

FACTORY MANAGEMENT

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PREFACE

There are various points of view from which a factory may be studied and described. To the manager, the engineer, the accountant, the economist, the working man—to each of these the factory is a problem seen from a particular angle, and a problem large enough to warrant voluminous treatment from the one point of view. In the present volume it has been the author's purpose to give as nearly as might be a balanced description of the operation of the various departments of the factory, to show their relation to each other and their problems as part of the greater problem of coördinating all activities of the organization toward the accomplishment of the single general purpose. In the author's teaching experience he has found that probably the best fashion in which to present a picture of the factory as a working organism is through the study of the problem of production control, and an attempt has therefore been made to gather up the various methods and theories on this subject into a somewhat connected philosophy of control.

Throughout the book an attempt has also been made to present the point of view of the owner and manager as well as that of the specialist. W. L. George has called the business man the great compromiser, and it is certainly true that where the student and the specialist are interested in the logical completeness and comprehensiveness of a system, the owner and entrepreneur is less interested in perfection of form than in effectiveness and economy of results.

Naturally in a book covering so wide a field as this, the author must acknowledge indebtedness to the ideas of many men. In common with the industrial engineering world he recognizes his debt to Frederick W. Taylor and to the little

group of engineers who with Taylor made such notable contributions to the study of industrial management. The assistance of Professors Walter E. Lagerquist, Fred E. Clark, and Eric L. Kohler in reading portions of the book and offering valuable suggestions for its improvement is gratefully acknowledged. It is a particular pleasure here to record my gratitude to Carl G. Barth, under whose kindly and stimulating direction the writer served his apprenticeship in organization work.

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CHAPTER I

THE FUNCTIONS OF THE FACTORY

A SMALL-TOWN druggist conceived the idea of a new style of sick-room fumigator, vaporizing formaldehyde in a simple and convenient tin candle. He bought the tin vaporizers and in a room above his corner drug store filled them with the preparation during odd times. The fumigator took hold of public favor and other lines were added. From this simple beginning arose a manufacturing and jobbing druggist's specialties industry, distributing its varied products nationally and equipped with its own extensive factory and sales organization.

Most factories arise from similar simple beginnings, either the small shop which by successful enterprise has expanded, or an organization in which men with previous experience in small things are able to start immediately on a larger scale. Looking at the successful factory one is always tempted to speculate as to just why it succeeded where so many others failed, just what are the essential factors in its success. And it is often singularly difficult, even for the proprietor himself, to put one's finger on the elusive something which has proven the magic touchstone. Yet we may name some of the conditions and qualities which in general often do contribute, singly or in combination, to the growth of an industrial organization.

In the case of the druggist mentioned the initial start which

enabled him to forge ahead of the rank and file was the novelty of his idea. Such ideas may be merely chance discoveries, or they may more likely be the result of a patient and systematic investigation. In any case, and for any type of successful novelty, whether of design or method of manufacture, of distribution or of adaptation to new uses, the effect of the novelty is to give a temporary monopoly advantage to the owner, which enables him to reap the profits which provide for further expansion. The "Eversharp" pencil is another interesting illustration. Other magazine pencils had been made for years, and apparently the Eversharp manufacturers were not able to secure patents basic enough permanently to retain the field, yet the fact that their pencil was the first to capture popular fancy enabled them to accumulate resources and build a good will which must have proven a heavy handicap to other aspirants in the field.

Good judgment, character and determination, courage, initiative, persistence and others of the orthodox virtues are also important elements in success. The student of management is apt to forget that the methods of science and the details of system and organization are but tools, which strong men use to accomplish results which they desire. There are problems and controversial questions enough, in all conscience, in the internal administration of the factory, yet the real battleground of industry is often in the market, where set rules form a poor substitute for the personal qualities of the leader.

All of these qualities are to a degree the common possession of the successful business man in any line and any rank. Deficiencies may be supplied here and there by the choice of complementary subordinates or associates, yet if the executive lacks many of these powers, leadership will pass from his hands to those of another.

Turning again to the factory we find a more special group of qualities, more easily found in subordinates. Technical ability and knowledge are necessary in the design of product

and the conduct of process. Selling ability and technique must provide the vital outlet for the stream of production.

Another problem appears and makes its increasing demands for special ability as the factory emerges from the status of the small one-man concern. This is the problem of organization. In the small factory the instinctively systematic procedure of an orderly mind may well suffice to meet the organization problems of the business. The manager knows everything that is going on and is there to see that it goes right. Little more is needed. As the business grows the work is divided and functionalized so that no one subordinate sees this work in its entirety. Methods must be found for defining the bounds of activity and for coordinating the efforts of men so that their work will fit into the general scheme even though they may not themselves be fully aware of what this scheme is. We find thus a distinct problem in developing a correct structure of organization, and a special technique of system and operation. It is with this problem that this book will primarily deal, recognizing at the same time that factory organization and methods from this standpoint are only one, and sometimes a lesser one, of the daily problems of the executive. Factories often achieve large commercial success in spite of an almost total lack of sound organization, yet it is a success needlessly lessened by waste, a success at the mercy of any competitor who adds organizing to commercial ability.

Scientific Management.—Most men abstractly recognize that for every effect inexorably there is a cause, yet few in practice are willing to go to the trouble of thinking through to causes and general principles. In fact, in many commercial problems the cost of a thoroughgoing investigation and research into a particular problem might exceed any possible profit yielded by it. Confronted with this dispiriting fact, under the constant pressure for immediate profits and results, the business man has too often yielded to the temptation of not thinking or investigating at all, but of relying on tra-

ditional methods and policies or blind chance for his guidance. It has been left to the engineer to apply systematically in industrial problems the methods of science which yielded such rich results in the field of physics and chemistry. Frederick W. Taylor was the first to give comprehensive published recognition to the fact that the methods of analysis of science could be applied in manufacturing control, that the problem of production was an equation whose factors could be measured and for which a solution of greatest effectiveness could be found. Taylor's work and that of his associates developed many specific devices and methods of value in industrial practice, but of more importance was the spirit of patient and thorough study to which this work was a stimulus, a spirit which has developed the invaluable research method of operation analysis, discussed in Chapters V and VIII, and which has raised cost accounting, production control, personnel and sales management from the status of largely empirical arts to that of definite and well understood means of control.

Studying the factory in operation, and particularly, comparing various types of factories, one is struck by certain basic similarities and problems common to all manufacturing of whatever type, and he begins to perceive certain lines of classification by which certain factories externally very different are found to be susceptible to the same general treatment. Following with some modifications the classification proposed by A. H. Church in his book "The Science and Practice of Management," we will at this point attempt a general classification of the functions of production. In Chapters II and III the general functions of finance and sales will be discussed in their relation to production, and in Chapter IV we will return to a classification of the various types of factory problem.

The Functions of Production.—Examining the structure of the factory organization we find that it, like other business, has first the two great functions of production and of sale, with the auxiliary functions of general administrative control

and leadership, of finance, and of record making and accounting. Concerning ourselves more particularly with production, all of the operations and functions involved in producing an article in the factory may be grouped into four fundamental types: design, supply, control, and operation.

THE FUNCTIONS OF PRODUCTION

1. *Design.*

- a. Of product—Engineering Department.
- b. Of process—Routing, Time Study, Planning Departments.
- c. Of operating methods—Methods or Efficiency Department.
- d. Of tools—Tool Design Department.
- e. Of selling methods—Advertising and Sales Research Departments.
- f. Of policy—General executives.

2. *Supply.*

- a. Of money—Treasurer's Department.
- b. Of materials—Purchasing, Receiving, Stores, Traffic, Shipping Departments.
- c. Of equipment—Purchasing, Tool, Maintenance and Plant Engineering Departments.
- d. Of men—Personnel Department.

3. *Control.*

- a. Of administration and policies—Board of Directors, general executives.
- b. Of sales—Sales Manager, Credit Manager.
- c. Of expenditures—Auditor.
- d. Of operating program—Planning, Dispatching, Follow-up Departments.
- e. Of operation and discipline—Superintendent, foremen.
- f. Of quality—Inspection Department.
- g. Records as a basis for control are furnished by
 - (1) Accounting Department.
 - (2) Statistical Department.

4. *Operation.*

- a. Selling—Salesmen, Advertising men.
- b. Operation—The great body of workmen and mechanics.
- c. Clerical—Clerks and minor executives.

FIG. 2.

Design.—Take an automobile factory as an illustration. The first step in production is the design of some sort of a car, of a *product*, and we find an engineering department which is constantly gathering and trying out new features of design. In a chemical industry a laboratory would perform this function, in a tailor shop the designer or style man. Sometimes in a repetitive factory the design is made up once for all, but always provision must be made or has once been made for this function. The *method of making* the product must also be designed. This work is done by the route clerk or operation layout engineer. Suitable *tools* and fixtures and special machines must be worked out by the tool design department to carry out the production process and the time for manufacture must be estimated as a basis for planning. All of these are design functions, which may be performed quite independently of the act of production. Design problems also arise in connection with the laying out of organization and system, and in the field of sales management.

Supply.—To make an automobile, castings, forgings, steel, lumber, fabric, upholstering materials, glass, and a multitude of special parts, accessories, etc., must be purchased, and this function of supply of *materials* is taken care of by the purchasing, receiving, stores, and material move departments. Money must be forthcoming in stated amounts to meet payrolls and bills payable, and one of the higher officials, usually the treasurer, sometimes the president or other official, is made responsible for planning and arranging for the supply of *money or credit*. *Tools and equipment* must be supplied. Usually these are secured by a buyer in the purchasing department, on recommendation of the superintendent or of a special equipment committee. And finally *workmen* must be secured, trained, and made effective members of the organization—the function of a personnel or employment department. In each of these supply functions we distinguish first the securing of the materials, money, or men, second the maintenance and care of the elements secured—accounting,

protection from deterioration, repair of damages, in the care of materials and money, and the special duties involved in the care and development of an organization of men and women.

Control.—Control is the third function. We have a design, and the materials, machinery and men stand ready. For their effective combination to produce a product we need a system, first for issuing orders, secondly for seeing that these orders are carried out and for inspecting the results. If we turn to the automobile factory we will find in it some form of *planning* department, which takes the standard times and production plans of the manufacturing design and transforms them into a detailed schedule, with each machine's or department's work so timed and proportioned that all will come out together and in the right quantities to produce the finished car. We will find also an organization responsible for the *supervision* of the men as they carry out these orders. This organization, sometimes called the "old line" part of the organization to distinguish it from the newer functional planning departments, includes the superintendents, foremen and gang bosses who are directly responsible for the performance and discipline of the men, who instruct them in their work, and in general reinforce and make effective the schedule of the planning department. An *inspection* department is necessary, in order to assure a control of quality. The *managing executive* himself performs an important part of the control function.

In order to profit by experience and to guide in many ways in making decisions, we need *information* of various sorts, brought to the executive who exercises the final control function, in such form that it gives him a clear picture of what is happening and of the factors which must be considered in deciding. There is therefore present in the factory as an auxiliary to the control departments a group of departments whose function it is to gather information, digest it, and present it in the form of records and summaries to the various executives concerned. The accounting organization is the chief

of the information services, with its statements of financial condition, of costs and results of operation, but various other summaries are made of the activities of the various departments and officials, such as a record of orders filled on time, of bonus or piece rates earned, of imperfect work, and of many other items of importance.

Operation.—Operation is the largest, in point of number employed, of the four functions. Out of ten people employed by the factory perhaps one will be employed in general administrative and sales work. One or two will be employed in shop administration and supervision. The remaining seven or eight will be direct producers as machinists or other workmen. These proportions of course differ widely in differing cases. Sometimes only one or two out of a hundred will be engaged in the indirect and auxiliary functions; at times there may be more salesmen, office people, etc., than there are workmen.

This description gives some sort of a picture of the functions of the factory. The actual organization will follow this outline in a broad way, but various considerations of convenience, of the need for check by one department on the activities of another, and similar considerations affect the actual organization materially. Thus, operation analysis is theoretically in the same family with engineering, but because of its need for intimate day-to-day contact with scheduling and shop operations this department is often put with scheduling and follow-up, in a general shop planning department. Stores and purchasing are closely related in theory, but are separated to provide a check on possible irregularities in the handling of materials. Inspection may be classified as a control function, although final inspection is frequently supervised by the engineering department to remove it from the pressure of the operating departments. Record keeping may be handled by one accounting and statistical department but is quite as likely to be broken up among small groups attached to the appropriate departments.

- Stockholders
- Board of Directors
- President
 - Vice President in Charge of Accounting
 - Auditing
 - Vice President in Charge of Sales
 - Contracts
 - Credit Department
 - Merchandise Manager
 - Warehouse Stocks
 - Service to Customer
 - Accounting, billing, claims
 - District Sales Manager
 - Advertising Department
- Treasurer
- Secretary
 - Legal Department
 - Vice President in Charge of Engineering
 - Vice President in Charge of Purchasing
 - Vice President in Charge of Manufacturing
 - Manufacturing Committee
 - Production Superintendent
 - Shop Methods
 - Drafting and Blue Printing
 - Operation Planning
 - Machine Analysis
 - Layout and Capacity
 - Tool Planning
 - Premium and Piece Work Rates
 - Material Orders and Records
 - Schedules
 - Stock Keeping and Material Handling
 - Dispatching
 - Tracing
 - Employment
 - Operating
 - General Foremen
 - Section Foremen
 - Inspection
 - Shop Clerical
 - Cost
 - Payroll
 - Accounting
 - Office Service
 - Plant Service
 - Construction Engineer
 - Service, Janitor, etc.
 - Protection
 - Methods and Betterment Department

FIG. 3.

A TYPICAL FACTORY ORGANIZATION.

Two diagrams are given below which illustrate the typical organization and departments found in good-sized manufacturing companies. In these diagrams, officers and department heads of the same rank are shown in the same line vertically, while those of subordinate rank are inset toward the right.

FIG. 4.

ORGANIZATION OF A LARGE MOTOR FACTORY
TWO PLANTS, EACH ABOUT 5,000 MEN.

President and General Manager
 Secretary
 Counsel
 Vice President and Manufacturing Engineer
 (1) Vice President in charge of Finance and Accounts
 (2) Vice President in charge of Sales
 (3) Vice President and Chief Engineer
 (4) Production Manager
 (5) Factory Manager, Plant A
 (6) Factory Manager, Plant B
 (7) Manager of Inspection.

The details of organization of these departments are charted below. The work of vice-presidents (2) and (3), while of great importance, is small in volume and these men require few assistants.

- (1) Vice President in charge of Finance and Accounts.
 (a) Treasurer
 Comptroller
 Factory accountant, Plant A
 Timekeeper
 Payroll and labor distribution
 Costs
 Factory bookkeeping
 Factory accountant, Plant B.
- (4) Production Manager
 (a) Chief of planning and scheduling, Plant A.
 General dispatcher
 Shortage dispatcher
 Material follow-up
 Engineering follow-up
 Shop follow-up
 Dispatcher of service and shipping

Fig. 4.—Continued

- (b) Chief of planning and scheduling, Plant B.
 - (c) Purchasing agent
 - Chief buyer
 - Buyers
 - Purchased parts follow-up
 - Traffic manager
 - (d) Labor Manager
 - Employment department
 - Employment office help
 - Instruction department
 - Restaurant
 - Welfare
 - Tool check-room
 - (e) Materials Manager
 - General storekeeper
 - Rough stock foreman
 - Finished stock foreman
 - Receiving clerk
 - Order clerk
 - Record clerk
 - (f) Tool Development Supervision
 - Production engineer
 - Operation layout
 - Tool design
 - Gauge design
 - Machine layout
 - Time study and demonstration
 - Chief clerk
 - Scheduling
 - Follow-up
 - Records
 - (g) Powerhouse Chief Engineer
 - (h) Plant protection department
 - (i) System and methods department
 - (j) Garage department.
- (5) Factory Manager, Plant A
- Assistant factory manager
- (a) Superintendent machine shop
 - Foreman, automatic lathe department
 - Foreman, crank shaft and cam shaft
 - Foreman, heat treatment
 - Foreman, punch presses
 - Foreman, blacksmith
 - Foreman, electrical
 - Foreman, crank case and cylinder
 - Foreman, connecting rod and piston
 - Foreman, screw machine
 - Foreman, yard labor

Fig. 4.—Continued

- Foreman, of equipment
- Trucking
- Shop orderly
- Janitors and sweepers
- (b) Tool construction superintendent
 - Chief clerk
 - Tool dispatching and follow-up
 - General foreman, tool room
 - Chief tool inspector.
- (6) Factory Manager, Plant B.
(Organization similar to 5.)
- (7) Quality Managers
 - (a) Chief Inspector, Plant A.
 - Assistant chief inspector
 - Inspector foreman, rough stock
 - Inspector foreman, receiving
 - Inspector foreman, machine shop
 - Inspector foreman, assembly
 - Metallurgical laboratory
 - Salvage department
 - (b) Chief inspector, Plant B.
(Organization similar to 7a.)

CHAPTER II

FINANCING

EVERY operation in manufacture and distribution requires capital, and the securing and regulation of the flow of this capital constitute a problem which requires more accurate solution the greater the volume of business done on a given investment and the more rapid the growth of the business. It is important to the man concerned in factory management that he shall see clearly the financial implications of the various operations of the factory.

Organizing the Business.—The initial impetus for a successful factory comes frequently from a new idea such as that of the fumigator mentioned in Chapter I. Or a salesman or other employee of an existing company, feeling that he has mastered the business and seeing an opportunity, may gather about him a suitable organization and start a new business. Sometimes a business, started as a small local mechanic's or service proposition, grows to the point where a larger organization is needed. In any case, either at the inception of the business or at some point in its expansion, there is likely to come a time when the owner's resources prove inadequate and he must secure additional funds, either from men who take a share in the business, or as a loan.

The Corporation.—The usual procedure in inducing others to share in the business is to organize a company, most frequently a corporation, and to sell shares in this company. In organizing a corporation, application is made for a charter to the secretary of state of the state in which incorporation is to be effected, the application setting forth the purpose and desired period of life, within statutory limits, of the corporation, the names of the applicants for the charter, the amount