budget, 635
Labor conditions, in plant location, 125
Labor contract, 426, 429
Labor cost, 644
Labor-cost method of allocating expenses, 648
Labor grades, 392
Labor-hour method of allocating expenses, 648
Labor leaders, 75
Labor-management conflict, 426
Labor Management Relations Act, 31, 98, 430, 432, 433, 434, 435
Labor scouts, 441
Labor supply, 346, 440
Labor time ticket, 645
Labor unions
  attitude toward piece rates, 368
  company, 30
  demand of to "look at the books," 349
  insurance plans of, 503
  relation to job evaluation, 392
  relation to machine production, 176
Laboratory inspection, 282
Lamps, types of, 211
Last-in, first-out method of pricing, 543
Lathe, 162
Layoffs, 464
Layout
  essentials of, 183
  making of, 192
  office, 197
  process, 184
  product, 186
  purposes in planning for, 182
  relation to other problems, 189, 488, 574
  restaurant, 200
  revision of, 195
Leadership
  changes in, 75
  nature of, 73
  types of, 74
Leniency, in rating, 406
Letter of application, 444
Leveling factor, 328
Levels of authority, 48
Liability of employers, 486
Life insurance, group, 502
Light intensity, 207
Light meter, 208

Lighting
  experiments in, 205
  importance of, 205
  methods of, 211
  phases of, 206
  relation of building to, 209
  relation of color to, 213
  sources of, 211
Lighting systems, maintenance of, 213
Line control, 50
Line departments, 43
Line organization, 43
Line and staff organization, 45
Lines of promotion, 63
Living costs, 347
Localized lighting, 211
Long-term contracts, 530
Loose standard in time study, 322, 332
Loyalty, fostering of, 103

M

McCormick Company, 50
Machine capacity, 191
Machine-hour method of allocating expenses, 648
Machine loads
  changes in, 606
  report on, 595
  summary of, 607
Machine overload, 607
Machine shop operations, 584
Machines
  benefits of, 177
  design of, 159
  inspection by, 279
  laborsaving, 176
  location of, 194
  operations by, 158
  output of, 165
  parts of, 158
  replacement of, 172
  selection of, 164
  types of, 159, 162
Maintenance
  budgeting of, 634
  of buildings, 153
  of lighting systems, 213
  of machines, 634
Man-to-man rating, 400
Man in the middle, 93
Management
  access to, 110
  beginnings of, 3
  development of, 3
  front line of, 87
  information for, 83, 227
  legislation affecting, 32
  multiple, 50
Management — *Cont.*
  new methods of, 33
  principles of, 12
  scientific, 12
  task, 12
Management consultants, 25
Manual dexterity, 450
Manually operated machines, 159
Manufacturing departments, 43
Manufacturing expenses
  accounting for, 645
  budgeting of, 635
Marginal laborer, 342
Marginal productivity theory, 342
Market, nearness to, 122
Master budget, 627
Materials
  availability of, 123, 253
  cost of, 252
  effect of air on, 218
  finding of, 549
  handling of, 165, 190
  location near source of, 123
  requisitioning of, 587
  storing of, 546
  strength of, 285
  types of, 527
Maximum inventory, 537
Measured day rate, 358
Meat-packing plants, location of, 123
Mechanical aptitude test, 449
Mechanization of industry
  cost of, 176
  management policy toward, 177
  union attitude toward, 176
Median, use of, in time study, 325
Medical services, 500
Mental test, 447
Mercury vapor lamp, 212
Merit rating, 27, 34, 398
Merrick, Dwight V., 21
Merrick multiple wage, 373
Meter, light, 208
Methods-time measurement, 331
Micrometer, 283
Midvale Steel Company, 4, 17, 44, 311
Mill construction, 145
Milling machine, 163
Minimum inventory, 537
Mnemonic classification, 549
Model
  motion, 16
  of plant layout, 195
Monitor roof, 149
Monotony, 227
Moore, Wilbert E., 394
Morale
  definition of, 103

Morale — *Cont.*
factors in, 104
importance of, 103
Moses, 77
Motion model, 16
Motion study
advantages to worker, 304
contribution of the Gilbreths to, 14, 301
economies of, 304
objections to, 305
purposes of, 296
relation of, to time study, 312
Motions
improvement of, 296
principles of, 301
Motivation of workers, 104
Motor response test, 450
Move ticket, 587
Multiple machine interference in time-study allowances, 329
Multiple management, 50
Multistory building, 143
Music, for employees, 226

N

National Bureau of Standards, 241, 264
National Labor Relations Act, 31, 98, 430
National Research Council, 29, 240
National Safety Council, 487, 495
Natural laws, 19
Negroes, employment of, 106
Noise
control of, 226
effect of, 225
Nonfinancial rewards, 80, 111, 112
Normal output, 650
Normal year, 650
Norris-LaGuardia Act, 426
Numerical classification, 551
Numerical filing, 531
Nurseries, for children of employees, 512

O

Objective traits, in merit-rating, 406
Observation sheet, 316
Office layout, 197
Old-age benefits, 508
On-the-job training, 477
Open shop, 432
Operating costs, relation to building, 141, 143
Operation ticket, 585
Operations, in production, 584
Opportunity cost, 654
Optical projection, 285
Orders, issuance of, 603
Organization
attributes of, 60
Organization — *Cont.*
chart of, 46
defects in, 69
functional, 52
line, 43
line and staff, 45
need for, 39
planning of, 69
Overapplied expense, 649
Overhead conveyors, 169
Ownership, form of, 39

P

Packard Motor Company, 98
Pallet system, 177
Palmistry, 25
Partial budget, 627
Partial inspection, 280
Partnership, organization of, 40
Parts
interchangeability of, 275
scheduling of, 615
sequence of completion of, 578
Paternalistic leadership, 9, 31, 74
Paving brick. varieties of, 261
Payment of workers
by the day, 356
incentive method of, 371
piece-rate method of, 366
relation of, to morale, 104
Pegboard
use in dispatching, 604
use in scheduling, 595
Pension plans, 508
Performance tests, 451
Permanent storage, 192
Person, Harlow S., 21
Personal investigation of prospective employee, 447
Personal needs, allowance for, in time study, 328
Personnel department, 415
Phrenology, 25
Physical examination, 452
Piece rates, 366
Pig-iron handler, 8
Pilot plant, 245
Pitched roof, 149
Planning department
organization of, 582
origin of, 10
Plant budget, 634
Plant cafeteria, 505
Plant layout; *see* Layout
Plant location
factors influencing, 122, 128, 129
procedure in, 132
use of financial statements in, 133

Plant magazine, 504
Plant ownership
  advantages of, 138
  risk of, 139
Plants, number of, 41
Plug gage, 284
Point system
  of employee rating, 403
  of job evaluation, 388
Power
  influence of, in plant location, 125
  purchased, 175
  source of, 175
Preferential shop, 432
Preparation
  in continuous production, 613
  in diversified production, 602
Prime costs, 648
Printing, steps in, 584
Process chart, 16, 192
Process costs, 643
Processes, layout by, 184
Product
  rating of, 276
  simplification of, 260
  standardization of, 264
  types of, 41
  varieties of, 260
Product design, 249
Production
  estimate of, 613
  improvement in methods of, 176
  preparation for, 602, 613
  seasonal variation in, 161
  stabilization of, 360
Production control
  advantages of, 573
  phases of, 570
Production order costs, 643
Production report, 621
Production run, 618
Products
  layout by, 186
  number of, 41, 261
  organization by, 43
Professional inspection, 278
Professional societies
  formation of, 26
  research by, 239
Profile inspection, 285
Profit sharing, 377
Progressive layout, 183
Promotion
  basis of, 63, 80, 460
  lines of, 63
  for merit, 64, 399
  three-position plan of, 63, 459
  types of, 458
Promotional chart, 460
Proneness to accident, 492
Publishing operations, 585
Purchased parts, 527
Purchases, types of, 523
Purchases budget, 633
Purchasing agent, 522, 532
Purchasing department, 522
Purchasing policies, 524
Pure research, 238
Pyramid storing, 561

Q

Qualities of leadership, 75
Quality, payment for, 277
Quality control; *see* Inspection
Quantity
  to manufacture, 537
  to order, 529, 537
Questionnaire, employee, 113

R

Radiant heating, 219
Railroads, safety program of, 487
Rate buster, 111
Rating of product, 276
Reciprocal buying, 526
Recognition, desire for, 108
Recommendations, of prospective employees, 446
Recreation activities, 503
Reflector, in lighting, 211
Reinforced-concrete construction, 147
Relative bargaining strength, 344
Reorder point, 537, 540
Repair boss, 53
Replacement cost, 172, 654
Requisition
  for employment, 441
  for materials, 587
Research
  example of, 241
  pure, 238
  types of, 237
  who conducts, 239
Research budget, 245
Research laboratory, 243
Responsibility, relation to authority, 61
Rest periods, 231
Restaurant layout, 200
Restriction of output, 4, 13, 111
Retirement plans, 508
Rewards
  for course completion, 480
  nonfinancial, 83, 111, 112
  for work done, 83
Ribbons, use of, for recognition, 112

Ring gage, 284
Robinson-Patman Act, 32
Roethlisberger, Fritz J., 30
Roofs, 149
Route clerk, 55
Routing
  in continuous production, 612
  in diversified production, 582
  phases of, 570
Rowan plan, 362

S

Safety
  built-in, 151
  contests in, 494
  inspection for, 484
  instruction in, 490
  movement for, 487
  program for, 92, 493
  in small firms, 497
Safety slogans, 487
Salaries of executives, 83
Sales budget, 631
Sampling inspection, 280
Savings from machine replacement, 173
Saw-tooth roof, 149, 209
Scale model of plant, 195
Scheduling
  information necessary for, 593
  nature of, 591
  phases of, 571
  purposes of, 592
Scientific management, 12
Scientific planning, 576
Seasonal variations
  in employment, 359
  in production, 161, 613, 649
Securities Act of 1933, 32
Securities Exchange Act, 32
Security
  of employer, 434
  of union, 430
  of worker, 106, 433
Selling expense budget, 636
Semiautomatic machines, 159
Semidirect lighting, 212
Semi-works, 245
Senior board, McCormick Company, 51
Seniority, 462
Service departments, 45, 91, 185
Service industries, 127
Shipping order, 588
Shop disciplinarian, 55
Shop overage, 608
Shop shortage, 608
Shop steward, 94, 436
Shovels, study of, 6
Simplification of product
  definition of, 260
  need for, 260
  program of, 262
Single-story building, 142, 209
Skill of worker, allowance for, 328
Slow-burning construction, 145
Small-town location, 129
Snapback method in time study, 319
Social groups, 110
Social interest test, 451
Social security benefits, 32
Social status, 101
Soldiering, 4, 13, 327, 463
Solidarity of workers, 110
Sound systems, 226
Sources of supply, 524
Space, effective use of
  in plant, 194
  in storeroom, 547
Space comprehension, 450
Special aptitude tests, 449
Special-purpose equipment, 163
Specifications
  in design, 254
  use of, in purchasing, 527
Speculative buying, 528
Speed boss, 11, 53
Stabilization
  of employment, 359
  of production, 360
  of wages, 359
Staff departments, 45, 91, 255
Standard cost, 651
Standard design, of buildings, 142
Standard element times, 330
Standard quantities, 537
Standardization
  of product, 264
  of working conditions, 7
Standards
  advantages of, 82, 265
  investigation of, 332
  use of time study for setting, 5, 324
Statement of profit and loss, estimated, 134, 638
Static budget, 629
Statistical methods, in inspection, 280
Status, desire for, 110
Steady work, desire for, 106
Steel cutting, experiments in, 7
Steel-frame construction, 146
Steel industry, accident program in, 487
Steward, union, 94, 436
Stock-purchase plans, 509
Stop watch, in time study, 316
Storage spaces, numbering of, 552
Storeroom layout, 547

Stores
arrangement of, 549
classes of, 535
deterioration of, 556
issuing of, 553
receiving of, 553
Straight-line layout, 183
Stunt peddlers, 27
Subjective traits, in merit rating, 406
Subordinates, development of, 79
Suburban location, 129
Sugar refineries, location of, 124
Suggestion systems, 507
Supersonic vibration, 288
Surgical benefits, 502
Surveys of employee opinion, 113
Sylvania Electric Products Company, 129
Synthesized motions, 306
Synthetic industries, 190
Systematic planning, 576

T

Tabor Manufacturing Company, 21
Taft-Hartley Act; *see* Labor Management Relations Act
Task and bonus plan, 373
Task system, 12
Taylor, Frederick W.
at Bethlehem Steel Company, 4
at Midvale Steel Company, 4
early life of, 3
fatigue study by, 8
functional foremanship plan of, 11, 52
standardization of work by, 6
summary of principles of, 11
Taylor differential rate, 9, 372
Taylor Society, 26
Taylor system, 1, 12
Technical societies
research work by, 241
standards established by, 268
Temporary storage, 192
Termination, report of, 467
Tests
inspection, 283
intelligence, 447
special aptitude, 449
trade, 450
Theories of wages, 342
Therbligs, 298
Thompson, Sanford E., 21
Three-position plan, 63
Tight standard in time study, 322, 332
Time study
allowances in, 328–29
beginning of, 5, 310
criticisms of, 334
making of, 314
Time Study — *Cont.*
relation of, to motion study, 312
uses of, 311
Time ticket, 645
Toledo charter, 428
Tolerances, in setting standards, 255
Total cost, 653
Towne, Henry R., 21
Trade associations
research by, 240
simplification work of, 263
standardization work of, 269
Trade tests, 450
Training
of executives, 80
of foremen, 94, 478
within industry, 478
organization for, 477
of subordinates, 79
of workers, 303, 471
Training programs, 474, 481
Transfer of employees, 459
Transportation facilities, 124
Trucks, in internal transportation, 169

U

Underapplied expense, 19, 649
Understudies, executive, 80
Unemployment
due to accident and disease, 486
technological, 176
Union security, 430
Union shop, 432
Union steward, 94, 436
Unions
contracts with, 426, 429
of foremen, 97
policy of, concerning machines, 176
reasons for, 427
Unit cost, 643
Unit credits, in wage payment, 378
Universities, research by, 240
Unsafe practices, 489
Upgrading, training for, 477
Use factor, in plant layout, 194

V

V-shaped roof, 149
Variances, 255
Varieties of product, 260
Vendors
relations with, 524
selection of, 525
Vertical co-ordination, 67
Vestibule training, 474
Visual aids, 478
Visual inspection, 279
Voluntary inspection, 278

W

Wage criteria, 346
Wage differentials, 347
Wage level, factors in, 346
Wage systems, 355
Wages, economics of, 342
Waste disposal, 126
Waste in industry, 264
Water supply, 126
Welfare work, 31
Western Electric Company, 29, 111
Whitney, Eli, 239
Williams, Whiting, 28, 231
Windowless factories, 223
Women, employment of, 106
Wood-frame construction, 145
Worker, Taylor's first class, 6, 10
Workers
  attitude of, toward machine production, 176
Workers — *Cont.*
  complaints of, 93
  effect of attitude of, 103
  incentives for, 371
  inspection by, 279
  motivation of, 104, 108
  security of, 106, 433
  selection of, 442
  treatment of, 113
Working conditions
  control of, 205
  relation of, to wages, 350
  responsibility of foreman for, 89
  responsibility of management for, 7
Workmen's compensation laws, 486
Workplace arrangement, 301

X

X-ray, use of, in inspection, 288

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