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SCIENTIFIC MANAGEMENT

A History and Criticism

BY

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TO

A. W. D.

AND

S. B. D.

PREFACE

This monograph has been written under the supervision of Professor Henry R. Seager, who suggested the field to be covered, and brightened the way by his encouragement. From his teaching and counsel arose the wish to treat the subject from the broadly-social point of view.

Most of the men whose work is described in the following pages have given me more or less of their time. But my debt on this score is mainly to Robert T. Kent, editor of *Industrial Engineering*. He has been my most useful guide as to the personalities and concrete events which constitute the real scientific management.

My friend, Mr. E. F. Simonds, gave indispensable assistance in the preparation of the first draft. I have recently profited by a number of suggestions offered by Dr. Carl E. Parry, of the Ohio State University, who read most of the manuscript.

Horace B. Drury.

Ohio State University,
March 9, 1915.

TABLE OF CONTENTS

PART I

A History of Scientific Management

CHAPTER I

CHAPTER II

CHAPTER III

CHAPTER IV

CHAPTER V

PART II

A Critical Review Of Important Aspects of Scientific Management

PAGE

CHAPTER VI

CHAPTER VII

CHAPTER VIII

CHAPTER IX

PART I

A HISTORY OF SCIENTIFIC MANAGEMENT

CHAPTER I

The Meaning of Scientific Management

I. THE ORIGIN OF THE TERM

The significance which has come to be associated with the words *scientific management* may be traced to an event which occurred in the latter part of 1910. In the early summer of that year, the railroads of the United States north of the Ohio and Potomac rivers and east of the Mississippi had filed with the Interstate Commerce Commission new freight tariffs, so framed as to involve a general and considerable advance in rates. The Interstate Commerce Commission had, on July 13, instituted an inquiry into the reasonableness of the proposed advances, and there had then followed in September, October, and November a series of hearings. The vast sums of money involved, and the fact that the impending decision might become an important precedent, led to a contest of extraordinary intensity on the part of both the railroads and their opponents, the shippers.

It happened that Louis D. Brandeis had assumed the leading position among the fifteen or twenty attorneys lined up against the proposed advances. The railroads, upon whom the law had placed the burden of proof, had maintained that the advances were necessitated by an increase in operating costs, due mainly to a recent rise in wages. Wages, they pleaded, make up nearly one-half of the total cost of railroad operation; and wages had been advanced in the spring of 1910 by from five to eight per cent. Therefore the railroads must receive greater revenue; or they would not have funds enough to make desired improvements, or the credit requisite for the successful flotation of their securities. In the face of these arguments, Mr. Brandeis dramatically took the aggressive, and striking out on a novel and unexpected tack, he declared that there was a means by which the railroads could raise wages, and at the same time—instead of increasing costs—actually reduce them. This system, which meant high wages and low labor-cost, he called *scientific management.*

Where did Mr. Brandeis find scientific management?

It may be stated that, prior to November, 1910, there was nothing which was generally known by that title. The actual principles of the industrial system which Brandeis had in mind had indeed been in process of formation for about thirty years; but "scientific management," the name, had not yet become an all-embracing slogan. Research shows some adoption of the *parts* of this phrase: the word "management" had been very commonly used, as in the phrase "modern management;" and "scientific" also was a favorite term. Even the combination, "scientific management," had occurred fortuitously in the writings of Frederick W. Taylor, the great leader in the movement, as early as 1903.[1] It is said, too, that the full expression was, at a later date, designedly used by Taylor in explaining his ideas to visitors at Chestnut Hill, Philadelphia. But these instances are cited merely by way of exception; there were other real names for the system—

[1] "Shop Management," *Transactions of the American Society of Mechanical Engineers*, vol. xxiv, p. 1366.

names more precise and much more common. "Scientific management" had a definite meaning for few persons, if any.

Nor was this general ignorance merely one of words. The idea back of the new movement was itself unfamiliar to most persons. The essentials of scientific management had indeed been presented to an inner circle in papers read before the American Society of Mechanical Engineers; while a considerably wider public had noted the results of its application on the Santa Fe railroad. But there was not, as later, a widespread popular movement, nor any general acquaintance with either principles or results.

Such was the situation when Mr. Brandeis happened to be retained by a manufacturer[1] whose plant was operating under the plan, today known by the name of scientific management, but then unchristened. Brandeis, after studying the plant's organization, had become convinced of its intrinsic merit. When therefore the railroads advanced the plea outlined above, he determined to propose, as an alternate solution of their dilemma, the adoption of the new principles: he made preparation to put on the witness stand some ten of the leading men connected with the movement.

As a preliminary step along this line, Mr. Brandeis called together several of his prospective witnesses for the purpose of working out a plan of presentation. He desired that they should reach an agreement whereby the same things should always be called by the same names, and that—most important of all—a single term might be found which would apply to the system as a whole. This word or phrase should properly describe the system,

[1] The late W. H. McElwain, shoe manufacturer.

and at the same time appeal to the imagination. The conference, held in the month of October, 1910, included five or six persons. After those present had considered the merits of about half a dozen different phrases, all agreed that, for the purpose of the hearings, the term "scientific management" should officially designate the system.[1]

The witnesses were introduced on the afternoon of November 21, and the hearing of their testimony, together with cross-examination, took up almost all of two days and a half. The witnesses testified that in their experience the application of scientific management—whether to the handling of pig iron, the shoveling of coal, bricklaying, or machinery manufacture—had increased the output per workman to at least two or three times its former volume. Especially startling was the statement of Harrington Emerson that the railroads of the United States might save $1,000,000 a day by paying greater attention to efficiency of operation. Early in January following Mr. Brandeis submitted a long brief, about half of which was devoted to the subject of scientific management. A few days later his final oral argument on this topic was delivered before the commission.

The effect of the insertion of the scientific-management argument into the rate-hearings contest was felt almost instantaneously by the whole country. Only a few days after the introduction of the evidence, the early December reviews[2] of current events gave great space to the

[1] This meeting, held at the apartments of H. L. Gantt, was, according to R. T. Kent, attended by Louis D. Brandeis, Henry L. Gantt, Frank B. Gilbreth, Henry V. Sheel, and Robert T. Kent. We are told by Mr. Brandeis that among the names suggested were "Taylor System," "Functional Management," "Shop Management," and "Efficiency."

[2] See *Outlook* and *Survey* for Dec. 3, 1910.

dramatic testimony of some of the witnesses. By January, one of the leading railroad journals[1] had begun a series of articles in which the railroads were defended against the implication that they were inefficiently managed. And through January, February, March, and every month of 1911, the periodical press, popular as well as technical, was filled with explanation after explanation as to what scientific management is, why it is good, or why it is worthless. By the fall of 1911, Dartmouth College had arranged for a conference to spread information as to the merits of scientific management;[2] while on the other hand, owing to the demands of organized labor, a special House committee was inquiring as to whether Congress should forbid the system in the government service.[3] In March, 1912, an efficiency society[4] was organized in New York City for the specific purpose of applying the principles of efficiency in every department of life. And by the time of writing this treatise many of the leading universities have established courses on scientific management.[5] The vision of the

[1] *Railway Age Gazette*, Jan.–July, 1911.

[2] See *Addresses and Discussions at the Conference on Scientific Management held Oct. 12, 13, 14, 1911.* First Tuck School Conference, Dartmouth College Conferences. Published by the Amos Tuck School of Administration and Finance, Dartmouth College, 1912.

[3] This committee was composed of Wm. B. Wilson, chairman, Wm. C. Redfield, and John Q. Tilson. See House of Representatives' Report no. 403, 62d Congress, 2d Session, for the committee's guarded approval of some and condemnation of other of the features of scientific management. Also see *Hearings before Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Managemeut*, published in three volumes by the Government Printing Office in 1912.

[4] Later incorporated as The Efficiency Society, Incorporated.

[5] To mention a few, Harvard, Columbia, New York University, Syracuse, and Pennsylvania State are known to have introduced special

movement is suggested by the statement of a Harvard instructor[1] to the effect that scientific management seems "to be the most important problem from the practical and theoretical point of view now before the industrial world." Significant also is the exhaustive treatment of scientific management in a series of addresses delivered before the Western Economic Association, and published in the *Journal of Political Economy* in May, June, and July, 1913.

In order to place before the eye further and final proof that it was the rate-hearings episode which introduced scientific management to the public, a statistical analysis has been made:

The yearly output of accessible periodical contributions whose *titles* have contained the term "*scientific management*"[2] has been counted, and found to be—

Prior to the rate-advance hearings	None
During December, 1910	2
During 1911	26
During 1912	14

These figures, which tell the story of the discovery of scientific management, are based upon a comprehensive bibliography of the "efficiency" literature appearing between 1898 and 1913.[3]

series of lectures or regular courses along the general lines of scientific management; while portions of the literature and some of the principles of scientific management are introduced into courses in economics or engineering very generally.

[1] C. Bertrand Thompson.

[2] Or "*science of management.*"

[3] "Select list of references on scientific management and efficiency," compiled under the direction of H. H. B. Meyer, chief bibliographer, Library of Congress, and published in the "Efficiency Number" (May, 1913) of *Special Libraries*.

That not only the name "scientific management," but the *idea* as well, became public property because of the rate-hearings contest, is statistically demonstrated by the enormous growth in the total literature on "efficiency," which occurred immediately after and because of the hearings:

All Periodical Articles on Efficiency Subjects.[1]

1907	8	1910 (6 of these in December)	15
1908	5	1911	59
1909	7	1912	38

Since many articles are about scientific management, but do not contain the term in the title, as a means of measuring the strength of the scientific-management movement this last table is more serviceable than the first.

The rate-advance hearings have now been treated at sufficient length to give the important result for the purpose of obtaining which the topic was introduced. The subject was taken up because it was deemed advantageous to determine at the outset just what is meant by scientific management. The foregoing paragraphs have made it clear, it is hoped, that if we wish to know what the term embraces, we must approach the subject from the point of view of Mr. Brandeis and the group who testified before the Interstate Commerce Commission. These were the men who first gave currency to the words "scientific management;" it was their account of it which led to the recent wave of public interest,—their interpretation which determined the public's conception as to the meaning of the expression.[2]

[1] Meyer, *op cit.*

[2] The scientific-management movement may therefore be regarded as pretty well defined by the thirteen names which, in one connection or

2. THE MOVEMENT BRIEFLY DESCRIBED

The roots of scientific management are to be found in the life and thought of the late Frederick W. Taylor.[1] Mr. Taylor, who had been a machinist and then a gang-boss in the employ of the Midvale Steel Company of Philadel-

another, creep into Mr. Brandeis' brief as those of persons identified with the system. Frederick W. Taylor is named as the discoverer of the earlier principles. From correspondence with Mr. Brandeis we learn that he shares the common view that "Mr. Taylor's contribution was of course greater than any other." As early associates of Taylor, Brandeis mentions H. L. Gantt and C. G. Barth. As experts who entered the field slightly later, he called as witnesses H. K. Hathaway, F. B. Gilbreth, and Harrington Emerson. As supervisors of plants where scientific management has been a notable success, may be classified H. V. Sheel and H. P. Kendall; as officers of corporations where scientific management has been installed, H. R. Towne and J. M. Dodge; as editors who have written about scientific management, R. T. Kent and J. B. Going. The name of J. H. Williams, who had introduced certain features of scientific management in a unionized printing establishment, completes the list. This ample list gives us our bearings. The remainder of this treatise will be a study, based upon a variety of sources, of the system which, in view of these names, we understand to be scientific management.

In spite of the brilliancy of Mr. Brandeis' campaign, that part of his argument which dealt with scientific management seems to have had little effect upon the Interstate Commerce Commission. In a report covering 64 pages the commission dismissed the subject of scientific management in two short paragraphs with the remark that the system was everywhere in an experimental stage, and that it had not been shown that these methods could be introduced into railroad operation to any considerable extent. The commission indeed decided against permitting an advance. But the main reason given was this: that the net earnings of the roads had been so liberal in the past that they could allow the men higher wages and still pay adequate dividends. The general question of efficiency of operation seems to have come in as an alternate consideration of rather secondary importance. The commission warned the railroads that, even if they should find in the future that their revenues were indeed inadequate, it would then devolve upon them to explain away the commission's impression that they had not been giving sufficient attention to economy of operation, nor adopted the superior methods used in competitive (non-monopolistic) industry.

[1] Died March 21, 1915.

phia, was promoted in 1882 to the position of machine-shop foreman. During his experience as a workman, Taylor had been constantly impressed by the failure of his neighbors to produce more than about one-third of a good day's work. Wages in the Midvale shop were on a piece-work basis, and the men were afraid to let the management guess how large a product they could really turn out because it might mean a cut. This tendency on the part of the workmen had resulted in a war between Taylor, the gang-boss, who was trying to induce the men to work faster, and the workmen under him, who were determined that by fair means or foul they would avoid working faster. As a result of this struggle, life to Taylor had become hardly worth living. Accordingly, shortly after he was given the greater authority of foreman, he determined to work out some system of management by which the interests of the workmen and of the management would be made the same.

The burning thought that possessed the mind of Mr. Taylor in those days was this—that the difficulty at the root of the whole matter was lack of knowledge as to what actually constituted a day's work. How could the men be held accountable for their full duty when the management had no idea of a man's capacity? Accordingly, the first thing which Taylor tried to do was to remove all obscurity on this point by making a scientific study of the time which it necessarily takes to do work. The thoroughness and persistence with which he applied himself to the accomplishment of this task is eloquently vouched for by the fact that in the one field of cutting metals he carried on research for twenty-six years and at a cost of $150,000 or $200,000.

But all this study in itself did nothing more than clear the way. The task having been determined, the next important thing was to make sure that it was performed. High pay for success, loss in case of failure—these were the two sides of the system by which Mr. Taylor proposed to push the workman from beneath and allure him from above, until it would be at once his necessity and his joy to make production leap forward and upward to the maximum. So there came from the earliest days to be associated with the name "scientific management," the principle of the differential rate, a scheme which remained a favorite with scientific-management votaries until the invention of the bonus and other devices, which accomplish the same purpose in a somewhat different way.

This effort to arouse the initiative of the workman and provide a means by which it becomes to his advantage to do his best constitutes, historically speaking, the first phase of scientific management. A second side began to be practiced simultaneously with the first, but received no great recognition in and for itself until the late nineties. This second aspect of scientific management is the effort to control, not the quantity of *effort* on the part of the workman, but the *manner* in which the work is done. Standardization of tools and equipment, routing and scheduling, the issuance of instruction cards to the men, the training of the employee in the most improved and scientific ways of performing his work, the selection of men for jobs for which their physical and mental make-up peculiarly fits them, more satisfactory systems for the management of stores—all these are features which originated incidentally in the course of pursuing the first aim of scientific management; but the incidental advantage resulting from their application has become so great that to-day these activities assume much prominence for their own sake.

As the third and last phase of scientific management, we shall regard modifications of organization. Changes in organization were necessitated by the enlargement of the functions undertaken by the management. As a matter of fact a novel type of management has been evolved which has become quite distinctive.[1]

Mr. Taylor early began to gather about himself a group of disciples. These disciples, though inspired in large measure by the vision and courage of their leader, were yet more than mere imitators. Taylor, in spite of his warm championship of practice as over against theory, was himself a man of great ideas—ideas which were considerably in advance of what had yet been fully worked out. It was largly as aids in putting these ideas into practice that his followers have made their impress upon scientific management. Not only in the practical administration

[1] Worth noting, but rather unclassifiable, is another aspect of scientific management much emphasized in recent years. It is held that scientific management produces a complete revolution in the mental attitude of workingmen and management, the one towards the other. Instead of spending strength fighting for the biggest share of the surplus earnings, as under other systems, the two groups enter into friendly coöperation and mutual help, and thus turn all their attention to the task of making the surplus so enormously great that there is enough for all.

The greater part of this "mental revolution" we would classify as a by-product growing out of the first phase of scientific management wherein the system aims to so adjust wages that it will be to the interest of all to enlarge the output. However, in this Mr. Taylor and his associates would perhaps not concur. They seem to regard the new spirit (especially on the management's side) as an original cause, as well as a result of their smoothly-working system. The mental change, they declare, is the essence, while the mechanical features are but useful adjuncts. They frequently minimize the importance of devices such as time study, wage-payment schemes, instruction cards, and improved organization.

Valuable though "harmony" may be, it seems to us too intangible and too general an idea for any one group to regard it as the basis of its industrial system. Only when an ideal has become a plan, do we have a system.

of plants, but also in developing the more subtle mathematical laws governing the operation of machines, and in applying new principles to wage systems and management in general, have these associates molded the outer form of, and given fuller content to the Taylor science of management.

The first colleague of Taylor was Henry L. Gantt, inventor of the bonus system, and today generally known as the surest result-getter of the men who are introducing scientific management. A dozen years later, but still among the earlier men, came Carl G. Barth, mathematician, and inventor of the slide rule. With these names may be associated H. K. Hathaway, famous for his skill in perfecting scientific management for the Tabor Manufacturing Company, and the eminent and versatile Morris L. Cooke, director of public works for the city of Philadelphia. Sanford E. Thompson performed pioneer work in extending the principles of scientific management from the machine shop into the building trades; while, a few years ago, Frank B. Gilbreth won great admiration by his display of genius in the reorganization of bricklaying. Finally may be mentioned Harrington Emerson who, in addition to his commercial activities, has had much to do with making "efficiency" an everyday word.

To go into details as to the extent to which these men have applied scientific management would be to draw out unduly this preliminary sketch, and steal from the chapters which are to follow their proper material. However, it may give definiteness to our conception of scientific management to mention a few of the more notable examples of its introduction. After the early innovations at Midvale, the next important scene of advance was at the plant of the Bethlehem Steel Company, where from 1898 to 1901, as a result of the combined efforts of the leading scientific-management practitioners of the day, epoch-making progress was made. It was here that the interesting studies of pig-iron handling and shoveling were made. It was during this period that the Taylor-White high-speed steel was developed, and that the Barth slide rule was invented. It was at the Bethlehem shops that the Gantt bonus system was evolved. The most important development of scientific management in the last ten years has been in the plants of the Tabor Manufacturing Company and the Link-Belt Company, both of Philadelphia. Scientific management has now, however, grown too large for the limits of any one plant or trade. Besides its introduction into machine shops and the building trades, scientific management has been applied in the textile industry, the printing industry, and so many others that the list grows monotonous. Of special interest to the public has been the introduction by Harrington Emerson of certain of the principles of scientific management in the shops of the Santa Fe railway, and its installation by the United States government at the Watertown Arsenal.

3. THE BOUNDARIES OF SCIENTIFIC MANAGEMENT

The description of the preceding sections may now be followed by some conclusions as to the boundaries of scientific management. In the first place, the system may be set down as confined to that one side of human life wherein men coöperate to attain industrial ends. The goal is usually material wealth; the actors must include a leader and a team of followers; the typical habitat of the system is, in short, the shop, the office, or the gang of laborers.[1]

[1] It is not meant to imply here that many suggestions cannot be drawn

Secondly, the horizon of scientific management may be further limited to that one phase of shop or industrial life which has to do with the control of men. Ruled out entirely are all considerations as to commercial policy—that is, programs for buying and selling, or decisions as to what goods shall be manufactured. Excluded from scientific management, also, is the financial aspect of business—that is, that which has to do with the relations of a company with its stockholders, the borrowing of funds, and the keeping of accounts. To one side, moreover, lie problems connected with the technique of production; that is, scientific management does not primarily concern itself with those aspects of chemistry, physics, and mechanical engineering, which determine the processes of manufacture.[1]

Finally, may we venture once again to narrow the scope of our subject, and conclude that scientific management's position is that of but one of the many movements which aim to improve the relations of management and men. Scientific management we regard as an histor-

from scientific management for application by the individual—for instance in medical work or in housekeeping. Our topic, however, is historical scientific management. And in the past the origin and important development of scientific management has been in the industrial field. For the promise of important influence in other fields, see Christine Frederick, *The New Housekeeping*, and Morris L. Cooke's report to the Carnegie Foundation for the Advancement of Teaching on *Academic and Industrial Efficiency* (bulletin number five). Such movements, however, are essentially an extension of scientific management, and beyond the special scope of this monograph. Cooke's report is discussed, *infra*, ch. iv, sec. 5.

[1] Scientific management must, of course, take all these other fields into consideration; and often marked improvement is attained in them because of the method of scientific management. The handling of men, however, is the system's first consideration, and its main reason for existence.

ical entity, something concrete, whose presence can be detected and verified by the observation of distinctive accompanying features. In the last analysis, "scientific management" is not a great deal more comprehensive than "the Taylor system."

Thus, neither all science, nor all management, nor all management that is scientific, forms the theme of this treatise. But that the special movement with which the monograph deals is worthy of consideration, we trust that no one who reads the following pages will gainsay.

CHAPTER II

EARLY ATTEMPTS AT A SOLUTION OF THE WAGES PROBLEM

THE present chapter is introduced mainly to prepare the way for a discussion of the genesis of scientific management in Chapter III.

The angle from which the genesis of scientific management will be viewed in these two chapters will be somewhat different from the rather personal viewpoint which prevailed in the earlier sketch of Frederick W. Taylor. Not only will the discussion of origins be much fuller here; but also, to our narration of what went on in Taylor's life, there will be added a portrayal of some things which were occurring in a larger field. This larger field was the membership of the American Society of Mechanical Engineers. Taylor, as well as all the other individuals who have been especially prominent in the scientific-management movement, have been members of this society. It was in papers read before its meetings that all the important contributions to the theory of scientific management were made. It will be our policy, in short, in discussing the genesis of the system, to treat its origin as the culmination of a succession of efforts on the part of the American Society of Mechanical Engineers to solve a certain problem. This method of dealing with the matter does not in the least detract from the credit due to Taylor; for, as we shall see, it was the contribution of Taylor which did most to shape the attitude taken by the society.

I. THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

The American Society of Mechanical Engineers was organized in 1880, and in 1884 adopted a set of rules in which it was declared that the object of the society was "to promote the Arts and Sciences connected with Engineering and Mechanical Construction." The first thing, therefore, which must be explained in accounting for the genesis of scientific management from within the membership of this body is why a society founded to promote engineering technique should have launched out into a consideration of problems of management. The reasons for this enlargement of function, and the proposal that it be attempted, are contained in a paper read before the society in 1886 by Henry R. Towne, and entitled, "The Engineer as an Economist."[1] The substance of the argument is as follows: The final value of the work of a mechanical engineer depends on whether or not the employer makes money out of his business; but the making of money depends not only on seeing that the technical matters connected with manufacture are intelligently looked after. To a surprisingly large extent, *works-management* and the methods of dealing with employees react on costs. A diagram is introduced to show how, in a certain establishment, a special system of piece and contract work resulted in a striking reduction of labor cost. In this lucrative field, who can accomplish more than one strong man charged with the management of the shop as a whole? But the person exercising this authority must be a man of engineering training and practical experience, not a clerk or accountant only. Therefore the engineer should make a study of the problems of management in order that he may be

[1] *Transactions of the American Society of Mechanical Engineers*, vol. vii.

qualified to serve in this new capacity. Mr. Towne concludes by proposing that the society undertake to gather, by means of papers presented before its meetings, a stock of information with regard to the little understood art of management. Thus was suggested the policy which the society soon began to practice, and which has been followed with notable success to the present day.

2. THE WAGES PROBLEM

When the American Society of Mechanical Engineers undertook to promote the art of management, they were not interested equally in all of management's different aspects. The problem which they considered almost exclusively, and the only one which will be discussed in this history of scientific management, may be called the wages problem. In order to understand in just what form this problem appeared to the engineers, it will be advisable to look at the operation of the main wage systems.

Wages are generally paid on the basis of one of two criteria. The one criterion is the amount of time put at the employer's disposal by the employee, the other the amount of work which the employee performs. The wages system which depends altogether on the former mode of reckoning is called the day-work plan; the system which depends altogether on the latter mode is called the piece-work plan.

Now engineers, and all other men of experience, hope for something better than the day-work plan; for they find that a man working under it does not produce up to his full capacity: he too often feels that an increase of effort benefits only the employer. David F. Schloss, who has made a thorough study of English factories, writes:[1] "I

[1] *Methods of Industrial Remuneration*, p. 53.

have, in instances too numerous to mention, found that the excess of work obtained by putting men on piece-wage has been from 30 to 50 per cent." Frederick A. Halsey declares[1] that under the day-work plan "matters naturally settle down to an easy-going pace, in which the workmen have little interest in their work, and the employer pays extravagantly for his product." Frederick W. Taylor observes[2] that

> The men are paid according to the position which they fill, and not according to their individual character, energy, skill, and reliability. The effect of this system is distinctly demoralizing and leveling ; even the ambitious men soon conclude that since there is no profit to them in working hard, the best thing for them to do is to work just as little as they can and still keep their position. And under these conditions the invariable tendency is to drag them all down even below the level of the medium.

Hope of promotion and fear of discharge indeed keep the men at work, but the efficiency induced by holding these possibilities before their eyes ordinarily falls far short of reaching the manufacturer's ideal.

Now these failings of the day-work system are obvious to all, and so, from time immemorial, employers have introduced wherever possible the second great system of wage payment, that of piece-work. Under this system the plan of payment according to the amount of time employed is abandoned. The basis becomes the workman's efficiency as measured by his output. The piece-work system at first glance seems ideal; but that there are certain obstacles which prevent its perfect

[1] "The Premium Plan of Paying for Labor," in *Transactions of the American Society of Mechanical Engineers*, vol. xii, p. 755.

[2] "A Piece-Rate System," in *Transactions*, vol. xvi, p. 861.

application and largely destroy its effectiveness, the following discussion will show.

It is a matter of general experience that an employer ordinarily starts a piece-work system as follows: He estimates how long it should take a skillful workman to perform each job. Then, having in mind a fair hourly rate, he so figures the price per piece that the said skillful employee will just about earn the proper wage, provided he applies himself with industry.

Now the object of the piece-work system is to encourage each man to do his best. Suppose, therefore, that an ambitious workman succeeds in greatly increasing the volume of his output. He earns, let us say, 30 per cent more than his fellows. All goes well for a while. But one day an officer of the company looks over the pay roll, and calls the foreman's attention to the fact that some of the men are receiving wages 30 per cent too high. A mistake has been made, they conclude, and the rate is promptly cut.

This cutting of rates has occurred so frequently and invariably in factory life[1] that workmen have learned what to expect. If they increase their output, in the hope of earning higher wages, sooner or later the rates will be cut; and the men will find themselves working much harder, but for no greater pay, than before. So labor unions frequently limit the earnings of their members—and thus the output—imposing a heavy fine upon those who transgress; and workmen sometimes go to considerable trouble to work slowly while appearing to

[1] As an illustration of the extremes to which rate-cutting is carried, we may cite Secretary Redfield's mention of an employer who boasted that he had cut the piece-rate five times on a single job. Tuck School Conference on Scientific Management, *Addresses and Discussions*, p. 355.

work fast. The piece-work system is therefore condemned by many as having fallen short of accomplishing the purpose for which it was created. It does not make it to the interest of the workmen to increase their output.[1]

[1] Rate-cutting, though often mean and unfair, is usually unavoidable in connection with the straight piece-work system. The employer who is setting a price for a new kind of work almost invariably overestimates the time which it will take to perform it. He has too many things to occupy his attention to be able to work out the cleverest procedure which may be employed in the performance of the task. When the job is first being tried out, the experimenter's halting movements little suggest the extreme rapidity which the dexterous workman may ultimately acquire. A rate is set. An energetic worker starts upon the job and in each passing year discovers new tricks of the trade, new methods of enlarging the output. If the piece-rate remained constant, wages would rise to unusual levels—ten dollars a day, possibly, in some cases. Now the employee undoubtedly deserves a reward for improving the methods of his work, but it is questionable whether he is entitled to as great a return as an unreduced piece-rate would yield him. The improvements are probably simple ones that almost anyone could devise, and which a good man ought to be expected to make, given the opportunity. Just as the manufacturer expects to see the savings due to his own improvements ultimately reflected in reduced prices to the purchasing public, so the piece-worker has no inalienable right to enjoy perpetually a given rate. Especially would the employer in the above illustration be justified in cutting the rate upon giving the job to a new man. For why should a workman earn unheard-of wages who has done nothing except adopt methods invented by his predecessor or neighbor? Finally, even the most generous-hearted employer would bc unable to pay high rates for work when his less conscientious competitors are figuring their selling prices on a lower basis. Thus it is seen that the ordinary methods of introducing piece-work necessarily involve the continuous repetition of a cycle, of which the first stage is the establishment of imperfect rates; the second, the earning of unusual wages; and the third the cutting of the rates. The corollary of these tactics on the part of the management is naturally an effort on the part of the men to limit output. In the struggle, the management usually makes headway against the men; but it is generally only after years of slow progress that the rates come to approximate a reasonable return on the basis of thoroughly efficient work.

3. PROFIT SHARING

We can now appreciate the problem before the mechanical engineers. Whether the day-work or the piece-work plans were in use, they felt that very serious economic losses resulted. Accordingly, the attention of many men was turned towards finding a solution of the difficulty, and a series of movements was begun of which the most conspicuous was to be that of scientific management. The American Society of Mechanical Engineers were not, however, the first in the field; and as, in inventing their own plans of reform, they not unnaturally started out where others had left off, it will be necessary to explain what ideas were already current.

In the latter half of the eighties there was just one movement which was winning adherents and attracting the attention of the society, and that was a movement towards profit sharing.

A philosophy might be constructed for profit sharing as follows: When a man works for himself, there is no labor problem; for, when his profits are his own, there is every inducement for him to work to the limit of his comfort. But when men are gathered together in industrial groups, and all the profits derived from their labor go to the owner of the plant, the workman is no longer concerned as to the success of the enterprise. Why should he not shirk when there is a chance? Why should he care if he spoils material or interferes with the smooth running of the factory? Now since it was this diverting of profits from the men to the absentee owner that gave rise to the labor problem, profit sharing, by reversing the process, would seem to strike at the very root of the evil. If profits are divided among all, all will be led to coöperate, and all will prosper.

This general philosophy of profit sharing must be supplemented, however, by a statement or two with regard to the principles upon which it is usually put into practice. Inasmuch as it is the employer who must take the initiative in introducing profit sharing, the employer takes care that there be no diminution in his own previous earnings. It is therefore stipulated that, unless profits are larger than they have been in the past, there will be no profit sharing. And if profits are larger, what is to be shared is not the total amount of profits, but the *gain* over what they have been in the past. It is possible that this entire gain will be turned over to the employees, but not at all likely. The employer usually wants to get some advantage out of the plan himself, and so the common arrangement provides that only a certain share of the gain is to go to the employees, and the rest is to be retained by the establishment. The income of the employee derived from profit sharing is, of course, a reward entirely above and independent of his regular wages or salary.

The first systematic practice of profit sharing is said to have been started in 1842 by M. Leclaire, a house-painter and decorator, of Paris.[1] It was taken up shortly afterwards by a number of other French and German establishments, and as the years have gone by has been adopted rather extensively—first in France, and then more recently in England. Of interest for our purpose is the fact that the idea was received in the United States so favorably during the eighties, that in 1889 Mr. Gilman was able to record the names of thirty-four American establishments which had adopted it in some form; so that in the number of its establishments the United States in that year ranked second only to France.[2] As all but

[1] Gilman, *Profit Sharing*, p. 66.

[2] In the following decade all but eleven of these thirty-four establish-

three of these introductions had been made since the beginning of the decade, it may be seen that profit sharing was indeed in the atmosphere at this period. It is not surprising therefore that the first proposals for a solution of the wages problem made before the American Society of Mechanical Engineers were along profit-sharing lines, and that long afterwards the idea was still being discussed in the papers read before the society.[1]

4. HENRY R. TOWNE'S "GAIN-SHARING"

The first paper presented before the American Society of Mechanical Engineers in which a serious attempt was made to grapple with the wages problem was read in 1889 by President Henry R. Towne, under the title of "Gain-Sharing."[2] Mr. Towne had made a study of

ments dropped the profit-sharing system, so that though twelve new establishments had introduced it, the total number in 1899 was but twenty-three. Gilman, *A Dividend to Labor*, p. 346.

[1] For further information with regard to profit sharing see (for critical comment) Schloss, *Methods of Industrial Remuneration*, pp. 254-309; and (for a defense) Gilman, *Profit Sharing*, 1889, and *A Dividend to Labor*, 1899.

[2] *Transactions*, vol. x. After Mr. Towne's earlier proposal that the society consider problems of management, Mr. W. E. Partridge had made a start in this direction in a paper read in November, 1886, entitled "Capital's Need for High-Priced Labor" (*Transactions*, vol. viii.). Mr. Partridge argues that the prevailing theory in regard to wages, which holds that "the less the price paid for labor, the less will the product cost," is wrong. On the contrary, the general problem of the employer is "to increase the earning powers of his men from year to year, and to do it in such a way that the men not only earn more, but are more profitable to him." In June, 1887, William Kent presented a short paper entitled "A Problem in Profit Sharing" (*Transactions*, vol. viii.), in which he suggested the very plan later developed in Towne's "Gain-Sharing." But Mr. Kent had not worked out any details, and declared that he was not aware that the plan which he suggested had ever been tried. Mr. Towne, on the other hand, was able to state at the time Kent's paper was read that, as it had happened, he

profit sharing as practiced in Europe and America, and had come to the conclusion that conditions in industry were such, that some plan by which the self-interest of the workman would be identified with the success of his employer must be adopted. But in the prevailing types of profit sharing Mr. Towne saw the following great defects: The workmen benefit by, or suffer loss from, fluctuations in profits for which they themselves are not in the least responsible. Changes in the prices of raw materials or finished product, varying skill on the part of the management as relates to the larger matters of equipment and organization, varying efficiency on the part of the mercantile staff in purchasing supplies or finding a market for the output—these are some of the things which, under orthodox profit sharing, unduly augment or unfairly curtail the dividends of the workmen.

So Mr. Towne proposed a new type of profit sharing. plan His plan was to isolate in the bookkeeping those components of cost which the laborer has it in his power to influence, and base the division of profits upon the amount of reduction in these costs. From year to year a record was to be kept of the total wages paid to labor; of the amount of raw material used[1] (so as to check waste); of the cost of incidental supplies (such as oil, waste, tools, and implements); of the cost of power, light, and water; of the cost of renewals and repairs of plant; and of the cost of superintendence, clerk hire, *etc.* If, at the end of the year, the cost of these items per unit

had put Kent's precise plan into operation on January 1, preceding. Thus Towne's "Gain-Sharing" paper deals with achievements older than Kent's suggestions.

[1] To determine the value of raw material, the amount used was multiplied by an arbitrary fixed price, thus eliminating the effect of price fluctuations.

of product was found to be less than it had been when the plan was put into effect, it was to be assumed that the workmen had effected this saving; and this sum, this gain, was to be shared with them.[1]

An erroneous picture of gain-sharing would, however, be conveyed if we did not mention two important modifying features. The gain-sharing plan was drawn up in the form of a "contract," which the employer obligated himself to leave unaltered until the date set for termination, the period of duration being never less than one year, and preferably lasting from three to five years. The original costs, with which later costs were to be compared in order to determine the gain, were referred to in these contracts as "contract prices." The first point to be noted is that the contract prices were not always the actual original costs as determined by the books. Of the contracts which Mr. Towne presents as examples, he says that "in a majority of cases the contract prices were fixed at rates which were a reduction of from ten to twenty per cent, and in one case of thirty per cent from previous costs." He justifies this action on the ground that there was good reason to believe that increased effort would result in a very considerable reduction in costs.

A second thing to be considered is that the gain-sharing was not necessarily permanent. At the close of the contract period, "if during the previous term the cost of product has been considerably reduced, he [the employer] will presumably (although this is not always the wisest course) proportionately reduce the contract

[1] Mr. Towne divided the gain on the basis of one-half to the operatives. Of the 50 per cent going to the operatives, he recommends giving 10 or 15 per cent to the foreman, and dividing the remaining 40 or 35 per cent among the subordinates in proportion to the amount of their annual wages.

prices." Mr. Towne recommends that (where the previous cost of product is well known) the contract period be made a long one, so that the men may not limit their exertion because of the prospect of a reduction of the contract prices in the near future. Under the long contract period, "the employee can afford, for the sake of present gain, to disregard this question as one only affecting a somewhat remote future, and to use his best efforts and intelligence to effect a reduction in the cost of product." Then, when the opportunity for a revision of prices occurs, the employer will be able "to make a larger reduction than he would probably attain in the same time under the plan of frequent revisions, and can also then afford to act more liberally toward the employees in the matter."

The reader of Mr. Towne's paper is easily convinced that in the long run the gain-sharing plan really left everything in the hands of the employer, and that on his discretion and talent for dealing tactfully and considerately with the men it had to depend almost entirely for either success or justification.[1]

5. FREDERICK A. HALSEY'S "PREMIUM PLAN"

The next important attempt to present a solution of the wages problem before the American Society of Mechanical Engineers occurred in 1891, when Frederick A.

[1] The gain-sharing plan was invented by Mr. Towne in 1886, put into operation in the works of the Yale & Towne Manufacturing Company in January, 1887, and by May, 1889, some 300 were employed under the system. Mr. Towne was in 1889 enthusiastic over its success. The employees had cheerfully accepted the plan, and (in the instance which Mr. Towne mentions) had drawn dividends equal to about 4 or 5 per cent of their yearly earnings. The Yale & Towne gain-sharing system was, like most other American profit-sharing enterprises, abandoned in the nineties (Gilman, *A Dividend to Labor*, p. 351). For the introduction of scientific management in this plant, see *infra*, ch. v., sec. 3.

Halsey read a paper entitled "The Premium Plan of Paying for Labor."[1]

The Halsey premium plan is, in effect, an adaptation of piece-work. Mr. Halsey tells us that he has no use for day-work, because of the easy-going pace and lack of interest which accompany it. At the same time he fails to see much good in profit sharing: In the first place profit sharing is patronage, in that profits may arise from better management or many other causes other than the merits of the workmen. Secondly, it is demoralizing; the surplus profits, due to the increased activity of the more energetic, are apportioned pro rata among all—including the lazy; this spectacle dampens the ardor of even the most enterprising workmen. Thirdly, profit sharing is ineffective, in that rewards six months or a year ahead are too remote. Fourthly, it is not fair for workmen to share profits, for they do not share losses. And finally, the workmen have no means of knowing whether the agreement is carried out honestly by the management.

Halsey's main attack, however, is upon the iniquity of the orthodox piece-work system. In terse but lucid phrases he expresses the fundamental difficulty which we have already discussed. To quote: As soon as a piece-worker increases his output so that he earns beyond what the employer had expected, the latter cuts the rate, which

> is in appearance and in fact an announcement to the workman that his earnings will not be allowed to exceed a certain amount, and that should he push them above that amount he will be met with another cut . . . matters gradually settle down as before to an easy-going pace . . . Their earnings

[1] *Transactions*, vol. xii.

are somewhat more and the cost of the work is somewhat less than under the day's-work plan, but there is no more spirit of progress than under the older method. The employer is constantly on the lookout for a chance to cut the piece prices, that being his only method of reducing cost; and the men are constantly on the lookout to defeat the employer's well understood plan.

Thus Mr. Halsey, speaking from wide experience, holds that the piece-work system "seldom works smoothly, and never produces the results which it should." The piece-work system, like day-work and profit sharing, is incapable of infusing a spirit of enterprise into the workmen.[1]

Halsey's constructive plan is a scheme by which he proposes to so alter the piece-work system that it will never be necessary under any circumstances to cut the rates. His method consists in first determining the time which the men have been taking to do their work, and then announcing that if they will finish it quicker, they will be given, in addition to their old day rate, a new premium rate of so much an hour for the *time saved*. This premium rate is always less than the day rate.

In order to arrive at the fundamental distinction between the premium plan and the piece-work plan, we will first note what would happen if the premium rate were made as great as the day rate (instead of always being

[1] Mr. Halsey discusses the piece-work system before the profit-sharing plan, and indeed discards it along with the rest. But from the comparative and analytical point of view, the premium plan is as we shall see more nearly piece-work than anything else. Though Halsey speaks pointedly of the faults of piece-work, its principle, the appeal to individual self-interest, he makes the corner-stone of his own system. So we have discussed the various plans out of order, that we might dispose first of those systems which Halsey rejects altogether, and treat last the one from which his own system is adapted.

less). That the premium system would in that case be identical with straight piece-work, the following illustration will show. Assume that a man, who has been working under the day-work system at 30c. an hour, turning out one job every hour, is put under the premium system. Suppose that the man is told that he will be paid his old rate of 30c. an hour for the time which he works, and also (if he finishes in less than an hour) be paid at the same rate for the rest of the hour which he does not work. This would be equivalent to piece-work, the said employee being always assured of an hour's pay whether the work takes him a full hour or only twenty minutes. If he finishes in twenty minutes, he would be credited with twenty minutes of work and forty minutes of time saved, one hour in all. The next twenty minutes he could earn another hour's pay, and so forth. The system would be in effect a piece-work mechanism, the rate per piece being here 30c.

But the premium rate, instead of being as high as the day rate, is usually about one-third of the same; and this fact makes the premium system different from straight piece-work. In the following tables, the day rate is fixed at 30c. and the premium rate at 10c. Note that the rate of increase in total earnings is low as compared with the rate of increase in output. Notice especially the correspondence of the total earnings with the figures in the lower column, which are inserted in order to verify an interpretation of the premium system in terms of piece-prices.

The Premium Plan

Output (10-hour day)	Time saved	Premium		Day rate		Total earnings
10 pieces	0 hrs.	$0.00	+	$3.00	=	$3.00
15 "	5 "	0.50	+	3.00	=	3.50
20 "	10 "	1.00	+	3.00	=	4.00
25 "	15 "	1.50	+	3.00	=	4.50
30 "	20 "	2.00	+	3.00	=	5.00

Hypothetical Plan

30 cents for first ten pieces, 10 cents thereafter

10 pieces	$3.00
15 "	3.50
20 "	4.00
25 "	4.50
30 "	5.00

Conclusions may now be reached regarding the real nature of the premium system. The plan first guarantees to each worker a full day rate, and then, having allotted to him a quantity of work which under the day-work system it would take him a day to perform, it offers to pay him for whatever he produces above that minimum a premium [or piece-rate] equal to *one-third*[1] of the day-work cost. It is the one-third feature which is the unique and essential point in the scheme; "Making the hourly premium less than the hourly wages is the foundation stone on which rest all the merits of the system . . ." (Halsey.)

[1] One-third is the most typical figure. Mr. Halsey says, however, that nothing but good sense can decide just how high the rate should be in any given case. The proper rate varies with the nature of the work. Where an increase in production is accompanied by a proportionate increase in muscular exertion, a liberal premium is required. Where the only requirement for speeding-up is an increased attention to speeds and feeds of machines, combined with an increase in manual dexterity and the avoidance of lost time, the premium may be more moderate. In some cases ten cents an hour would not be at all enough. Of other cases, Mr. Halsey says that he has "produced excellent results with premiums as low as three cents an hour."

As regards the merits of the Halsey plan, one advantage claimed for it is a simplification of rate-setting. Under the ordinary piece-work system this is a rather delicate matter. A foreman who undertakes to set a piece-price for work as yet done only by the day must first go to the trouble of estimating how long it should take under the new system, the idea being, of course, to reduce the time. Under the Halsey system, on the contrary, "the attempt to determine the possible output is abandoned. Present output is taken as the basis."[1] This means that, when the premium system is introduced, the men are allowed for performing the work just the length of time which the records show they have been taking in the past. Now they may double or treble the output; but because some two-thirds of the gain goes to the employer and only one-third is retained by the men, the gain of the latter is in no instance excessive. The security of the management consists in the fact that they gather a substantial portion of the gain—not in their care in ascertaining exactly how speedily the work can be done. Hence much record-keeping and calculation is avoided. The time limits come ready-made to the hands of the bosses. Both rate-setting and rate-cutting are automatic.

Among the other advantages of the premium plan is the fact that every workman is guaranteed a day rate, no matter what the output. Also, the instant that an employee turns out even slightly more than under the day-work plan, that moment his premium begins to accumulate. These arrangements eliminate a certain friction which ordinarily accompanies piece-work; it is no longer necessary to force up the speed suddenly to the point where piece-work is a paying proposition.

[1] *Transactions*, vol. xvi., p. 886.

But the chief reason for the development of the premium plan was neither to save the foreman trouble nor to soften a workman's first contact with the piece-work system. The great difficulty attached to straight piece-work, according to Halsey, is the fact that foremen do not know, and can not know, in how short a time the work should be done. Mistakes in rate-setting are inevitable. The premium system, which allows the workman's pay to fluctuate only one-third as much as his output, strikes at the root of this difficulty. In fact, the loss resulting from a mistake in setting a time limit is so much lessened that the management makes it a principle never to make a reduction. Thus a tradition is built up that rates once established are permanent, and the men have no motive for restricting output.

Speculation as to an employer's probable profits under the premium plan, as compared with those under ordinary piece-work, should take the following points into consideration. Ordinary piece-work—though it professes to give a workman the entire value of his increased effort—may more properly be set down as a system which tends to transfer to the management the entire gain due to the workman's improvements, this being accomplished by rate-cutting. The premium plan, on the contrary, can not lay claim to yielding the management more than two-thirds of the profits. However, as the straight piece-work system tends to prevent improvements from being made, while the premium plan encourages the development of the possibilities of production, the latter is often in reality the more profitable of the two. That is, a tribute of two-thirds levied on a booming production may be greater than a tribute of all levied on the work of laggards.

The premium plan[1] was first applied to a shop, three years before the reading of Halsey's paper, by William Kent in the works of the Springer Torsion Balance Company.[2] By 1891 the system had been tried with success in three establishments, and since that time has

[1] This plan was Mr. Halsey's own invention. Frederick W. Taylor, first in 1895 and again in his classic paper on "Shop Management" (1903), has characterized it as a modification of the Towne gain-sharing system. This position, it seems to us, is hardly well taken. Not only did Halsey explain at the start that his idea was clearly formulated before the publication of Towne's paper, and was in no way suggested by the latter's system (*Transactions*, vol. xii., p. 780); but also, a comparison of the two plans shows that they are logically different. That of Towne calls for group-action; that of Halsey is an appeal to individual self-interest. The former would from time to time reduce the gain that falls to the lot of the men; while the latter insists that his very purpose is to avoid the necessity of cutting rates.

In only one respect is there a parallelism. Both propose to eliminate the antagonism between management and men by dividing the gain arising out of increased productivity. But even here the resemblance is not complete. Towne proposes to take a share of the profits that would otherwise go to the management and give it to the men (provided extra profits are earned through the men's increased efforts); while Halsey proposes to obviate rate-cutting by taking profits which the piece-work plan promises the men, and turning the same over to the management. The two systems are alike only in that they are both compromises.

The real reason why they seemed from Taylor's standpoint to be related is this, that neither of them tried to determine scientifically the exact amount of work which it is possible for men to turn out. Both systems, especially Halsey's, represented rather an evasion of this obligation. Instead of trying to take the matter more firmly in hand, they represented a loosening of the grasp, a despair as to the possibility of fixing rates accurately, and a resort to compromise that will minimize evils. But this similarity proves nothing as to the derivation of one system from the other; and to lay stress on the shadowy resemblance to the neglect of the marked differences is hardly just to Halsey nor a reasonable interpretation of the facts.

[2] *Transactions*, vol. xii., p. 768.

found increasing favor. By 1902[1] it was known to be in use in the United States, Canada, England, Scotland, Germany, Italy, and Belgium; while interest in it, at least, had been shown in Sweden and Austria. But it had attracted more intelligent and serious attention in Great Britain than in the United States or elsewhere.

As to the gains actually realized under the premium plan, the following figures, presented by Mr. Halsey some eleven years after the reading of his paper, tell their own story.[2] First, in a case where the manufacture of thirty-five large machines under the old system was followed at a later date by the manufacture of twenty duplicates under the premium system, a comparison of figures showed that the time on the second lot had been reduced 43 per cent. This figure is conceded to be only approximately a measure of the worth of the new system, as conflicting causes operated both to facilitate and hinder the work on the second contract as compared with that on the first. A second exhibit by the same company, not open to these objections, though unfortunately much smaller, showed an average reduction in time of 41 per cent. In this second instance the parts had been made over and over again, and both workmen and foremen had been originally positive that under the old system the time was down to the minimum and that it was useless to apply the premium plan to them. Another exhibit of considerable magnitude, furnished by another company, showed an average reduction in time of 39 per cent. The figures for the reduction in wages cost for the first and third exhibits were respectively 25 per cent and 28 per cent, the average increase in wages

[1] F. A. Halsey, "The Premium Plan of Paying for Labor," in John R. Commons, *Trade Unionism and Labor Problems*, p. 280.

[2] *Ibid.*, pp. 283-285.

paid per workman being respectively 29 per cent and 23 per cent. Mr. Halsey concludes:

These gains are so large as to excite incredulity. Most men of experience will not seriously consider a system which deliberately proposes to increase output by 70 per cent[1] while reducing wages costs and increasing daily wages by 25 per cent, and I am satisfied that if the plan did about half as well as it really does its growth would be much more rapid than it is. Apart from exact figures, which are difficult to get, is testimony from many men in many lines of work, which is substantially unanimous in saying that the system works in the manner described, and this testimony is not a matter of geography or nationality . . .

6. THE "ROWAN PLAN"

There is an ingenious modification of the premium plan, which was first put into operation in Glasgow. When David Rowan & Company, of that city, makers of marine engines, and the first British firm to take an interest in the premium plan, introduced the same into their works, they adopted a modification which, though not approved in the United States, has been followed to some extent in Great Britain, under the name of the Rowan plan.

It should be remembered that the object Mr. Halsey had in mind in inventing his system had been to obviate the necessity of rate-cutting through so arranging the piece-rates that the workmen could never earn excessive wages. The framers of the Rowan plan feared that this result would not be realized in all cases. Suppose, for instance, that through some unexpected development, a man should produce ten times as great an output as

[1] A reduction in time of 41 per cent is equivalent to an increase in output of 70 per cent.

formerly. Even after the Halsey plan had given two-thirds of the increase to the management, the workman would still earn three times more than, or four times as much as, he was getting under the day rate. Although the multiplication of output by ten would perhaps be rather extreme, yet the framers of the Rowan system did have a serious apprehension that in some cases workmen under the Halsey system might earn wages so excessive as to necessitate a cut.

The Rowan plan therefore provides that after a certain amount of time has been allotted to a workman as a standard time for the performing of his work, he shall for a shortening of that time be rewarded by a raise in his day rate, the premium added bearing to the day rate the same proportion that the *time saved* bears to the *time allotted*. Thus if the time allotted is 60 minutes and the work is performed in 40 minutes, then the premium added to the day rate must amount to the time saved (20 minutes) divided by the time allotted (60 minutes), or one-third. If the workman's day rate is 30c. an hour, it is now raised to 40c. an hour (30 plus one-third of 30); and since he was working for 40 minutes (two-thirds of an hour), his pay for the job is 26⅔c. (two-thirds of 40).

The following graph shows the real significance of this modification :

$\frac{\text{time saved}}{\text{time allotted}} = \frac{\text{hourly premium}}{\text{hourly rate}}$ 10 + 30 = 40¢ an hour

40 minutes work = 26 ⅔ ¢

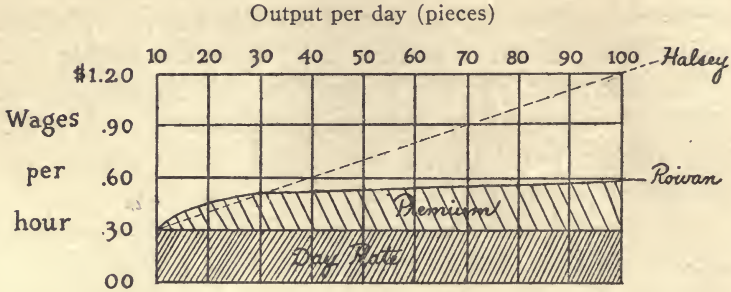
$\frac{20}{60} = \frac{\text{hourly premium}}{30}$

hourly premium = $\frac{20}{60} \times 30$

= 10

CHART

Comparing Halsey and Rowan Systems



The Rowan plan thus accomplishes its purpose. The proportion of *time saved* to *time allotted* must always be a fraction less than one, and the rate of premium can therefore for no output quite equal the day rate. Thus double pay is the limit beyond which wages absolutely cannot pass. The seeming inhumanity of the system is offset by the fact that, until a man has tripled his output, his pay is actually higher than under the Halsey plan. It thus combines a high reward for the man who by his industry doubles the output, with a positive though somewhat elastic stopping of the upward spurt of wages in the case of a man who has found a "soft snap."

CHAPTER III

The Genesis of the Principles of Scientific Management

The preceding chapter may lay a double claim to having prepared the way for the treatment in this of the genesis of scientific management.

In the first place, its description of the faults of the ordinary methods of wage payment, and of the efforts of Towne and Halsey to introduce worthier systems, has yielded a stock of information regarding the labor situation, without which, or some similar explanation, we could not understand the design in scientific management.

The other, more important, consequence of the last chapter's review is the fact that only after such a survey could one appreciate the unique character of the new movement. It will be this knowledge of the plans of the earlier builders which will enable us to decide whether scientific management is to be regarded as the last stone in an edifice long in process of construction; or whether it is indeed a growth for which there has been no earlier counterpart either in Europe or America. That scientific management falls rather under the latter classification, that it is a system whose methods are more or less different from anything that has gone before, will be among the implications of the present chapter on the development of its fundamental principles.

I. THE FIRST SCIENTIFIC MANAGEMENT

The first systematic presentation of what is properly called scientific management occurred in 1895, when Frederick W. Taylor read before the American Society of Mechanical Engineers a paper entitled "A Piece-Rate System."[1] Scientific management had in fact beeen invented and put into practice some ten or fifteen years before 1895. But inasmuch as from those earlier days no full statement of the principles has come down to us, we will not try to subdivide the system's development into minor periods, but will regard as a single epoch the years before 1895, and present as the initial philosophy of the system the principles summed up by Taylor in the above-mentioned paper.[2]

An examination of "A Piece-Rate System" shows that the great object in establishing scientific management was to solve the wages problem. The nature of this problem is so well understood that a grasp of Taylor's point of view towards it should be conveyed by a mere reference to his two main arguments: In the first place, he says that under the day-work system the men soon conclude that there is no profit to them in working hard; secondly, he extends his indictment to piece-work, and charges that under the latter the desire of the men to stave off cuts leads to the almost equally serious evil of restricted output. Taylor's method of attacking the wages problem consisted in an

[1] *Transactions*, vol. xvi.

[2] As the first steps toward the development of scientific management were taken about 1880, and some of its most vital features were in operation as early as 1883, scientific management goes back to an earlier date than either Towne's gain-sharing or Halsey's premium plan. For many years, however, few persons knew of Taylor's activities, so that the engineers who listened to his paper of 1895 thought of the system therein outlined as the most recent of the three. Halsey, for one, was until that time unacquainted with Taylor's main ideas, as witness his statements, *Transactions*, vol. xvi, pp. 884, 886.

improvement of piece-work by virtue of which rate-cutting was to be eliminated.

The originality in Taylor's scheme consisted, however, neither in his view of the problem, nor in his singling out of rate-cutting as a target for reform. It was when he offered his specific proposal as to how rate-cutting might be avoided that the construction of his own unique system began. Up to the time of the reading of the paper under study, the solution of the rate-cutting problem which had attracted most attention was that which has been described under the name of the premium plan. The inventor of the premium plan had claimed that the cure for rate-cutting lay in giving to the workman only a fraction of the value resulting from his speeding up. Taylor's idea was quite different. He argued that if the management merely knew how long it should take a man working at his best to complete a job—that information alone would eliminate the necessity of cutting rates. For the management could then so fix the rates in the first place that the men would be compelled to do a good day's work in order to make reasonable wages; and further—since all would have to do their best to make fair earnings—so no man could by virtue of any effort attain to an excessive income. In short, an exact, scientific determination of the maximum speed at which work can be done is, according to Taylor, the means to be invoked for solving the wages problem.

Now, it was precisely because Halsey had denied the possibility of obtaining such data that that leader among engineers had gone to the trouble of inventing his premium system. Taylor's proposal, therefore, requires backing up in the shape of practical suggestions as to how his records may be obtained. This basic proposition Taylor discusses under the caption of *elementary rate-fixing*, a term which has since been displaced by the broader and more suggestive title, *elementary time study*.

a. *Elementary Time Study*

As compared with the methods usually employed in timing workmen, the unique characteristic of elementary time study is this, that it involves an analysis of a job as a whole into the elementary movements of man and machine, which when followed the one by the other accomplish the desired end. Thus, if the job be the planing of a piece of cast iron, the following analysis might be made:

Analysis by Elementary Time Study of the Planing of a Surface on a Piece of Cast Iron [1]

Work done by man	*Minutes*
Lift piece from floor to planer table	——
Level and set work true on table	——
Put on stops and bolts	——
Remove stops and bolts	——
Remove piece to floor	——
Clean machine	——
Work done by machine	
Rough off cut ¼ in. thick, 4 feet long, 2½ ins. wide	——
Rough off cut ⅛ in. thick, 3 feet long, 12 ins. wide, *etc.*	——
Finish cut 4 feet long, 2½ ins. wide	——
Finish cut 3 feet long, 12 ins. wide, *etc.*	——
Total	——
Add —— per cent for unavoidable delays	——

More fully stated, the first step in elementary time study is to divide a task into its simple elements; the second is to jot down opposite each element the number of seconds or minutes which, according to a stop watch, it takes a workman to perform it; the third is to add these unit times together to obtain a total time; and the fourth is to multiply this sum by a factor which allows for rest and other necessary delays. Its essence is thus the obtaining of a standard time, not through an unanalytical observa-

[1] Taken with slight alterations from "A Piece-Rate System," *Transactions*, vol. xvi, p. 871.

tion of the job as a whole, but rather through adding together the unit times required for the individual acts whose aggregate constitutes the job.

But the question arises, Why this complicated and costly analysis? Wherein does Taylor attain results superior to those which would have been realized through the simpler method of timing jobs as a whole?

It should first be noted that elementary time study, far from being as tedious and expensive as it at first glance appears, is in reality rather simple. The reason for this simplicity arises from the fact that the elements into which each job may be split up are comparable with similar elements which enter into other jobs. Thus, to draw an analogy, the jobs in any one trade might be likened to the chemical compounds. Both are countless in their number and confusing in their complexity. But just as the chemist can reduce by analysis all of his innumerable compounds to some seventy interchangeable elements, so also the time-study man, on splitting up his thousands of factory jobs into their component elements, finds that he has reduced them all to a comparatively small number of fundamental operations.

To be specific, a glance at the time-study analysis printed above makes it evident that all of the operations classified as "work done by man" must appear over and over again in hundreds of different jobs. Also, although any one of those operations classified as "work done by machine" varies in difficulty for different jobs according to whether their specifications call for the cutting away of a larger or smaller amount of metal, nevertheless each of these operations belongs to a group among which the variations in time required may be calculated by the use of mathematical formulas.

The effect of these facts upon the mechanism of elementary time study is this: they make it possible to keep on file in the office, records showing the number of minutes or seconds required for the performance of each work element entering into the jobs in the shop; then when a new job is to be introduced, it is only necessary to divide it into its elements, copy from the records the time required to perform each operation, add these unit times together, and finally multiply by the usual factor of safety, or margin for rest and delays. Gantt states that during a certain month ninety-two per cent of the new tasks imposed in one shop were set solely from data in the office, without the rate-setter entering the shop at all. Indeed, argue the advocates of scientific management, is not this system much more simple than the old way, according to which the foreman was accustomed to gather records from a number of similar, yet non-identical jobs, and then guess as best he could as to how long the new job should take?

The above explanation answers in part the question as to the why and wherefore of elementary time study—in that it indicates that the system is simpler in operation than the methods formerly used. As closely following from this simplicity of operation should be mentioned a second advantage, one which is realized mainly in connection with large non-repetitive work. According to the old system, which based piece-rates upon past records covering jobs as a whole, it would be practically impossible to put special work on a piece-work basis, the probability being that the rate so estimated would be wide of the mark. Elementary time study, by offering an easy method for the accurate fixing of a rate before the job has been begun, permits the extension of the piece-rate system to non-repetitive work.

The main reason, however, for the invention of elementary time study was not the simplification of rate-setting, nor yet the extension of the piece-work plan to non-repetitive work. The chief object of its creation was to secure *accuracy of results*. Under the old plan of measuring a complicated task as one unit, the workman who desired to deceive, or the workman who was ignorant or unskilful, was likely to throw in a number of extra operations, thus leading to a padding of the time. Indeed, it was this padding of the time upon the occasion of the original rate-setting that caused the subsequent rate-cutting, and hence all the trouble. Taylor claims that the mechanism of elementary time study, in counting every operation in the work, entirely eliminates the possibility of padding. At the same time, the system also enables the time-study man to judge whether his subject is performing the actually necessary operations at a standard speed. For the elements that enter into the job are in most cases similar to elements with which the expert has become familiar in studying other jobs. Thus he comes to the work with fairly definite ideas as to how long every operation should take, and if the time-study man and the workman pit their wits against one another, the advantage is with the former. The system, therefore, assures the honesty of the workman observed. It eliminates the uncertainty creeping into lump measurements as to whether it is the job that is being timed or merely a series of "fake" or clumsy motions. As a result, it provides unimpeachable data, which may be used as a basis for fixing piece-rates—piece-rates which it will never be necessary to cut. In a word, elementary time study, according to the advocates of scientific management, is the key to the solution of the wages problem.

b. *The Differential Rate*

The determination by elementary time study of the maximum speed at which work can be done is not, however, a complete solution of the wages problem. The management must further find some means to induce the men to actually work at this maximum rate. The means which Mr. Taylor warmly advocated until many years after his reading of "A Piece-Rate System" is called the differential rate. By the differential rate is meant a piece-rate scheme by which a low rate per piece is paid for a small output, and a higher rate per piece for a larger output. Its effect is to make the difference between the pay given to a good worker and that given to a poor worker even greater than the difference in their respective productivities. Its purpose is to make it doubly certain that the men will keep up to the maximum rate which elementary time study has established as possible of achievement.

It is assumed by Mr. Taylor in the paper under consideration that the differential rate is justified by the fact that, as production increases in volume, the amount of overhead expense per article diminishes. He says that many manufacturers

> lose sight of the fact that taxes, insurance, depreciation, rent, interest, salaries, office expenses, miscellaneous labor, sales expenses, and frequently the cost of power (which in the aggregate amount to as much as wages paid to workmen) remain about the same whether the output of the establishment is great or small.[1]

But when they only understand the situation, "the employers can well afford to pay higher wages per piece even permanently, providing each man and machine in the establishment turns out a proportionately larger amount of work."[2]

But an observation of what Taylor says in other places

[1] *Transactions*, vol. xvi, p. 867.

[2] *Ibid.*, p. 867.

shows that in starting the differential-rate system he had no intention of actually paying workmen higher wages per piece than they had received before. Thus he declares:[1]

Mr. Halsey is in error, however, in his assumption that my system of piece-work involves paying a higher price per piece than is paid under the ordinary system. On the contrary, with the differential rate the price will, in nine cases out of ten, be much lower than would be paid per piece either under the ordinary piece-work plan or on day's work.

What Mr. Taylor did have in mind was the opposite policy of *lowering the earnings* of those who refused to come up to the standard. The following illustration given by Mr. Taylor in his paper clearly shows this. In the first case to which the differential rate was applied, the turning of a standard steel forging, the price on days when less than 10 pieces were turned out was fixed at 25c. each. On days when 10 pieces or more were turned out, the price was raised to 35c. each. However, the important fact to be noted is that under the old system the men had been paid not 25c., or even 35c., but 50c. a piece. Thus the differential-rate system amounted here to a general cut from 50c. to 35c.; the differential feature was merely a further provision penalizing those who did not accept the reduction—those who failed to increase correspondingly, and more than correspondingly, their output. "Make good at 35c. or you will receive only 25c., in which case you might as well quit," was, in effect, the command. Or, to put it in Taylor's words, "the lower differential rate should be fixed at a figure which will allow the workman to earn scarcely an ordinary day's pay when he falls off from his maximum pace[2] . . . [a figure] so small as to be unat-

[1] *Transactions,* vol. xvi, p. 887.

[2] *Ibid.,* p. 873.

tractive even to an inferior man."[1] The 25c. rate in the case cited was therefore not supposed to be an adequate compensation, but rather a punishment, the entire object of the system being simply to force production to a definite predetermined standard.

Though the differential rate thus punishes those who fall short of the standard, at the same time it rewards those who succeed by paying them a wage substantially greater than would have been allowed under the ordinary piece-work system. The men are assured, furthermore, that if they keep up to the specified pace, their rates will never be cut, and that they may continue indefinitely to earn a larger wage than is usual for the trade.

Thus, to summarize, a combination of elementary time study, the differential rate, and a policy of never cutting rates, means first, the removal of restrictions on output due to fear of rate-cutting; second, the forcing of production up to the maximum, because of the introduction of the differential rate; and third, the cheerful maintenance of this speed by the men, due to the fact that their permanent earnings are sufficiently above the average to make them contented. While—in the illustration on which Mr. Taylor dwells—the speed was such that the men "were obliged to work at their maximum pace from morning to night," so that it made a "big day's work, both for men and machines," yet "from the day they first turned 10 pieces to the present time [1895], a period of more than ten years, the men who understood their work have scarcely failed a single day to turn at this rate." The differential rate was in all cases accepted willingly by the men.

Although maximum output is especially desirable where expensive machinery piles up overhead expense, it is evi-

[1] *Transactions,* vol. xvi, p. 874.

dent from the above explanations that the differential rate does not base its justification upon this argument alone; its logic might be applied wherever piece-rates are practicable.

c. *Conclusions*

In the first stage of its genesis, scientific management therefore consisted of two main features: first, the determination by elementary time study of what constitutes a day's work; and second, the differential rate.

As to the relative merits of the two principles, Mr. Taylor had the following to say: [1]

> Of the two devices for increasing the output of a shop, the differential rate and the scientific rate-fixing department, the latter is by far the more important. The differential rate is invaluable at the start, as a means of convincing men that the management is in earnest in its intention of paying a premium for hard work; and it at all times furnishes the best means of maintaining the top notch of production; but when, through its application, the men and the management have come to appreciate the mutual benefit of harmonious coöperation and respect for each other's rights, it ceases to be an absolute necessity. On the other hand, the rate-fixing department, for an establishment doing a large variety of work, becomes absolutely indispensable. The longer it is in operation the more necessary it becomes.

As to the actual value of elementary time study and the differential rate, Mr. Taylor claimed that they had been in successful operation for the preceding ten years. He summarized as follows the typical results:

[1] *Transactions, loc. cit.*, p. 875.

TABLE SHOWING SUPERIORITY OF DIFFERENTIAL RATE OVER ORDINARY PIECE-WORK FROM THE VIEWPOINT BOTH OF THE MANAGEMENT AND THE MEN [1]

Ordinary Piece-Work (*5 pieces at 50c. each*)		*Differential Rate* (*10 pieces at 35c. each*)	
Wages	$2.50	Wages	$3.50
Machine cost	3.37	Machine cost	3.37
Total cost per day	5.87	Total cost per day	6.87
Cost per piece	$1.17	Cost per piece	$ .69

Thus Mr. Taylor regarded as typical an increase in production of 100 per cent, an increase in wages of 40 per cent, and a reduction in cost of 41 per cent.

A word now as to the distinction between the points of view of Towne and Halsey and of Taylor. The most conspicuous respect in which Mr. Taylor differed from these gentlemen was in his confidence in the management's ability to gain an intimate knowledge as to the details of work. Towne and Halsey conceived improvement in industry as being of very slow growth. They thought that it must necessarily take a long time for the methods of work to be brought to perfection; that for many years there might be a gradual increase in speed as the workmen would discover short cuts that would reduce the time. Taylor, on the contrary, boldly proposes that the management determine absolutely and without any room for doubt just how long it should take to do work, now and for all the future. When Taylor has once completed his investigations, production is supposed to be forced up to the maximum at one leap. There is to be no subsequent improvement extending over a course of years. Or if there is, it is not important enough to enter into the calculations. Far from being possessed by that fear of making a mistake in fixing the rates, which caused Towne and Halsey to pro-

[1] Adapted from Taylor's table, *loc. cit.*, p. 879.

pose to divide profits between management and men, Taylor advocates, in the differential rate, a system which would magnify instead of minimize the effect of mistakes. Thus the one point in "A Piece-Rate System" which is most suggestive of the future development of scientific management is this, that the management is supposed to know more about the work than the men themselves—to know more than they know at present, and more than they can discover in the future.[1]

It may be noted that the hearers of Taylor's paper, in spite of the author's repeated emphasis on elementary time study, were at the time more interested in the differential rate. With the passage of years, however, the tables have been somewhat turned, so that, although Taylor long continued to claim some merit for the differential rate, his followers soon abandoned that part of scientific management almost altogether. The study of unit times now stands as the single basis of the system.[2]

2. THE SCOPE OF SCIENTIFIC MANAGEMENT ENLARGED

Between 1895 and 1903 certain fundamental additions were made to the body of scientific-management doctrine

[1] We are speaking here of improvements in the method of work, the process, tools, and equipment remaining the same. These last will, of course, frequently be changed. But the process having been determined for the time being and the tools and material conditions of work having been specified, the success of Mr. Taylor's system depends upon the management's discovering at the outset the very best way in which the tools, *etc.*, can be handled. The rate must stand until there is another change in conditions.

[2] Mr. Taylor had never heard of the differential rate before it was invented and put into operation by himself in 1884. It is, however, essentially the same thing as is to be found in certain French industries, and called "progressive wages" in M. Leroy-Beaulieu's *Essai sur la répartition des richesses.* This should not detract at all from Mr. Taylor's independent discovery and application of the principle to American industry.

and practice; one returning to view the system's progress in the latter year would discover that the old features had come to constitute only one aspect of a greatly enlarged system.[1] In the study of this second stage of development, the most important source is the re-statement of principles contained in "Shop Management," a paper read by Frederick W. Taylor in June, 1903, before the American Society of Mechanical Engineers.[2] In "Shop Management," we have the classic of scientific-management literature, a paper which both sums up the achievements of the past and marks out the lines along which were to occur the chief developments of the future. The three following divisions will discuss the three principal aspects of the completely formulated system.

a. *The First Phase of Complete Scientific Management: Securing the Initiative of the Workmen*

In the first part of "Shop Management," one meets with those devices for determining maximum output and inducing the men to work up to that limit, which constituted the one theme of "A Piece-Rate System." Such attempts to secure the initiative of the workmen may now be classified as simply the first phase of the enlarged system. Before dismissing this aspect of the subject it will only be necessary to add such details as will bring the story down to the year 1903.

The first new point brought out in "Shop Management" consists in the announcement that the great success of the system is due to the passing by of ordinary workmen and the employment of unusual men only. The reason why

[1] The development of 1895-1903 included the advances made at Bethlehem and the work of Sanford E. Thompson in reorganizing the building trades.

[2] *Transactions*, vol. xxiv.

Taylor's men could accomplish so much more than those in other shops was because he had taken sufficient pains, and offered high enough wages to draw to him superior workmen—men who were so constituted mentally and physically that they could maintain a very rapid pace. "The possibility of coupling high wages with a low labor cost rests mainly upon the enormous difference between the amount of work which a first-class man can do under favorable circumstances and the work which is actually done by the average man." [1] In most cases first-class men can do "from two to four times as much as is done on an average."

A second conspicuous feature of "Shop Management" is the relatively lighter stress now laid upon the differential rate. The differential rate is still recommended as the simplest and most forceful way of controlling the labor situation. But as more convenient in some circumstances is mentioned Mr. Gantt's device, invented two years earlier, known as "Task Work with a Bonus." We may note that the recommendation of both of these systems is based on the fact that each in its own way causes the men to receive automatically and daily either an extra reward in case of complete success, or a distinct loss in case they fall off even a little. In some cases, it is stated, day-work or straight piece-work may be coupled with elementary time study and made to achieve excellent results. Thus the conclusion may be drawn from Mr. Taylor's discussion that the precise wage system has now become comparatively unimportant, and depends for its justification largely upon the circumstances of the case. The only important consideration is to adopt some means by which extra high wages are offered for extra hard work.

One other observation: The precision with which Tay-

[1] *P.* 1345.

lor was accustomed to analyze human nature is well illustrated by the following quotation, taken from his advice as to how great, under varying circumstances, a workman's extra reward should be:[1]

The writer has found, for example, after making many mistakes above and below the proper mark, that to get the maximum output for ordinary shop work requiring neither special brains, very close application, skill, nor extra hard work, . . . it is necessary to pay about 30 per cent more than the average. For ordinary day labor requiring little brains or special skill, but calling for strength, severe bodily exertion and fatigue, it is necessary to pay from 50 per cent to 60 per cent above the average. For work requiring especial skill or brains, coupled with close application but without severe bodily exertion, such as the more difficult and delicate machinist's work, from 70 per cent to 80 per cent beyond the average. And for work requiring skill, brains, close application, strength and severe bodily exertion, such, for instance, as that involved in running a well run steam hammer doing miscellaneous work, from 80 per cent to 100 per cent beyond the average.

Outside of the above-noted explanations, and a stock of new illustrative material, "Shop Management's" treatment of the phase of scientific management which has to do with the securing of the initiative of the workmen is essentially the same as that presented eight years before. The starting-point of the system is still the determination of a "standard time," or "quickest time," by the study of "unit times." The manner in which the final results are assured is indicated by the capitalized mottoes, "A Large Daily Task," "High Pay for Success," and "Loss in Case of Failure." (The significance of another motto, "Standard Conditions," is bound up more

[1] *P.* 1346.

with the second than with the first aspect of scientific management.)

b. *The Second Phase of Complete Scientific Management: Improving Methods of Work*

The second group of principles contained in "Shop Management" do not appear all in one place, but are scattered, for the most part, through the latter half of the paper. They have to do, not with drawing more effort from the men, but with introducing more efficient methods of work. The manner in which this new field was entered will be the topic of discussion in the following half a dozen sections. The leading principles will be stated and illustrated therein—as nearly as can be, in the order of their respective importance.

(1) Standardization of Tools and Equipment

The original reason for the infusion of standardization into scientific management was a demand for it on the part of scientific rate-fixing. It was early realized that it might well happen that a job which time-study analysis had found could be done in one hour would actually take various workmen times ranging from one hour, to an hour and a half, or two hours—for no other reason than that their respective machines were in different conditions. It was to avoid this unevenness of earnings, which would brand the system as ridiculous and unfair, even more than to secure the advantage of better equipment for its own sake, that the question of standardization of tools and equipment was first taken up.

> It is uniformity that is required. Better have them [the tools] uniformly second class than mainly first with some second and some third class thrown in at random. In the latter case the workmen will almost always adopt the pace which conforms to the third class instead of the first or second.[1]

[1] *Transactions, loc. cit.*, p. 1407.

Thus standardization was originally regarded as merely a preliminary step—a means to the attainment of the more important end of securing maximum effort on the part of the workmen. As early as 1895, however, it was recognized that the means was in itself of considerable value. Thus in "A Piece-Rate System," Mr. Taylor says [1] that "not the least of the benefits of elementary rate-fixing are the indirect results." He then refers to the great benefits which were derived at the plant of the Midvale Steel Company because elementary time study enabled the management to correct faults and make improvements in machine construction. The study "developed the fact that they [the machines] were none of them designed and speeded so as to cut steel to the best advantage." The company has accordingly "demanded alterations from the standard in almost every machine which they have bought during the past eight years," and has itself superintended "the design of many special tools which would not have been thought of had it not been for elementary rate-fixing." Not only has there been improvement due to the study of machines—

But what is, perhaps, of more importance still, the rate-fixing department has shown the necessity of carefully systematizing all of the small details in the running of each shop; such as the care of belting, the proper shape for cutting tools, and the dressing, grinding, and issuing same, oiling machines, issuing orders for work, obtaining accurate labor and material returns, and a host of other minor methods and processes. These details, which are usually regarded as of comparatively small importance, and many of which are left to the individual judgment of the foreman and workmen, are shown by the rate-fixing department to be of paramount importance in obtaining the

[1] The quotations in this paragraph are taken from *Transactions*, vol. xvi, p. 877.

maximum output, and to require the most careful and systematic study and attention in order to insure uniformity and a fair and equal chance for each workman.

These improvements in machines and in shop routine are a joint product of the effort to establish standards for tools and equipment, and the desire to discover the quickest time in which work can be done.

Thus there is in "A Piece-Rate System" one page which forcefully enumerates the incidental advantages rising from standardization — a passage which clearly anticipates the prominence to be given to the subject later in "Shop Management." This fact makes it a little hard to tell when scientific management was enlarged to cover standardization—the same was utilized from the beginning. If, however, we make our decision as to when different features were added to scientific management depend upon the time when they assumed a real place in the thought of the leaders, we may decide that standardization properly fitted into the system of 1903, but not into that of 1895.

Standardization is looked upon to-day as important, not only because it means *uniformity* of working conditions, but also because it means that all tools and all working conditions will be of the *best.*

The origin of the other features next to be considered need not be discussed as critically as was necessary in the case of standardization. They find no expression in "A Piece-Rate System." Though doubtless most of them were latent in the system in 1895, only in "Shop Management," and indeed not fully then, were they revealed as one of the great major ends of scientific management.

(2) Routing and Scheduling

By routing is meant the designation of the machine or man to which work is to be sent. Two sorts of advantages may be sought. In some cases the end in view is to choose the machines, or perhaps arrange them, so that the work will not need to be moved an unnecessary distance. In other cases, not the distances, but the machines themselves, or their operators, are the objects of study. Thus the chief in charge of an efficient routing system takes care that the machines and men always have the right amount of work on hand; which means, among other things, that the loss of time through waiting for a job is eliminated. He also endeavors to send the work to those machines and men that are best fitted for it. Finally, rush jobs are dispatched first, and a system is arranged by which large orders are not kept waiting because of negligence in completing some of their parts. Scheduling is routing as regards the time aspect. By routing, it is decided where the work shall be done; by scheduling, when. Thus they are merely the two sides of the same thing.

From the time when the first factory was opened until the present day, it has of course been not the least of the duties of the management to decide when and by whom the work shall be done. Routing and scheduling are here classified as a part of scientific management only because in connection with this system they have been carried to a remarkable degree of refinement. The reason for this unusual development is, of course, due to the fact that the workmen, to make their proper pay, are obliged to apply themselves vigorously and constantly, a situation which makes it of the utmost importance that the work pass through the shop in so orderly a manner that the men may be employed without interruption. But the mechanism of routing once having for this reason been put into operation, scientific management has seized the opportunity afforded, to accomplish savings along all the broader lines mentioned above. It is explained in "Shop Management" [1] that there is a special "Order of Work or Route Clerk," who lays out "the exact route which each piece of work is to travel through the shop from machine to machine," and who daily writes out instructions which "constitute the chief means for directing the workmen [as well as the bosses] in this particular function." The result is shown not only in the earnings of the men, but also in the prompt and economical completion of the work.

It may be noted in this connection that routing and scheduling, though an essential part of scientific management at the time when "Shop Management" was written, were later to receive a much fuller development—as in the plant of the Tabor Manufacturing Company. Routing and scheduling now constitute one of the most profitable features of the system.

(3) Instruction Cards

An instruction card is a set of directions for the performance of a special piece of work. To many this system seems supervision gone mad. What possible saving can there be in one man's anticipating every act on the part of another by issuing a written order! The key to an understanding of the purpose of the instruction card is to be found in the peculiar conditions existing in a shop given over to the cutting of metals. It was here that the system originated, and it is of such a shop that Mr. Taylor and others are thinking when they speak of the instruction card.

The story of the situation in metal-cutting shops, of the long effort of Taylor and others to facilitate production therein, and of their final triumph—this is referred to and briefly treated in "Shop Management." For a sketch of the movement, however, it is advisable to rely on the far

[1] *Transactions*, vol. xxiv, p. 1393.

better account given three years later in Taylor's paper, "On the Art of Cutting Metals" [1]—a treatise which was at the time appraised by the editor of the *Transactions* as probably the most remarkable contribution ever received by the American Society of Mechanical Engineers.

The gist of the problem which confronts a workman in charge of a metal-cutting machine is thus concisely put in the last-named paper:

> There are three questions which must be answered each day in every machine shop by every machinist who is running a metal-cutting machine, such as a lathe, planer, drill press, milling machine, *etc.*, namely:
>
> (a) What tool shall I use?
> (b) What cutting speed [2] shall I use?
> (c) What feed shall I use?

This problem, although one to which the machinist has perhaps devoted many years, is quite impossible of accurate solution by his judgment alone. For a choice of the most efficient speed and feed is not the same from job to job; but its determination is almost infinitely complicated by the fact that it depends upon twelve variables. There must be taken into account (a) the quality of the metal which is to be cut, (b) the diameter of the work, (c) the depth of cut, (d) the thickness of the shaving, and so on through (e), (f), (g), and five others. The desire to find a scientific way of solving this hitherto unsatisfactorily approached question led Taylor, in 1880, to start an investigation along these lines, as a part of his managerial duties.

[1] *Transactions,* vol. xxviii, p. 31.

[2] Taking a lathe for illustration, the *speed* is the rate at which the surface to be dressed is brought into contact with the tool, while the *feed* is the rate at which the tool—or the work—is moved laterally so that the tool may come in contact with fresh areas of surface.

The task proved unexpectedly severe. Mr. Taylor thought he would complete it in six months, but instead it took twenty-six years. More than 800,000 pounds of iron and steel were cut up into chips, and through the aid of certain great corporations between $150,000 and $200,000 was spent on the experiments. Nevertheless the problem was solved, and most important of all, the scientific formulae obtained were embodied between 1899 and 1902 in slide rules, " which are so simple that they enable an ordinary workman to make practical and rapid every-day use in the shop of all the laws and formulae deduced from [the] experiments."

As a matter of shop practice, however, it is much easier to have this clerical work attended to in the office, and it is for precisely this reason that the instruction card was introduced. Blanks similar to the one shown below are filled out in the office, or as we may now call it the " planning department," and then sent to the men on the machines. They tell the workmen briefly

> the general and detail drawing to refer to, the piece number and the cost order number to charge the work to, the special jigs, fixtures, or tools to use, where to start each cut, the exact depth of each cut, and how many cuts to take, the speed and feed to be used for each cut, and the time within which each operation must be finished,[1]

as well as information regarding the rate of pay. Care is also taken to suggest such an order for the performance of the different operations as will minimize unnecessary adjustments of the machine, and facilitate the handling of the work.

[1] *Transactions*, vol. xxiv, p. 1393.

A BLANK

TIRE-TURNING INSTRUCTION CARD[1]

Machine shop ....
Order for ....Tires.................
Do work on Tire No. ....
as follows and per blue print..

	[1] Templet.	[2] Size to be cut to.	[3] Depth of cut.	[4] Driving belt.	[5] Feed.	[6] Rate.	[7] Time this operation should take.
Surface to be machined	......	......	......	......	......	......	......
Set tire on machine ready to turn	......	......	......	......	......	......	......
Rough face front edge	......	......	......	......	......	......	......
Finish face front edge....................	......	......	......	......	......	......	......
Rough bore front.................	......	......	......	......	......	......	......
Finish bore front	......	......	......	......	......	......	......
Rough face front I. S. C.	......	......	......	......	......	......	......
Cut out filled	......	......	......	......	......	......	......
Rough bore front I. S. F..................	......	......	......	......	......	......	......
Rough face back edge......................	......	......	......	......	......	......	......
Finish face back edge......................	......	......	......	......	......	......	......
Finish bore back	......	......	......	......	......	......	......
Rough bore back	......	......	......	......	......	......	......
Rough face back I. S. F.	......	......	......	......	......	......	......
Cut out filled	......	......	......	......	......	......	......
Cut recess	......	......	......	......	......	......	......
Rough turn thread	......	......	......	......	......	......	......
Finish turn thread	......	......	......	......	......	......	......
Rough turn flange	......	......	......	......	......	......	......
Finish turn flange	......	......	......	......	......	......	......
Clean fillet of flange	......	......	......	......	......	......	......
Remove tire from machine and clean face plate..	......	......	......	......	......	......	......

It is thus seen that the instruction card is a combination of specifications covering the work, and of instructions as to methods. Its use is primarily in that field where there

[1] *Transactions,* vol. xxiv, p. 1382.

is associated with manual work a large and rather abstruse technical element, and especially where inefficiency would not only lead to a high wage cost, but also involve waste in the operation of expensive machine processes. It frequently represents the results of years of scientific study put in the most convenient form for the use of the workmen. If the card be for special work, it cannot, of course, go into small details, but merely gives a skeleton of the important things to look after in the execution of the task.

Though the idea of the instruction card has been extended to serve various other purposes, its type is the special card described above. When a scientific-management expert speaks of an "instruction card," he is not thinking of general information tabulated for permanent reference —at least not usually. This latter device could, of course, form a part of scientific management; but, as a matter of fact, it has never received emphasis.

(4) Motion Study [1]

Shortly after the beginning of the Spanish war (1898), a rise in the price of pig iron led the Bethlehem Steel Com-

[1] Perhaps the most interesting illustration of motion study is Gilbreth's reorganization of bricklaying. Striking, also, were the extensive experiments made at Bethlehem covering the art of shoveling. The first of these tasks, however, was not undertaken until some years after "Shop Management" was written, and the latter was given scanty consideration therein. Indeed, one cannot gather a very satisfactory account of motion study entirely from literature written as early as 1903. Details are lacking; perhaps at the time the value of the principle was not really appreciated. It would be a mistake, however, to pass the subject of motion study entirely by in this connection; for it was in fact highly developed by 1903, and indeed at many points almost came to the surface of "Shop Management." We have therefore ventured to describe an undertaking whose results are given in that paper, though for working details we must rely almost altogether on Taylor's later *Principles of Scientific Management* (1911).

pany to sell, and to prepare to load on cars, eighty thousand tons of pig iron, until then stored in small piles in an open field. The pig-iron handlers had started on the great task at an average rate of 12½ long tons per man per day, a rate which was, "on the whole, about as fast . . . as it was anywhere else at that time." Then it was that Mr. Taylor determined to apply scientific management; and, by combining an offer of high pay for success with careful selection of his men and scientific direction as to the way in which they should attack their work, succeeded in increasing the average achievement, so that every man loaded, not 12½, but 47½ long tons a day. These phenomenal results could not have been produced by motion study alone; but that it was a necessary factor, the following explanation will make clear.

In the field of heavy laboring, science's opportunity to help the workman lies, not in suggesting a system of deft or ingenious movements, but rather in minimizing muscular strain—in utilizing human energy to the utmost. When Mr. Taylor determined to increase the achievements of pig-iron handlers at Bethlehem, he dared not induce them to speed up as they themselves might choose; he foresaw that they would start in with a rush, and stop because of fatigue long before the day's task was performed. It was found, however, that a man of suitable physique could increase the number of tons handled with perfect safety provided the overseers enforced periods of rest at frequent intervals. In short, this guiding principle was discovered: that to do his best, a first-class laborer carrying pigs weighing 92 pounds each should be under load only 43 per cent of the time. The "science" of handling pig iron, therefore, consisted first in choosing the proper men, and then in making them rest at intervals which had been found by careful investigation to be the most efficient; only by thus regulating the expenditure of energy could the 47½ tons be loaded on the car.

The above account illustrates two of the chief reasons why the management is sometimes better equipped than the workmen to plan the latter's motions. In the first place, in grappling with the problem of pig-iron handling, the Bethlehem management was able to employ better trained brains than were prevalent among the laborers. That the latter would have been utterly incapable of finding the correct solution of the problem is evidenced by their entire ignorance of the very concept of percentage. In the second place, the highest success would have been impossible without the appropriation of a larger amount of time and money than any one individual could have afforded.

A third argument for the introduction of motion study by the management finds force in those circumstances where one individual, no matter how able or learned, could not possibly adopt efficient methods—because he is working in coöperation with others to whose habits he must conform. A good example of this is presented in Gilbreth's reorganization of bricklaying.

(5) Selection of Workmen

Incidental reference has been made to the selection of only first-class men to serve as pig-iron handlers. Mr. Taylor explains that of the seventy-five men who had before constituted the gang at Bethlehem, only one out of eight was physically capable of maintaining the pace set under scientific management.

In another part of "Shop Management," there is described the application of scientific management to the inspection of bicycle balls in the works of the Symonds Rolling Machine Company, as a result of which "thirty-five girls did the work formerly done by one hundred and twenty."[1] Taylor later[2] explained that, in this case, "the one element which did more than all of the others was the careful selection of girls with quick perception to replace those whose perceptions were slow."

These two illustrations, covering widely dissimilar sorts of work, show that a great increase in efficiency may sometimes be realized through selecting from the countless types of possible workers only those whose mental or physical make-up especially adapts them for the work at hand. The pace for such a selected group may be made far more rapid than would be otherwise possible — without doing anyone an injury.

(6) Supplies

The fundamental object of scientific management being to permit every man to accomplish the full amount of work of which he is capable, the system consequently takes great pains to guard against a lack of supplies. As soon as an order is received requisitions are made out for all the materials which will be needed, so that the clerk in charge of stores may have ample warning. This clerk keeps a balance record of the goods actually in the bins, minus such materials as have been reserved for the filling of requisitions. He has set for him a minimum limit. When a requisition informs him that there are coming through the shop, orders which when filled will reduce the stock below this limit, he at once notifies the purchasing agent or other proper party, and steps are taken towards replenishment. Of far greater consequence than the elimination of forced waiting on the part of the men is the prevention, through this system, of delays in the filling of orders.

[1] *Transactions*, vol. xxiv, p. 1384.

[2] *Principles of Scientific Management* (1911), p. 96.

Under the general head of supplies may be mentioned two additional features. First, the shops which have introduced scientific management are proud of their tool rooms. Considerable ingenuity has been displayed in arranging tools in a space-economizing order, and a clever system of mnemonic symbols has been introduced to avoid confusion. Every tool must be in perfect condition when given to the workman. The other point is that scientific management takes phenomenal pains to look after all those small supplies for the lack of which high-priced workmen are often compelled to delay their work. Everything that a man may need to complete a job is brought to him before the task is begun.

In closing, it should be noted that the several features discussed under the head of supplies, although mentioned in "Shop Management," were to find their most perfect development later in the plant of the Tabor Manufacturing Company.

(7) Conclusions

The above sections have considered the ways in which scientific management has gone beyond mere task-setting and striven to improve the methods of work.

A beginning of the development in this direction was noted in the system as presented in 1895, along the line of standardization. But that this phase was not then regarded as of very great consequence is shown by the following quotation:[1] "The above result [the gain from scientific management] was mostly, though not entirely, due to the differential rate. The superior system of managing all of the small details of the shop counted for considerable."

Credit belongs to "Shop Management" (1903) for the

[1] Taylor, description of scientific management at Midvale, "A Piece-Rate System," *Transactions*, vol. xvi, p. 879.

main announcement of the entry of scientific management into the field of directing men. There, for the first time, the planning of work was given prominence. Nevertheless even in " Shop Management," we found that several important efficiency features were given but small space.

It really took seven years more for the full significance of the new phase to be appreciated. But by 1910 it had certainly come into its own; in that year Brandeis went so far as to avow that the essence of the whole system is in the separation of *planning* from *performing*.[1]

The question as to whether this new emphasis is a proper one—whether scientific management is mainly a device for drawing effort out of men, or rather a system of efficient factory methods—this important question will be treated critically at a later point.

c. *The Third Phase of Complete Scientific Management: Organization*

The reader of the foregoing must have been impressed with the arduousness of the labor which scientific management encounters in each of its two great fields. To accomplish the system's first end, a management must determine by elaborate analysis the exact time which it should take to perform each factory job; to be successful from the second point of view, it must undertake a thorough study

[1] This shifting in emphasis may have been due to the fact that the earlier papers were written primarily for engineers and manufacturers, while the later statements were framed for the general public,—being part of a program to popularize the new system. The thought therefore shifted between 1903 and 1910 from the system's selfish aspects to those more widely beneficial; and its philosophy was revised, even where practice remained almost unaltered.

Quite the contrary had been the case between 1895 and 1903. There was in this earlier period a real broadening of scope. But the advance in presentation attained by 1903 was behind, rather than ahead of, the improvement in substance.

of the efficiency of innumerable details of factory life. Moreover, the difficulty of the task is increased by another consideration: After the bosses have assigned the work to the men, they take upon themselves the further duty of seeing that the goal is actually attained; that is, the management makes itself responsible for the success of each workman—studies the causes of each individual's failures and discouragements, and is, in fact, a teacher, ever ready to lend a helping hand. Considering everything, therefore, the amount of direction under scientific management is often several times as great as under ordinary systems.

The assumption by the directing force of these manifold duties has brought it about that, simultaneously with the appearance of the first two phases of the system, the management has been compelled to develop in a third direction. Organization, its growth and adaptation to meet the strain imposed upon it, becomes the topic of the present section.

The first and most obvious alteration in the organization of a plant consequent upon the introduction of scientific management is the establishment of a planning department. This change is significant first because it means a larger organization. In the works of the Tabor Manufacturing Company, for instance, before the introduction of scientific management, the number of men whose activity centered in the office was 5, as against 105 employed in purely shop work; afterwards, the ratio was 20 to 75. The strength of the management per one hundred men in the shop was thus made more than five times as great.[1]

But the change in organization which attends the establishment of a planning department is not one of size only. Reorganization means the centralization of a certain type

[1] *Evidence Taken by the Interstate Commerce Commission in the Matter of Proposed Advances in Freight Rates by Carriers* (1910), vol. lv, p. 2660.

of work in one planning-room. Not only are the new functions of management carried on in the planning-room, but wherever possible, work that was before performed by the men in the shop is put into the hands of clerks in the office. Indeed, it is claimed that almost all of what appear to be novel duties, created by scientific management, should really be classified as falling under this latter head—that of work which was previously done,—only in clumsy fashion,—by the workmen. The imposing of duties upon the planning department, therefore, consists, not so much in piling up new tasks, as in relieving the grimy hands of the machinists of certain clerical routine; and in planning as much of the work as possible in a place where adequate records, roomy desks, and expert heads are available.

As far as possible the workmen, as well as the gang bosses and foremen, should be entirely relieved of the work of planning, and of all work which is more or less clerical in its nature. All possible brain work should be removed from the shop and centered in the planning or laying-out department. . . .[1]

2- The second great change in organization due to scientific management is a certain specialization among the members of the planning and directing force. This development, which is called functional management, is in part a consequence of increased numbers, but not entirely. The main reason given by Mr. Taylor for introducing functional management is the scarcity of good all-around foremen. To quote:[2]

These nine qualities go to make up a well rounded man: Brains, education, special or technical knowledge [or] manual dexterity or strength, tact, energy, grit, honesty, judgment or common sense, and good health.

[1] "Shop Management," in *Transactions*, vol. xxiv, p. 1390.

[2] *Ibid.*, p. 1389.

Plenty of men who possess only three of the above qualities can be hired at any time for laborers' wages. Add four of these qualities together and you get a higher priced man. The man combining five of these qualities begins to be hard to find, and those with six, seven, and eight are almost impossible to get.

Mr. Taylor reviews the things which an ordinary foreman is supposed to do and finds them so complex that he abandons altogether the old system of having all sides of a workman's activities directed by one person. He substitutes for it a system of eight bosses, eight functional foremen, who each have only a few things to look after. Four of these bosses are on hand in the shop. "The *gang boss* has charge of the preparation of all work up to the time that the piece is set in the machine."[1] Matters connected with the assignment of tasks, the supplying of jigs, templets, drawings, *etc.*, and the accurate and rapid setting of work are his peculiar function. The province of the *speed boss* begins after the piece is in the lathe or planer, and ends when the actual machining is done. It is his duty to see that the proper tools are chosen, that the cuts are started in the right place, that the best speeds, feeds, and depths of cut are used. The functions of the *inspector* are self-explanatory.[2] "The *repair boss* sees that each workman keeps his machine clean, free from rust and scratches, and that he oils and treats it properly," *etc.*

Four other bosses are in the planning-room, but they nevertheless come in direct contact with the work of each machinist, mainly through writing. The *order of work or route clerk* makes out daily lists covering "the exact order

[1] *Transactions, loc. cit.*, p. 1392.

[2] In more recent years, at least, the inspector under scientific management has been entrusted with the teaching of workman as to how they may attain to necessary standards.

in which the work is to be done by each class of machines or men." The *instruction-card clerk,* by means of the instruction card, transmits to the man at the machine, not only all necessary details as to the specifications for the work, but also such data, drawn from the files in the office, as may suggest the most efficient methods of operation. The *time and cost clerk* gives to the men, also by means of the instruction card, such information as they should have concerning time and rates, and secures from them proper returns for the office records. The *shop disciplinarian,* "in case of insubordination or impudence, repeated failure to do their duty, lateness or unexcused absence, . . . takes the workmen or bosses in hand and applies the proper remedy, and sees that a complete record of each man's virtues and defects is kept." He should have much to do with readjusting wages; one of his important functions should be that of peace-maker.[1]

While a critical estimate of the importance of the features just outlined is reserved for a later chapter, this much may be indicated here, that the above type of organization is not as fundamental a part of scientific management as are the two primary phases. Changes of organization of some sort certainly must be made. But the precise scheme here described, though believed by the closer adherents of Mr. Taylor to constitute the best possible solution of the problem, is viewed by others as too elaborate to be adapted to all shop situations.

In general, scientific management involves an internal readjustment by which division of labor and specialization of skill are pushed much further than before, both as regards the work of the shop and that of the management.

[1] Functional foremanship has been described here in the terms of the metal-cutting shop. Its application to other industries would be attended by considerable alteration in detail, but perhaps little change in essential principle.

3. CONCLUSION: THE GENESIS OF THE PRINCIPLES OF SCIENTIFIC MANAGEMENT

With the publication of "Shop Management" the genesis of scientific management may be regarded as complete. There have, indeed, been great changes since 1903; but each of the developments of the last twelve years may be classified as either a new emphasis on, or a more perfect working-out of, some one or another of the old ideas. The two following chapters will present the facts regarding the application of the aforesaid principles. A characterization of the life and work of the several great leaders, and then a more detailed survey of the chief instances of the introduction of the system, will complete, by bringing down to the present date, the history of scientific management.

CHAPTER IV

LIVES OF THE LEADERS

Including Certain Contributions to the Enrichment of Scientific Management

I. FREDERICK WINSLOW TAYLOR

So much has already been said in regard to the founder of scientific management that we will here content ourselves with presenting little more than a summary of his life. Frederick Winslow, son of Franklin and Emily (Winslow) Taylor, was born March 20, 1856, at Germantown, Philadelphia. He received part of his primary education in France, Germany, and Italy,[1] and was prepared for Harvard at Phillips Exeter Academy (where his instructor in mathematics was George A. Wentworth, the author of many well-known textbooks). Impaired eyesight, however, changed his educational plans, and during four years of his youth he served apprenticeships as a pattern-maker and as a machinist, in a small pump-works at Philadelphia.

When, at the age of 22, he was ready to practice his trade, the depression still lingering from the panic of 1873 compelled him to start as a laborer. Thus was begun an eleven years' employment in the works of the Midvale Steel Company, during which Taylor was rapidly promoted. From 1878 to 1880 he served as laborer, clerk,

[1] He was abroad for three years and a half, and attended schools in Paris, Berlin, Stuttgart, and Italy.

and (for about two months) journeyman machinist; from 1880 to 1882 as gang-boss; from 1882 until the time of his leaving in 1889, as foreman, chief draughtsman, and finally (having taken the degree of Mechanical Engineer from the Stevens Institute of Technology in 1883), as chief engineer. It was when Taylor became gang-boss in 1880 that he first determined to discover, by scientific methods, how long it should take men to perform each given piece of work; and it was in the fall of 1882, shortly after he had been elevated to the position of foreman, that he started to put the first features of scientific management into operation.

In 1889 Mr. Taylor decided to apply his ideas in a wider field. He served for three years a corporation operating large pulp-mills in Maine, and then attempted in various parts of the country a reorganization of industrial plants. This involved a variety of manufacturing, structural, and engineering work; but his most celebrated undertakings were in connection with the plant of the Bethlehem Steel Company between 1898 and 1901. In 1901, Mr. Taylor's possession of a fortune enabled him to retire from work for pay;[1] but it was only to give himself more completely to the cause of scientific management. Thus he testified[2] that, since 1901, in giving assistance to friends who desired to improve their own or others' plants, he had "spent more than one-third" of his income, and given his "whole personal time" — this without any money compensation, direct or remote. Especially as adviser of, and owner of a small interest in the Tabor Manufacturing Company, and as a consultant for the Link-Belt Company, has he

[1] *Hearings before Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Management*, p. 1507.

[2] *Ibid.*, p. 1490.

had a hand in the creation of what is regarded as the highest development of scientific management.

Mr. Taylor has taken out about one hundred patents, his greatest invention being the discovery between 1898 and 1900, jointly with Mr. Maunsel White, of the Taylor-White high-speed steel. This invention, according to the highest authorities, has revolutionized the machine shops of the world, enabling tools to cut metal at least three times as rapidly as before. The inventors received $100,-000 for the English patents alone. Fame again came to Mr. Taylor upon his publication, in 1906, of the results of the extended researches of himself and others in the art of cutting metals [1]—a work of genuine scientific character, and of the highest practical importance. Mr. Taylor, however, regarded as of far greater moment than all this other work his share in the discovery of the principles of scientific management.

Among the honors which have been conferred upon Taylor are a gold medal from the Paris Exposition of 1900, the presidency of the American Society of Mechanical Engineers during 1906, and the degree of Doctor of Science from the University of Pennsylvania, also in 1906. In January, 1912, he stated that he was then receiving, from all parts of the country, invitations to make addresses at the rate of one a day. His *Principles of Scientific Management* has been translated into French, German, Dutch, Danish, Swedish, Lettisch, Italian, Japanese, and Mexican; his "Shop Management" into French, German, Dutch, and Russian.

Mr. Taylor died March 21, 1915, just after passing his fifty-ninth birthday. The physical fitness that once won

[1] "On the Art of Cutting Metals," in *Transactions of the American Society of Mechanical Engineers*, vol. xxviii.

him a national tennis championship, and the mental stamina and bull-dog tenacity with which he always held to an idea which he had decided to pursue, were mellowed and broadened with the passing years into those genial qualities of host and friend that made the Taylor home at Chestnut Hill, Philadelphia, a delightful Mecca for those interested in scientific management, and Mr. Taylor himself the elder among a group of loyal followers.[1] Even the men who most disapprove of scientific management have nothing but good to say about Mr. Taylor personally, and his death will be felt as a personal bereavement by a large circle of friends as well as a great loss to the cause which he so ably and so unselfishly served.[2]

[1] Many who recognize the bigness of Taylor's service view unfavorably some aspects of his methods. They complain that he would not relax at all from one original plan, but insisted that a shop be reorganized in every detail according to a prolonged and complicated program. Furthermore, the thoroughness of his reform had to include the timing of operations in units much more refined than most other efficiency men attempt. For these reasons, and because he retired from regular practice as early as 1901, critics and even friends insist that Taylor has himself accomplished far less than various followers who have caught his spirit but revised his methods. This assertion, however, they rarely intend as a reflection on Taylor's leadership, as many efficiency engineers only remotely connected with the Taylor following are ready to admit that if it had not been for Taylor's example, they would probably not be found in their present line of work.

[2] Among Mr. Taylor's chief writings may be enumerated the following papers read before the American Society of Mechanical Engineers: "A Piece-Rate System" (1895); "Shop Management" (1903); "On the Art of Cutting Metals" (1906). With S. E. Thompson, he has written *Concrete, Plain and Reinforced* (1905), and *Concrete Costs* (1911). His philosophy is, however, best expressed in *The Principles of Scientific Management* (1911). His system is also explained in contributions to the periodicals; in numerous addresses; in testimony before the special House committee which investigated scientific management (1911-12); and in testimony before the Industrial Relations Commission (April, 1914).

2. HENRY L. GANTT

Henry L. Gantt, who is five years younger than Taylor, graduated from Johns Hopkins University with the degree of A. B. in 1880; taught school for the following three years; and, in 1884, secured his M. E. from Stevens Institute of Technology. His first important work was for the Midvale Steel Company, where he remained six years.[1] It was here that (in 1887) he first came in contact with the methods of scientific management, being employed for a year and a half under the direction of Mr. Taylor. His task was to find some means by which the laws governing the cutting of metals might be quickly applied to the practical work of the machine shop. The solution then discovered was only moderately satisfactory; but the incident meant much for scientific management, for from 1887 until the present day Mr. Gantt has, with few interruptions, spent all of his time in the service of this system.

Gantt's contact with Taylor was cut short in the eighties, and was only intermittent in the varied work of the next ten years. It was renewed again in the completest manner when in March, 1899, Taylor had Gantt called to Bethlehem. Between 1899 and 1902, one of Gantt's duties at Bethlehem was to help another aid of Taylor, Carl G. Barth, in his development of the slide rule, a device which solved with remarkable ease the problem which in the eighties Gantt had by himself only partially disposed of. The main credit for the slide rule belongs, however, to Barth; Gantt regards as his own greatest achievement of the period the development of "Task Work with a Bonus."

The story runs that, after about two years of careful investigation in the machine shop at Bethlehem and the gradual adoption of many notable improvements, it was

[1] 1887 to 1893.

evident that operations could be performed a great deal faster than the men had as yet been induced to work. But the management hesitated to force production up to the then possible standard through the introduction of the differential rate, for this would mean the establishment, upon the basis of imperfect methods, of piece-rates which could never be cut. They wished first to carry the process of improvement somewhat further. Accordingly, as a temporary expedient, Mr. Gantt, on March 11, 1901, proposed that the establishment offer a daily bonus of fifty cents to whoever should perform all the tasks set down on his instruction card—thus substituting a very flexible standard of work for the rigid piece-work system.

This was at first regarded as only a temporary measure, but by a later amendment the bonus system was adapted for permanent use. It was made to offer not only a reward for the completion of the task in the allotted time, but also an additional inducement to those who were able to do still better. It was made to consist in giving to all workers their day rate, but to the men who finished their tasks in the time set or less, pay for the number of hours allotted *plus a certain additional time* (for instance, for a three hours' task, four hours' pay), — this same number of hours pay to be always given for work, whether finished in standard time or less. Thus the system is, for the man who is accustomed to perform his tasks or more, the exact equivalent of piece-work.

The bonus system — whether it be of the original type (designed only for temporary use) or of the amended variety (suited to become a part of the permanent system) —is like the differential-rate system in this, that they both make a complete study of the possibilities of work, and then give the man who performs a good day's task a higher rate of pay than is customary in the trade. The *original* type of bonus differs from the differential rate in that the former involves no creation of unalterable piece-rates. The *amended* bonus system is more flexible than the differential rate, in that if it be so desired different men can be allowed varying amounts of pay for the same work — by simply basing their remuneration on higher or lower day rates.[1] Both the new varieties depart from the old path in that they give the regular day's pay to learners and others who fall short of the standard.

Mr. Gantt lays considerable stress on a supplementary feature adopted at the suggestion of the machine-shop superintendent, Mr. Earle, by which the boss is paid a small bonus for each of his men who earns a bonus. In addition, a second bonus is given if every one of the subordinates is successful. These devices are designed to make the boss deal fairly with all in his assignment of work, and especially vigilant in removing difficulties from the paths of the weaker men.

Immediately after its suggestion, the task and bonus system was put into operation; it was at once recognized as valuable, and is now said to have very nearly displaced the differential rate.

But to return to the career of Mr. Gantt—a change having been made in the management of the Bethlehem Steel Company, he left their employ in 1902, and entered the profession of consulting engineer; in this he is still engaged. A partial list of the plants in which he has done more or less work would include the American Locomotive Company, the Canadian Pacific railway, the Sayle's bleacheries, the works of Joseph Bancroft at Wilmington,

[1] This is almost (though not quite) as true of the plan which Mr. Gantt first proposed.

the Brighton mills, and the Cheney silk mills.[1] His greatest achievement thus far has been in the plant of the Union Typewriter Company;[2] of still greater promise—though only recently developed to any considerable scale—is his work for the Westinghouse Electric Company.[3] It should be said that in very few of these plants has Mr. Gantt installed his system in its entirety, and that in many of them his work was done at a period when he had not developed his own ideas as completely as he has at present.

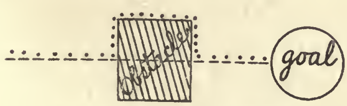
We have seen that Gantt's greatest contribution to the method of scientific management is a very mild and easily introduced wage system, and that he has had an unusually wide experience in reorganizing factories (the number and importance of which the above list only suggests). The key to his success is a disposition to adjust his course to the practical aspects of whatever situation confronts him. Thus—

When an Obstacle Appears

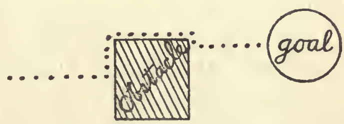
Taylor's course - - - was to plough right through.

But Gantt's . . . is to adapt himself most easily to the situation.

Sometimes, indeed, Gantt does not reach his original goal, but decides on a new one.



As Illustrated by a Friend of the Two Men



As Modified by Gantt, Himself

[1] Considerable interest has been shown in scientific-management's early—though only partial—installation in the works of the Symonds Rolling Machine Company, where Mr. Gantt was at the time superintendent. See *supra*, p. 79; and *infra*, p. 124.

[2] Makers of Remington, Monarch, and Smith-Premier Typewriters.

[3] "When scientific management is completely established at the Westinghouse plant," writes a thoroughly informed and impartial observer, "its effect will be more far-reaching than the effects of any work that has been heretofore done."

Mr. Gantt regards every factory as a law unto itself. His idea of scientific management is not that of one mold, which all factory organizations must be warped to fit; but as he sees it, there are as many distinct scientific managements as there are different shops. By many who ought to know, Gantt is regarded as the strongest man in the scientific-management movement. He is said to be the man who is getting results.[1]

3. CARL G. BARTH

Carl G. Barth, though perhaps a few months the senior of Gantt, and an acquaintance of Taylor since the middle eighties, did not come into actual touch with scientific management until 1899. His earlier training was acquired in his native Norway, and consisted of the equivalent of a high-school education, followed by a technical course lasting a year and a half; and then four years practical experience, of which the first two were spent as an apprentice in the navy-yard boiler and machine shops, and the second two in teaching mathematics and mechanical drawing interspersed for a time with service in the superintendent-of-the-yard's office.

As a youth of about twenty-one, Barth emigrated to America, and found employment in the drawing-room of William Sellers & Company, of Philadelphia. With this concern he remained (excepting a short intermission) for fourteen successive years, at the end of which period he was occupying the position of chief designer of machinery on a salary of $3,000. During most of this time Barth

[1] Mr. Gantt's leading works are: "A Bonus System for Rewarding Labor" (Dec., 1901), "A Graphical Daily Balance in Manufacture" (1903), and "Training of Workmen" (1908)—the three foregoing being found in the *Transactions of the American Society of Mechanical Engineers;* his book, *Work, Wages and Profits* (1910 and new editions); and various periodical contributions.

had been devoting his odd hours to teaching: for six years meeting mechanical-drawing classes at the Franklin Institute on some evenings of the week and private pupils in mathematics on the others; and then for two years conducting a private evening school of his own. But now a taste for a career as a professor of engineering was rapidly developing; and in order to equip himself for such a position, Barth first gave up evening work for pay, that he might improve his knowledge of engineering subjects. Shortly afterwards (in 1895) he left William Sellers & Company to accept the modest offer of a St. Louis concern,[1] which would give experience in designing engines. After two years of rather versatile service here, and then three months spent in designing special machines for the St. Louis water commission, he was identified with the International Correspondence Schools for about a year and a half, and with the manual training and mathematical work of the Ethical Culture Schools of New York for a school year of nine months.

In June, 1899, Taylor sought to avail himself of this technical equipment by bringing Barth to Bethlehem "to effect a more satisfactory solution for the mathematical problems connected with the art of cutting metals and its application to the every-day running of machine tools."[2] Barth not only solved this difficult mathematical problem in a few months by the invention of the slide rule, an invention whose far-reaching importance we have set forth elsewhere,[3] but he was from the first put in charge of the machines doing Taylor's experimental work. When all this was over with, he was made machine-shop engineer, and

[1] The Rankin and Fritch Foundry and Machine Company.

[2] Quotations from testimony of Barth before special House committee.

[3] See *supra*, pp. 73-75, and 92.

given the duty, among other things, of "reconstructing and respeeding, repairs, and maintenance of all machinery and tools in their large machine shop."

Though Barth at this time "paid but little attention to the general management side" of scientific management, he was very much interested in those features of the system with which his work brought him in special contact. The result has been that, since leaving the employ of the Bethlehem Steel Company in 1901, he has "practically busied [him]self with nothing else" than introducing the Taylor system into factories; and though afterwards he broadened out until he understood every side of scientific management, he still remains particularly efficient in those elements which center about the manipulation of machine tools. According to Gantt, he is the most expert of the scientific-management men in looking over and strengthening the weak places in machines. According to Taylor,[1] he is "the most accomplished of all the men engaged in this work" (installing the system as a whole), a man who has "made a greater success of introducing scientific management into the difficult companies than any other single man."

After leaving Bethlehem, Barth's first fifteen months were spent in investigating conditions in the plant of his old employer, William Sellers & Company, the work, however, not being carried to completion. Mr. Barth then spent four years and a half introducing scientific management into the plant of the Link-Belt Company, where to begin with he had charge of only the mechanical features. After the first year, however, he was compelled to assume the burden of installing all the various sides of the system, —being enabled to do this through a certain amount of

[1] From *correspondence* dated Oct. 6, 1913.

general and gratuitous direction on the part of Mr. Taylor. This superintendence was for a couple of years more or less regular, but later very limited. Simultaneously with the systematizing of the Link-Belt Company, Barth had charge of similar but even more important work in the plant of the Tabor Manufacturing Company,—also under the general guidance of Taylor. Here he had the valuable assistance during part of the time of H. K. Hathaway. The first job undertaken on Barth's own responsibility was at the Yale & Towne Manufacturing Company's plant, where scientific management was introduced in the one department (hoist) in which machine operations count for the most. Among other plants where Barth has installed more or less of what he loyally calls the "Taylor System," are the Fairbanks Scale Company; the Government Arsenal at Watertown, with the aid of D. V. Merrick; and—what constitutes his present great undertaking—the Pullman Company,[1] of Chicago.

4. HORACE K. HATHAWAY

While Gantt is praised as a manager, and Barth as a mathematician and master of mechanical equipment, to Horace K. Hathaway belongs, according to Taylor, the credit for being the best all-around man in the movement. Mr. Hathaway is sixteen or seventeen years the junior of the two men just mentioned, being at the time of writing thirty-eight years old. He has no degree in engineering, but received his training during two years (1894-96) spent in a trade school (Williamson), and a year and a half spent as an apprentice with the Midvale Steel Company (1906-7). After completing his apprenticeship, he continued in the employ of the Midvale Steel company until 1902. He served about six months as a journeyman machinist, and

[1] It is rumored that Barth's work for the Pullman Company has been fruitful of revolutionary—though yet unpublished—discoveries.

then worked up in the organization through the positions of draftsman, inspector, and gang-boss, until he was finally made foreman over all the tool-making and tool-keeping rooms in the plant. In 1902 he left Midvale to become superintendent for the Payne Engine Company, a small concern, with which he remained for two years.

It was immediately following this that, in 1904, Hathaway first came in contact with scientific management,[1] through being detailed to assist Barth install the "Taylor System" in the Philadelphia plant of the Link-Belt Company. This first assignment was, however, comparatively unimportant. After only two or three months, Hathaway was transferred from the Link-Belt plant, and placed with the Tabor Manufacturing Company—at the time also in charge of Barth. Here, as the years went by, he gave so good an account of himself that he eventually became the most important person about the works. As vice-president of the company, he brought the organization to so high a degree of perfection that the Tabor plant has come to be regarded as the finest example of the success of scientific management. Its productivity, it is said, has been multiplied by three.

In addition to his continued participation in the affairs of the Tabor Manufacturing Company, Hathaway has more recently taken on the profession of consulting engineer, with headquarters in Philadelphia. Among the plants in which he has installed scientific management are the Acme Wire Company and, in coöperation with Morris L. Cooke, the Plimpton Press.[2]

[1] Taylor had left Midvale seven years before Hathaway's coming, and the system there had remained in the rudimentary form which constituted the highest development of the eighties.

[2] A further characterization of the work of Hathaway need not be given here, since reference may be made to the reorganization of the Tabor Manufacturing Company as treated in the next chapter.

5. MORRIS L. COOKE

The special importance of the work of Morris L. Cooke is derived from the fact that it marks an extension of scientific management into new fields. We will pass over without comment Cooke's life as a mechanical engineer, and even that part of his career which had to do with the introduction of scientific management into printing,[1] in order that we may come at once to the two unique lines along which he has distinguished himself.

The first of these undertakings grew out of the decision of the Carnegie Foundation for the Advancement of Teaching to get a man familiar with modern business management to estimate the cost and output of leading American universities. The man commissioned to make this study was Cooke; the field selected for investigation comprised the various departments of physics; the institutions visited were Columbia, Harvard, Massachusetts Institute of Technology, Toronto, Wisconsin, Haverford, Princeton, and Williams. Though Cooke's 134-page report, published in 1910 as *Bulletin Number Five* of the Carnegie Foundation, contains various valuable recommendations in regard to the strictly financial and business relations of the university, these cannot be discussed here. Our one interest at this time is in pointing out certain passages in which Cooke —who is a staunch Taylor man—tries to apply *scientific management* to the universities' central educational end.

Corresponding roughly to what we have termed the first phase of scientific management—which means in industrial plants the apportioning of scientifically determined tasks among all the workers—Cooke has utilized a standard for gauging the productivity of the respective departments of physics. His unit of measurement is the student hour—

[1] In the Plimpton Press (with Hathaway); and the Forbes Lithograph Company.

that is, one hour spent by one student under direction—whether it be in the lecture or recitation room, or in the laboratory. The total output in student hours is easily obtained by multiplying the number of hours devoted to each course by the number of students registered therein, and then adding the products together. The unit cost of instruction is calculated by dividing this total into the aggregate expense of the department. It is not claimed that this method furnishes complete data for deciding whether or not any particular work pays, as it does not take into account the value of the courses offered, or the relative quality of the instruction under different men or in various institutions; but Mr. Cooke does think that along with other considerations the exact cost of operation per unit of output is worth knowing. He finds that, of the institutions studied, Columbia, Harvard, and Haverford were spending the greatest sums per student hour in their respective departments of physics ($1.08 in each), and Wisconsin the least ($0.60). While Cooke does not himself attempt the "setting of a task" for university men, at some points he makes suggestions along that line. For instance, he says that if the student hour be used as a basis for determining what shall constitute a term's teaching, it might be weighted so that a lecture hour would count as *three* where a laboratory hour would be valued as *one*. The student hour, it should be said, is advanced as a useful unit for undergraduate teaching only, and is not advanced as applicable to graduate or research work.

Corresponding to the second phase of commercial scientific management, which aims to improve the methods of work, Mr. Cooke speaks with less hesitation. He regards as the cardinal principle in university administration the careful arrangement of the work so that the unusually able and highly valuable men who make up the ranks of professors may specialize in the important fields for which they are peculiarly qualified. Thus it seemed to him a great waste when, "during the interviews which [he] had with college professors, he found them spending time in taking inventories, keeping track of appropriations, mimeographing examination papers and handling routine correspondence"; and he also finds fault with their being given the management of buildings. Part of this work could be delegated to clerks, and much of it could be done more efficiently by central administrative departments, that would look after special functions for the university as a whole. A more radical suggestion is that the institution assist in the actual instruction; it is proposed that standard lecture notes be worked up by men specially commissioned for the purpose; and that these be used as common tools by all lecturers covering the subject. Such details as the more complete utilization of rooms, the placing of lecture halls used by large numbers of persons on the first floor (instead of museums), and the designing of buildings, come in for considerable attention.

But the greatest stress of Cooke's report is on the organization aspect. After reviewing the so-called one-man type of administration, which he finds is now in rare use, and criticizing the prevalent system of committee management, which he censures as giving too much autonomy to the departments and too little authority to either the president of the university or the department heads, Cooke offers as his leading suggestion for the improvement of academic efficiency the adoption of "functional management." In a machine shop, functional management means the appointment of some eight bosses, each of whom looks after some special phase of the work; in a university, functional management would mean the splitting-up of the manifold duties of administration—and perhaps even of instruction and student guidance—into some ten or a hundred functions, in each of which one person would be the supreme authority. To illustrate: we may take Cooke's extreme example,

a single individual personally assume the direction of a large building including laboratories, machine shops, power plants, *etc.*; maintain order and discipline among seven hundred at times boisterous spirits; direct and inspire the teaching force of a score of rather unusually able men; lecture on the most attenuated physical theories; keep in touch with a large body of graduates; carry on research work, *etc.*

From such a man, overloaded with duties which he cannot possibly perform with efficiency, Cooke would take away all but a few functions—as he would also from committees in which management has been similarly centralized. A large part of the administrative work—such as purchasing, the supervision of buildings and grounds, registration, and even discipline—could be done for all the departments by central agencies—as a few, but not many, of the institutions studied had already begun to do; and the other functions could be divided up among the men of the department, segregating and safeguarding to each person that type of work for which he alone is perhaps best qualified.

This treatment of Mr. Cooke's report has been introduced, not only to give the reader a basis for judgment as to how far scientific management does or does not offer new or valuable suggestions for the organization of education and the other larger social activities, but also in order that—for those who are more familiar with college than with factory life—the principles of scientific management may be brought closer home. The significance of the system becomes apparent, for instance, when Cooke compares the University of Toronto favorably with Harvard, in that in the former less than 38 per cent of the total salary fund of the department of physics goes to men above the grade of instructor, while in Harvard the percentage is 84. If the ideas of Taylor could be applied as thoroughly to undergraduate instruction at Harvard as they have been to some shops, it would mean that the bulk of the work—at least as far as standard courses are concerned—would be transferred from professors to instructors. That is, a system of standard lecture notes and a subdivision of responsibility would enable less experienced and less capable men to obtain satisfactory results. Through scientific assignment of tasks based on a detailed analysis of just what these instructors did with their time, schedules would be drawn up which would greatly increase the number of student hours per individual, the instructors being compensated by an increase in pay. To complete the analogy, there would be substituted for the president, deans, and heads of departments, a large planning department, composed of the abler professors and administrators, who would in their respective spheres direct the machinery of education. The theory would be: first, that the general good would be promoted by an advance in the technique of organization which would permit the replacement of the original roadmakers by men of less force and capacity, men who would be cheaper, who would turn out more work, and who would be perhaps as efficient as those of the earlier day; and second, that in no case would the individual welfare be jeopardized, as the abler professors might turn to other fields, and their successors would find in the new conditions better opportunities than would be open elsewhere. Cooke has not suggested that things be carried to this extreme in education, but something very similar has been done in some of the trades, and perhaps the drawing of the picture will help to an understanding as to why most managers and many skilled artisans are cautious about putting themselves under scientific management.

The second opportunity of Morris L. Cooke to extend the application of scientific management into new fields occurred when he was made director of public works for the city of Philadelphia. During 1912, the first year of his administration, it was claimed that a reduction of $750,000 was effected in the expenses of the department. A study of his report shows that in this first year the greater part of his improvements were such as any capable business man might have made. However, a few of the distinctive features of scientific management had already made their appearance, as, for instance, in the setting of tasks for street cleaners.[1]

6. SANFORD E. THOMPSON

Sanford E. Thompson, referred to by Taylor[2] as "perhaps the most experienced man in motion and time study in this country," was born in 1867, took the degree of C. E., and since 1885 has been engaged in practical civil and mechanical engineering. In 1895 he started to cooperate with Taylor in some of the latter's investigations,

[1] *Cf.* C. Bertrand Thompson's statement in the *Quarterly Journal of Economics,* Feb., 1915: "Owing to the peculiarities of the Philadelphia law, and the constant opposition of Councils and the previous almost inconceivably corrupt state of the department, it has not been possible to make a thorough application of most of the fundamental principles of scientific management. The results attained thus far, amounting to a saving of over $1,300,000, are due primarily to the injection of simple honesty into the department, and secondly to the utilization, so far as conditions would permit, of expert knowledge secured wherever it was obtainable."

Mr. Cooke spent a year and a half reorganizing the administration of the American Society of Mechanical Engineers, and also played an important part in making the arrangements for the Tuck School Conference on scientific management.

[2] *Principles of Scientific Management,* p. 88.

and in 1896 and the years following undertook on his own responsibility an exhaustive study of the time required to do various work connected with the building trades. In six years he made a complete study of eight of the most important: excavation, masonry, bricklaying (including sewer-work and paving), carpentry, concrete and cement work, lathing and plastering, slating and roofing, and rock quarrying.

Thompson's method is to split up jobs as a whole into very minute elements. Complicated mathematical formulas tell him just how long it should take under various conditions to throw a single shovelful of earth. Likewise, the number of seconds required to dump a wheel-barrow, to walk one foot, to drive one nail, to place one cleat, and to do a thousand other things, are all obtained by stop-watch analysis and carefully recorded. As a result, a contractor can estimate much more exactly than under the old system how much it will cost to complete a given work, and a foreman can hold his men responsible for a full day's task.

While the prime object of Thompson's work has been the effective handling of men and the accurate estimation of costs, his studies have incidentally increased the efficiency of effort.

In connection with the making of forms [in concrete construction], for example, it was found by time study that a certain type of hammer was better than any other. It was found that a certain method of erecting the forms was considerably cheaper than any other plan. It was found that the number and size of nails, which ordinarily varied with each individual carpenter, could be fixed by definite standards to avoid waste in time and materials. It was found that there were certain methods of handling the lumber which were cheaper than any other way. It was shown by actual figures how much saving could be accomplished by furnishing laborers to do all of the heavy work so that the carpenters could stick to their job of carpentry. [1]

Thompson is credited by Taylor with having developed in the course of his studies implements for taking observations which are in many respects the best in use. He was the man immediately in charge of the motion-study analysis of bicycle-ball inspection in the plant of the Symonds Rolling Machine Company. He is now in private practice as a consulting engineer making a specialty of concrete and reinforced concrete design, construction, and tests. His chief works are: *Concrete, Plain and Reinforced* (1905), and *Concrete Costs* (1911), both written jointly with Taylor.

7. FRANK B. GILBRETH

Of Frank B. Gilbreth and Harrington Emerson — the last men whose work we will discuss in detail—it may be said that, with the possible exception of Frederick W. Taylor, they have been far more successful than any others in turning towards scientific management the interest of the general public.[2]

Gilbreth was born in 1868, completed his formal education with graduation from the English High School of Boston in 1885, went into business, and in the course of time became established as a successful contracting engineer engaged in large-scale undertakings. Between 1895 and 1904 his main office was in Boston; since 1904, in New York City. It was not until about 1906 [3] that, having

[1] Sanford E. Thompson, "Time-Study and Task Work," in *Journal of Political Economy,* May, 1913, p. 380.

[2] The most successful of the scientific-management men. Mr. Brandeis' all-important rôle should not be forgotten.

[3] In July, 1910, Mr. Taylor spoke of the date as being "some four years" earlier.

read Taylor's papers on "Shop Management" and "On the Art of Cutting Metals," and having conferred with their author personally, Gilbreth made his first attempt in the field of scientific management. This consisted in a reorganization of bricklaying, an undertaking whose brilliant execution was to win for him a national reputation and to constitute with his later work one of the most fascinating chapters in the history of scientific management.

Gilbreth, following in the footsteps of all other scientific-management leaders, incorporated in his fully-developed bricklaying system an ingenious provision by which the number of bricks laid by each man might be easily calculated; he provided that those individuals who should come up to a certain high standard should receive wages 25 or 30 per cent higher than the wages common among other bricklayers in the vicinity.

But it should be stated at the outset that the real emphasis in Gilbreth's scientific management, and that which from first to last has given to it its distinctive note, is on constructive motion study — that is, the scientific analysis of the motions that go into work, with the idea of eliminating avoidable effort. We have seen that the original object of Taylor, Thompson, and most of the others was to discover how much men could do if they tried, and that their development of new methods of work, though important, was incidental. In the paragraphs that follow, we shall see that of Gilbreth it would be more fitting to say that he started out in the first place with the object of devising new and better methods, and that his introduction of management features like the task and bonus was chiefly to secure obedience to directions.

To present some of the more salient motion and fatigue-saving features of the Gilbreth system of bricklaying, it may be noted in the first place that the obvious waste of making a man bend over, and then raise the weight of his body, every time he has to pick up a brick — a thousand times or more a day—was eliminated by arranging adjustable scaffolds and so piling up the brick that there would be between the body of the workman, the height of the wall, and the height of the brick supply and mortar-box, just that relation which would permit the easiest, most upright work. In the second place, there was taken away from the high-priced bricklayers and turned over to low-priced laborers the simple work of arranging the bricks with their top-sides up. Gilbreth tells us that the top of a hand-made brick is always a little wider and rougher than the bottom, and that under ordinary systems the bricklayer "flops" each brick over in his hand a time or two to make sure which is the right side. This operation was eliminated under the new system, for the bricks were properly arranged by the low-priced helpers on "packets" holding eighteen [1] each, so that they might be easily grabbed by the craftsman and inserted without examination into the wall. Thirdly, it may be noted that the mortar was tempered so carefully that the bricks could be thrust into place by a simple shove and without the usual tap of the trowel.

In the above, as well as in many other ways, the work of bricklaying was so simplified that the eighteen motions formerly thought necessary to place a brick were reduced to four and a half, and indeed in one case to two. Those which remained were made as simple and effective as thorough study could make them. The final result was that Gilbreth's men, who had formerly worked to their limit to lay 1000 bricks a day, were able after a short period of instruction to reach a daily output of 2,700. Gilbreth erected a number of buildings in accordance with this plan, and

[1] Eighteen bricks weigh about ninety-two pounds, which, it was discovered at Bethlehem, constitute a laborer's most efficient load.

still holds patents covering several of the mechanical features.

Not long after the perfection of the system, however, its inventor abandoned the contracting business altogether, and began to turn his entire energy towards introducing scientific management into factories. The best example of what Gilbreth has accomplished along this new line is afforded by the New England Butt Company, a concern engaged in the manufacture of rope-making machinery, at Providence, Rhode Island. The system there installed may be said to be patterned after that in use in the plant of the Tabor Manufacturing Company, differing from the latter chiefly in the greater attention that has been given to contriving many small conveniences which lighten the work. We need, therefore, not describe Gilbreth's methods in detail, but will present only those features which are his own distinct contribution to management technique. He has made two notable contributions, of which the first is micro-motion study.

Prior to the introduction of micro-motion study, the best instrument available for timing motions was the stop watch. But there is a certain limit of refinement beyond which it is impossible to split up motions by this method. By timing a repeated sequence, so that first one group of motions is included and then another, it is indeed possible to obtain accurate records of intervals of time, too fleeting to be measured by themselves. Nevertheless, the system is not convenient for the effective analysis of such operations as, for instance, the folding of a handkerchief. Accordingly, for work of this character Gilbreth uses a motion-picture apparatus, including in the field of vision a large-faced clock, the rapid movements of whose hands record very minute subdivisions of a minute. Behind the subject is a network of lines spaced at regular distances as on a crosssection paper, against which as a background the dimensions of a motion can be read off. After the record has been obtained, it is possible to go over the film with a magnifying-glass, and decide at leisure just how long and over exactly what space exceedingly rapid motions have extended. Thus even in the case of the nimblest work, the micro-motion-study expert can detect false motions, and tell the worker which of his various ways of working are the most efficient. The invention is more brilliant than widely applicable, and up to a recent date has received more attention in the magazines than in the workshop.

By a later invention of Gilbreth's, also tried out at the New England Butt Company's plant, a record of the path of a motion is made on a photographic plate by fastening a small electric bulb on the subject's finger. By using a stereoscopic camera, space in three dimensions is shown; by making the bulb flash light only at regular intervals, the path becomes a succession of dots, which indicate the time consumed.

In conclusion: We have seen that the special field of Gilbreth is not the solving of engineering and other technical problems of manufacturing, nor is he interested primarily in systems of management, but his stronghold is constructive motion study. Into the study of this latter subject he has thrown himself with all the ardor of a strenuous nature; and, not limiting himself to those "bread and butter" achievements that bring immediate financial results, he has striven to apply motion study to all manner of activities. Thus, in New York hospitals he attempted a micro-motion-study analysis of surgical operations; and again we learn that he is investigating the muscular activity that underlies the "singing tone" of the skilled musician. Indeed, the elaborateness of Gilbreth's methods and the restlessness of his ambition proclaim the appearance of the scientist in a profession where most men would say that commercial considerations alone should rule.

Among Gilbreth's works are his *Field System* (1908), *Concrete System* (1908), and *Bricklaying System* (1909). *Motion Study* (1911) approaches the subject from many interesting points of view. Gilbreth's *Primer of Scientific Management* (1912) contains the clearest explanation of this system that has yet appeared.

8. HARRINGTON EMERSON

In the case of each of the men whom we have thus far considered, the original impulse along the path of scientific management was derived without question directly from Frederick Winslow Taylor. When, however, we come to the career of Harrington Emerson, we pass from the immediate Taylor group, and find ourselves in the presence of a man who has been under more complex influences.

Harrington Emerson, the son of a professor of political economy, was born in Trenton, New Jersey, but spent his youth in Europe. It is to French character, and to German military efficiency as evidenced before his eyes in the conduct of the Franco-Prussian war, that Emerson attributes his present strongest ideal—the setting of precise standards. His admiration for systematic method and perfect coöperation was further strengthened by studies under a European music-teacher, by observation of the remarkable results obtained by breeders of fine horses, and by contact with A. B. Smith, a skilful railroad surveyor.

Emerson's earlier efforts in the field of systematizing management were in railway shops—his entry into the profession of reorganizing miscellaneous industrial plants being a later development. He tells us [1] that in 1895 he

[1] *Correspondence* dated Sept. 27, 1913.

"began a series of rapid surveys of American industrial plants, determining what their product and costs were compared to what they ought to be. In 1900 [he] checked up minutely the losses occurring in the use of materials. In 1902 [he] planned, scheduled and despatched work through a large factory." Of all Emerson's undertakings, however, that which has attracted the most attention was his "betterment work" introduced into the shops of the Santa Fe railway during three years beginning in 1904, a story which we will treat briefly in the next chapter. He has installed his system partially, though in no instance completely, in "some 200 different plants from Alaska to Mexico, from Louisiana to Canada, from Southern California to Maine."[1] At present his activity is carried on through the Emerson Company, an organization which employs between thirty and forty efficiency specialists.

To take up Emerson's distinguishing characteristics, in the first place, he calls his system "efficiency" rather than "scientific management." The distinction, though mainly one of words, is not without some significance. "Efficiency" is the relation between what is accomplished and what might be accomplished; to secure it one strives to introduce the best obtainable methods, to compare productivity in different plants and bring all up to the one highest standard. In the case of "scientific management," on the other hand, the emphasis is not so much on producing goods as cheaply in this plant as in that one, but rather the aim is to do well from an absolute viewpoint. Thus "scientific management" may mean *creation;* while "efficiency" contemplates simply a *comparison* of costs in different plants, and a *choosing of the one best system* already in use; however, the two ideas, far from being mutually exclusive, are

[1] *Correspondence* dated Sept. 27, 1913.

but complementary aspects of the same movement, the former being invention, the latter application.

In the second place, Emerson opposes functional management with its numerous heads, and substitutes for it the "line and staff" idea, under which there is but one boss (the line). The functional experts (or staff) whom Emerson employs are not executive officers, but simply advise the single responsible authority; and it is the latter who puts all plans into practice through command over his "line" subordinates. The idea is to avoid creating too many bosses, and yet operate under expert advice.

In the third place, Emerson uses a wage system which bases remuneration partly upon the "efficiency per cent" of the employee. A standard task is set on the basis of time-study analysis, and the workman who just completes the same in the allotted time is credited with 100 per cent efficiency. Efficiency may thus be reckoned as below, above, or at 100 per cent. Although everyone receives his day rate, which is supposed to be a normal compensation when compared with prevailing wages, a man who cannot attain 66.7 per cent efficiency is regarded as subnormal and is in danger of discharge. At 67 per cent a small bonus is paid, which grows in size until at 90 per cent efficiency it reaches 10 per cent. Above this point one per cent in bonus is added for each additional one per cent gain in efficiency. Emerson has thus developed a wage system which is in its results practically the same as Gantt's "task and bonus" plan, except that under the Gantt system no bonus is paid until a man comes up to standard performance, in the hope that the large increase then suddenly granted will bring all up to a common productivity.

In general, Emerson's methods are flexible, rather than stereotyped; his time studies and standards are approximate rather than exhaustively exact; and he relies much on the self-direction of his subordinates. His company strives for the big gains that may be easily attained, and will accept a hurry order if funds for complete reorganization are lacking.

Harrington Emerson is nearly three years older than Frederick W. Taylor; he did not meet the latter until comparatively late (probably not much before 1900),[1] and the two never worked together.[2] Emerson was present, however, when Taylor's "Shop Management" was read, in 1903, and has done almost all of his mature work in the light (if he chose to use it) of that exposition. As regards his general thought, we have seen that Emerson has received stimuli from many sources; but as concerns the application of efficiency to industrial plants, there is good ground for believing that he is much more deeply indebted to Taylor than to any other. Indeed, men well acquainted with both have told us that Emerson was once accustomed to refer to Taylor as the source of his ideas: Taylor he regarded as trying to do too much, as being in advance of his time; it was he, Emerson, who, by rendering lofty projects more practical, was able to achieve results. On the other hand, it cannot be denied that Emerson has brought into the field a great deal of original force. He may have adopted some of Taylor's ideas; but if so, his conduct is similar to the appropriation which every man makes of any scheme that appeals to him as useful; and beyond this, he has at the same time combined them with so many ideas derived from other sources that his resulting philosophical

[1] In 1912 Emerson referred to his introduction to Taylor as having occurred some ten years earlier. However it must have been at least twelve years, as he writes of a conversation which occurred between them in 1900.

[2] Some members of the present Taylor group started under Emerson —as F. A. Parkhurst. We know of an active engineer, formerly with Emerson, who tells us that he now follows Gantt's methods.

system is a truly original contribution to the subject. Certainly in his books he has expressed himself in a way which is in many respects far more effective than the style of the other scientific-management or efficiency men.

In fact, Emerson has done more than any other single man to popularize the subject of scientific management. His statement that the railroads could save $1,000,000 a day by introducing efficiency methods was the keynote which started the present interest in the subject. His books, *Efficiency* (a reprint in 1911 of periodical contributions of 1908 and 1909), and *The Twelve Principles of Efficiency* (1912), taken with his magazine articles and addresses, have perhaps done more than anything else to make "efficiency" a household word.

9. THE SCIENTIFIC-MANAGEMENT MEN AS A BODY

As regards the other scientific-management men, attention should at least be called to Frederick A. Parkhurst, author of *Applied Methods of Scientific Management*; to Dr. Hollis Godfrey, scientist and contributor to the *Atlantic Monthly*, now president of Drexel Institute; to Dwight V. Merrick, declared by one well-informed authority to be at present the most skilled expert in time study, who at one time worked for the Link-Belt Company, then assisted Carl G. Barth install scientific management in the Watertown Arsenal, and is now with the H. H. Franklin Manufacturing Company; to Charles Day, of Day & Zimmerman, prominent consulting engineers of Philadelphia, the author of *Industrial Plants*; to C. J. Morrison, formerly with Harrington Emerson, but now of the firm of Froggatt, Morrison & Company, which firm has introduced the methods of scientific management into some thirty-two plants; to Henry V. Sheel, of the Brighton mills; to Henry P. Kendall, of the Plimpton Press; to William Kent, and

Robert T. Kent, consulting engineers and editors of *Industrial Engineering*; and to Charles W. Mixter, who claims to have offered the first college work on scientific management some seven or eight years ago, and who has more recently entered the active work. Among the prominent manufacturers who have taken up the scientific-management movement, two in particular are men of distinction: Henry R. Towne, president of the Yale & Towne Manufacturing Company, and James M. Dodge, president of the board of directors of the Link-Belt Company.

To put the strength of the scientific-management movement in more definite terms: We may first note that the Society for the Promotion of the Science of Management, whose membership is practically a roll of the leading Taylor men, numbers about seventy-five. Again, the Efficiency Society Incorporated started to compile a list of all the men professionally engaged in reorganizing industrial enterprises; and this roll had at our last count reached one hundred and eighty. As this list made no pretense of being complete—in fact, some very prominent names had not yet been placed upon it—it is probable that the actual number of persons whose entire time is devoted to introducing some type of "efficiency" is very much greater than one hundred and eighty. If, finally, there be added in, all the factory managers who are trying to introduce improved methods for themselves, the extent of the broader scientific-management movement is seen to be bordering on the immeasurable.

While many of this larger group are only ordinary in ability, and probably lack knowledge as to what scientific management really is, one is safe in saying that, at the fountain-head at least, the system is represented by earnest and capable men; the sketches which have been given above prove this. But if further proof be needed, it is only necessary to point out that three of the leaders in the scientific-management movement have been presidents of the American Society of Mechanical Engineers (Taylor, Towne, and Dodge), and that, conversely, many of the most active officers and committeemen of that organization are identified with, and throw their influence in favor of these new industrial ideas. Perhaps no other tribunal in America could by its approval add more prestige—at least as far as manufacturing technique is concerned—to the standing of scientific management.

Such is the size and character of the scientific-management movement. In the next chapter we shall endeavor to ascertain to what extent the movement has to date altered the industrial world.

CHAPTER V

A Survey of the Trades and Plants in which Scientific Management Has Been Introduced

I. THE PRESENT STATUS OF THE HISTORIC ILLUSTRATIONS OF SCIENTIFIC MANAGEMENT

a. *The Midvale Steel Company*

At the birthplace of scientific management, and the seat of its development from 1882 to 1889, the system is said to have remained static since Frederick W. Taylor left in the latter year; and though the ideas which constituted it in the eighties are still being applied, and, it is said, more successfully than ever before, Midvale has adopted none of the later features which have made the old scientific management seem but fragmentary. Midvale is one of America's three great armor plate-making plants, and produces heavy forgings of many types.

b. *The Bethlehem Steel Company*

Turning next to an examination of what has happened at Bethlehem, where innovations were made which were advertised for a decade—if not until the present time—as the most striking proof of what scientific management can accomplish, it may be said that the references all date back to work which was done between 1898 and 1901, or at the very latest, 1902. This is because the system installed there met with the disapproval of Charles M. Schwab when he came into control of the plant in September, 1901;

Taylor had at this time already retired; Barth left the same year, and Gantt in 1902.

The status of scientific management at Bethlehem since 1901 is a controverted matter. The present owners say that they have rid themselves of Taylor and his ideas, and declare in their irritation that they "don't want to hear anything more about scientific management." Gantt and his associates grow equally warm in expressing their views. They accuse Schwab of being an irreclaimable "driver"; they say that though he pretended to repudiate the whole of their system, he really continued to enforce those features which aim to bring production up to the maximum, divorcing from the system, however, its essential principles of liberal pay and fair treatment. This policy, according to Taylor, did not work well: Although at first an attempt was made to do away with bonuses, "at the end of the month (so the foreman and the men told [Taylor]), Mr. Schwab was [all too] glad to put the premium back again, because the product of the shop had dropped to about one-half." [1] In spite of such warnings, Gantt says,[2] Mr. Schwab continued to debase scientific-management's better ideals regarding the treatment of workmen, until there came the great strike of 1910. Though Schwab is thus alleged to have wandered away from certain of the teachings of scientific management, it is claimed that on the whole his plant has retained the important features of the system. Thus we meet with conflicting testimony: that of the Bethlehem management that Taylor and his system have been "kicked out," and that of some of the opposing

[1] Testimony of Taylor, *Hearings before Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Management*, p. 1506.

[2] *Work, Wages and Profits*, p. 107.

party, who have revisited the works, and say that its essentials are in operation.

Without venturing to pass judgment as to the truth of the charges against Mr. Schwab, there is good reason for believing that a considerable portion of scientific management is to-day imbeded in the Bethlehem organization. Our authority is no other than a statement issued by the Bethlehem Steel Company itself, and constituting Appendix C of a Government *Report on Strike at Bethlehem Steel Works*,[1] prepared after the 1910 trouble. This statement carefully explains that in its machine shops the time required to perform each operation entering into the work is determined by "observation" [elementary time study]; that on the basis of this "standard information" a "man in charge of the rating" allows a proper time for the completion of each individual job [task-setting]; and that for success a bonus of 20 per cent above a fair day rate is given, while if the task be completed in less than the standard time, the gain is shared equally between the company and the workman [the Gantt "task and bonus" system, except that the Gantt plan gives all the gain to the workman]. Finally, there is displayed a "work slip" [instruction card] which with its detailed enumeration of operations, directions as to regulation of machine, *etc.*, looks for all the world as though it might have come out of Taylor's "Shop Management." Now, the Bethlehem Steel Company has doubtless made changes during the last fourteen years; but the above-outlined statement certainly shows that, in the machine shops at least, their advancement has not carried them away from the general principles laid down by Taylor, Gantt, and Barth.

As to the fate of the novel Bethlehem experiments in

[1] Sen. Doc. no. 521, 61 C., 2 S.

scientific pig-iron handling and shoveling,[1] the insight given by the contents of the last paragraph dispose one to credit the assertion of Taylor that as a matter of fact "they are still carting around forty tons of pig iron a day at Bethlehem" (his way of roughly indicating that the output is still approximating 47½ instead of 12½ tons); and to accept as a correct explanation his further state-

[1] The "science" of shoveling being one of the most interesting discoveries of the Bethlehem period, and not having come in for description before, it may be explained here that among its fundamentals are the selection of large scoops for the handling of light, and small shovels for the handling of heavy materials, so that the load will for every class of work approximate twenty-one pounds, which load experiment has shown to be the most efficient. Studies were made of the relative advantages of earth, wood, and iron surfaces underneath the pile. Workmen were instructed in the best way of pushing in their shovels, *etc.* The time required to throw to any given height or distance was brought under a formula, and tasks were set, based upon these distances and the laws of human endurance. A personal record was kept of the work of each man, and for standard performance individuals were given substantial bonuses, so that the average earnings for all of the men rose about 60 per cent (from $1.15 to $1.88). That no time might be lost through having too many men in one place and too few in another, or through waiting between jobs, a central office was established from which "every laborer's work was planned out well in advance, and the workmen were all moved from place to place by the clerks with elaborate diagrams or maps of the yard before them." The results claimed for this system were a reduction of the force of yard laborers from between 400 and 600 to 140, an increase in the average number of tons handled per man per day from 16 to 59, and (Taylor assures us) beneficial effects on the workmen. The net savings for the third year, after including in the costs "the office and tool-room expenses, and the wages of all labor superintendents, foremen, clerks, time-study men, *etc.*, are placed at $36,400, "and during the six months following, when all of the work of the yard was on task work, the saving was at the rate of between $75,000 and $80,000 per year." (*Principles of Scientifice Management*, p. 71.) According to Taylor's testimony before the Industrial Relations Commission, 1900 observations were made covering the shoveling of a single kind of material.

ment that, while he himself has not been back at Bethlehem, others who have say that shoveling is still carried on according to his methods.[1]

If it should happen that we have reached an unwarranted conclusion, and the remnants of scientific management at Bethlehem are indeed unimportant, even then it would still be true that the historical movements which occurred there have a present-day standing. In that case it could be pointed out that the system there developed for machine shops has since been incorporated, along with new ideas, in other plants. Whether or not shoveling is now performed "scientifically" at Bethlehem, the art, Taylor assured us, has certainly been introduced elsewhere. For instance, glimpses of it are caught in the reports of General Crozier on the Watertown Arsenal. Finally, to illustrate the subtle manner in which scientific-management ideas may be transferred to new soil, data developed in the pig-iron work concerning the laws of human endurance have been applied to bricklaying.

The investment in the Bethlehem Steel Company, including capital, funded debt, and surplus, is given in the Government report referred to above, as over $40,000,000, the normal number of employees as about 8,300. The company manufactures gun forgings, marine and general engine forgings, and heavy machinery and ordnance of every description.

c. *Bicycle-Ball-Bearing Inspection*

A different fate befell scientific management in the works of the Symonds Rolling Machine Company, of Fitchburg, Massachusetts, where during the bicycle craze more bicycle

[1] The statement in regard to shoveling was made direct to the writer; the assertion in regard to pig-iron handling was made through a third party.

ball bearings were manufactured than in any other shop in the United States: the concern is no longer in existence. Although we are told that not much scientific management was introduced in this place, considerable publicity was given to the study of bicycle-ball inspection—as referred to in an earlier passage.[1]

d. *Bricklaying*

Since Gilbreth left the contracting business, it is not known that his bricklaying methods are being applied anywhere in their entirety. He has noted, however, the use by others of various isolated features of his system—for instance, the "packet" idea in carrying bricks.

While the Gilbreth methods were in operation, they were hailed as the great example of coöperation between scientific management and the unions. Being himself a member of the Boston bricklayers' union, Gilbreth declared that he had after some difficulty overcome scruples about piecework by paying the men a straight day rate, and then giving a bonus for reaching a certain high output. It should be noted that this coöperation was never in the form of a definite agreement.

It is believed by some that Gilbreth abandoned the contracting business because this friendly relationship came to an end, that there were strikes, *etc.* The actual extent of trouble of this kind seems to have been a two-days' mix-up at Hudson Falls, New York, which proved to have been more of a misunderstanding within the labor organization itself than an affair of real seriousness. A letter received

[1] Page 79. Taylor had been engaged to systematize this plant, Gantt was general superintendent, and S. E. Thompson did the time-study work.

According to C. Bertrand Thompson ("Scientific Management in Practice," *Quarterly Journal of Economics,* Feb., 1915) it was here that the system of functional foremen first reached its full development.

from the corresponding secretary of one of the two Boston locals, replying to a request for information on the subject, speaks of no differences with Gilbreth other than the union's refusal to allow the use of the "fountain trowel." Nevertheless, labor's national leaders, who look forward to the possible consequences growing out of scientific management, are undeniably hostile to the new bricklaying.

Gilbreth's relationship to organized labor in the field of bricklaying seems, therefore, to have consisted in (1) the convincing of individual union men that it was to their interest to work according to his system; (2) non-interference on the part of the local organizations; (3) moral opposition on the part of national leaders; and (4) the disappearance of the issue through Gilbreth's going into a more promising profession.

e. *The Santa Fe*

In May, 1904, because of labor troubles, Harrington Emerson was given the task of reorganizing a part of the Santa Fe railway system. His authority extended only to that one department known as the motive power department; and he was, therefore, concerned mainly with the maintenance and repair of locomotives, much of which work was centralized in shops at Topeka. Nevertheless, by the time Emerson had worked out from Topeka to the end of the 10,000 or so miles of road, his system was affecting 12,000 men, and he had a task upon his hands which took three years of time, and the assistance of a large staff of railway experts (in 1906, 31 were on the work).

The cause of starting Emerson's "betterment work," as it was officially called, having been a strike, his first and most important aim was to establish a basis for permanent harmony by introducing an "individual effort and bonus system." Increased supervision of the men was to be undertaken, and for good work special rewards were to be given. Accordingly, time studies were made (about 4,000 by December, 1906), tasks were set, and bonuses offered. There were several distinguishing features which marked this phase of scientific management as it was introduced on the Santa Fe: First, extreme emphasis was laid on the individual character of the relations of men and management: "The schedule is a moral contract or agreement with the men as to a particular machine operation, rate of wages and time. Any change in men [*etc.*] calls for a new schedule." Second, there was a lack of insistence on the selection of unusual men: "The standard time set is reasonable, and one that can be reached without extraordinary effort; is, in fact, such time as a good foreman would demand."[1] And third, bonuses were paid to foremen. Thus the Santa Fe management sought to make of its employees industrious, well-paid, and loyal workmen.

But before actually setting tasks, it was necessary to study and standardize all tools and equipment, and this led in itself to important improvements. Specially notable was the improvement in the care of belting, this being taken out of the hands of the workmen and put into those of specialists, with a resulting saving of 70 per cent in the expense of belt maintenance. Perhaps the most interesting features which Emerson introduced were the various routing and scheduling devices. All of the work in the machine shop was so arranged that it could be controlled from dispatch-boards located in a central office; likewise on a bulletin-board was indicated the progress in the repair of each locomotive. Most of the other changes—such as the centralization of work at Topeka, and the introduction of im-

[1] Statements of Harrington Emerson, as printed in an editorial write-up entitled, "Betterment Work on the Santa Fe," *American Engineer and Railroad Journal*, Dec., 1906.

proved methods of cost accounting—are beyond the pale of things which are distinctively "scientific management."

It is agreed that the principles of scientific management were only part of them introduced on the Santa Fe. Nevertheless the estimated savings were at the time put at enormous figures. Thus in the article from which the above quotations were taken, its writer estimated from figures contained in the president's annual report that during the fiscal year ending June 31, 1906, fully a million and a quarter of dollars were saved. Other critics were equally enthusiastic, and the work attracted a great deal of attention throughout the country.

Since Emerson's connection with the Santa Fe was severed, there have been those who have said that the value of the work was illusory, and that now, as a matter of fact, the entire structure has been torn down by the officers of the company. Of this much there can be no doubt, that the facile way in which savings running into the millions were calculated is now recognized as unscientific. We have talked with some of the men who made the original estimates, and they now acknowledge the impossibility of even approximately stating how much the innovations were worth, and indeed smile a little at their own big figures.

As to the status on the Santa Fe to-day, the two following quotations, the one from Harrington Emerson, and the other from a present officer of the company, contain on the one hand an implied admission that there have been more or less important alterations, and on the other hand an acknowledgment on the part of the new managers that they have conserved much of Emerson's chief contribution. Thus Emerson writes: [1]

Since that time [his withdrawal six years before] there has

[1] *Correspondence* dated Sept. 27, 1913.

been a change in vice-presidents, two changes in superintendent of motive power, and not one of my original group of assistants is left. Nevertheless much of the work remains. About 60,000 work schedules were made out and bonus to the extent of $1,000,000 a year has been paid, and in large amount is still being paid.

From the other side, we are informed by Vice-President W. B. Storey [1] that while "it is not practicable to give an estimate of the saving due to 'betterment'," nevertheless: "The bonus system installed at the time Mr. Emerson was with us is still in effect on our road, although it has been modified in certain directions." In reply to an inquiry as to what parts of "betterment" had been abolished, he said: "The principal feature that has been eliminated is bonus to foremen and men in authority." A considerable part of Emerson's work has therefore been retained on the Santa Fe, and, as we are told by various authorities, is working satisfactorily.

f. *Conclusions as to the Past of Scientific Management*

Thus is brought down to date the story of those installations of scientific management which are discussed in the older literature of the subject. We may conclude that, while the facts do not warrant our saying with some that all of the stock illustrations of scientific management are to-day practically non-existent, nevertheless it is true that in each case something has happened to dim the glory of the achievement. Though abandoned in but few cases, and convicted of failure in none, stagnation, disavowal, or transformation, have destroyed their character as satisfactory evidence. However, as a matter of fact, the scientific-management men of to-day no longer care a great deal

[1] Quotations from *correspondence* dated March 17, 1914.

about these earlier examples. They regard most of them as but the remnants of experimental stages which their rapidly-developing movement has long ago left behind. In the following paragraphs we will turn, therefore, to a survey of certain scenes of contemporary activity, where the up-to-date system may be observed.

2. A STUDY OF SEVERAL INSTALLATIONS OF CONTEMPORARY IMPORTANCE

a. *The Tabor Manufacturing Company*

This is a Philadelphia concern employing about one hundred men; it is engaged in the manufacture of molding machinery, together with certain other machinery and appliances for machine-shop use. Though the company had been in business for a number of years, it was not until 1900 or later that it opened a shop for the purpose of doing its own manufacturing. The new venture was not very well organized, and the company sustained heavy losses, conditions being made still worse by a strike of the employees. After a time the president, Wilfred Lewis, who happened to be a personal friend of Frederick W. Taylor, sought and obtained the latter's financial aid. This was given on condition that scientific management be introduced. Reorganization was begun under the direction of Carl G. Barth, consulting engineer, with the aid of advance sheets from Taylor's paper on "Shop Management" (read in June, 1903), and some personal supervision by Taylor himself. In the fall of 1904, Horace K. Hathaway was engaged to give his entire time to the introduction of the system, and since then, working first under the direction of Barth and then independently, Hathaway has been the man responsible for scientific management in this plant; he is now vice-president. Taylor was owner of a small amount of stock, not at all a controlling interest, as is sometimes said.

The following claims have been made for scientific management in the Tabor works: The first year that Hathaway was with the company they continued to lose money—antagonism within the management hindered the start; the second year, expenses were just about met; while during the third and succeeding years there were large profits.[1] In 1910 the experience of this company was Brandeis' first and strongest argument as to the efficacy of scientific management. It was testified before the Interstate Commerce Commission that in 1910 the money value of the Tabor output was between two and three times as great as it had been in 1904, this value representing, as prices had fallen, a material output fully three times as great as in 1904. This remarkable showing had been effected without any increase in the size of the plant, the floor space remaining practically the same, merely some additional storage room having to be rented, and there having been but little new machinery added. More than this, the number of workmen, instead of being increased, had been actually reduced: where in 1904, 105 workmen were required in the shop and 5 in the office, in 1910 only 75 were employed in the shop and 20 in the office (or in supervising); thus scientific management had cut down the total force from 110 to 95.

[1] The Tabor Manufacturing Company is said to have failed recently to declare a dividend. However, our informant, one of the leading critics of scientific management, assigned the incident to commercial causes alone, and not to the shop system. Mr. Hathaway tells us that while business conditions have been unusually unfavorable recently, his company has as a matter of fact often passed dividends—the stock being all in the hands of a small group, who have followed a policy of strengthening the company's resources, accumulating stock, *etc.*, rather than seeking immediate returns.

A description of the introduction of scientific management into the Tabor works follows. The sketch will show scientific management from a new and more realistic angle. In our earlier discussion of the genesis of scientific management the main features of the system were presented in what might be called their logical sequence; that is, attention was first called to the ends in view, and secondly, to the means adopted. However, when a real factory—like the Tabor Manufacturing Company—actually starts to introduce scientific management, it is obvious that the various features must be installed in precisely the reverse of the logical order—that is, the first steps must be of a rather incidental nature, while the greater ends can be compassed only towards the last. Hence, as we review the experience of this company, we shall find our first, second, and third phases of scientific management somewhat rearranged.

The first effort in the Tabor plant was to improve conditions. All of the machines were gone over, strengthened where necessary, and put into first-class order. A plentiful supply of small tools, such as bolts and clamps for holding materials, was purchased and put at the disposal of the workmen. Cutting tools of the most scientific shapes and of uniform quality of steel were introduced. As coming partly under this same head of rearranging conditions may be mentioned improvements in tool-rooms, store-rooms, *etc.*

As rapidly as progress along this first line permitted, a second side of scientific management was taken up, namely, the organizing of the working force. The shop was placed under the control of a "functional management" with headquarters in a "planning department." To describe the Tabor system: As soon as an order has passed through the hands of the draftsman, it is analyzed to determine exactly what parts will have to be made, and then, the date for the completion of the entire order having been taken into consideration, an explanatory diagram is drawn up, which covers all the parts, and specifies just when each part should be finished and ready for assembly. The next step is to send a list of the materials which will be needed to the stock clerk, who makes sure that everything will be on hand in time; also by way of preparation, an instruction card is made out for every operation, which covers the things to be done, the best methods of doing them, the tools that will be needed, and the time which each element of the job should take. Everything is now put into the charge of the "order of work" clerk; keeping an eye on the planning-department diagram which stipulates when every operation must be finished, and at the same time keeping in touch with the daily work of every man and machine in the shop, this "general" routes and dispatches the jobs by means of elaborate bulletin-boards, the whole system thus resembling a great piece of clock-work.

Again viewing the Tabor functional management, and this time from the standpoint of the workman at a machine, functional management means that where formerly the workman had to hunt up the foreman to find out what he was to do, then search for materials, find and grind his own tools, *etc.*, now he has everything brought to him in advance, and laid out before him in first-class condition ready for starting to work. In addition, the workman has at hand an instruction card, which makes unnecessary a preliminary debate as to what to do first. Also at his service are three teachers, of whom the gang-boss and the speed-boss instruct him in the most expeditious way of setting up and of performing the work, while the inspector instructs him as to how he may obtain the necessary quality.

Not until the Tabor people had undertaken these two preliminary steps could there be installed the last and crowning feature of scientific management—the wage system. Briefly characterized, this consists in timing the elementary human movements entering into a job, calculating the machine times, and then using these data to decide how long it should take to complete the job; the company under all circumstances pays a day rate, which is, it is claimed, fully as high as that prevailing throughout the community for similar work; and then for successful accomplishment of the task it pays in addition a bonus amounting to 35 per cent. Some of the men always earn their bonus; others sometimes fail. The average amount carried home at the end of the week is said to be between 25 and 30 per cent greater than the same men could get elsewhere.

The Tabor Manufacturing Company's plant is the most celebrated demonstration ground and school connected with the scientific-management movement. One gentleman counted some twenty visitors who went through the shop in about three hours one afternoon. It is a favorite place for training young men who are later to become experts on their own account.

b. *The Link-Belt Company*

A twin brother of the Tabor Manufacturing Company—as far as scientific management is concerned—is the Philadelphia branch of the Link-Belt Company, a concern engaged in manufacturing elevating and conveying machinery, of special rather than standard types, and employing from four hundred to seven hundred and fifty men. In both the Tabor and Link-Belt plants, and at almost the same time, the introduction of scientific management was started by Carl G. Barth, under the general supervision of Frederick W. Taylor. Of the two, the Link-Belt people perhaps deserve credit for taking hold more promptly and attacking more vigorously and with less respect to cost pioneer difficulties. Some believe, however, that at the present time there is a shade of difference the other way, and that the Tabor organization has carried its system to a finer point of perfection. But these distinctions are not important: scientific management has been installed completely in both plants; their methods are nearly identical; both concerns are celebrated.

However, the statistics of the Link-Belt Company furnish the better basis for judgment as to the true value of scientific management; for in the case of the Tabor Manufacturing Company, all comparison is with a past when the concerns manufacturing was admittedly an immature, badly organized, and losing undertaking. The Link-Belt enterprise, on the contrary, was started about 1874 or 1875, and since 1878 the company has had with it James M. Dodge, a president of the American Society of Mechanical Engineers. In the nineties they had a superintendent well versed in some of the best shop practices. Indeed, they thought in 1903 that they were running a model shop, and the company was, in fact, making money. Hence the comparison, in the case of the Link-Belt Company, is between the best of the old and the best of the new.

In 1910 James M. Dodge, chairman of the board of directors, testified before the Interstate Commerce Commission that the Link-Belt Company was at that time producing twice as efficiently in its Philadelphia plant as in 1903 and 1904, meaning that, per man employed, the output of the works as a whole was twice as great. As regards wages, he declared that all were paid what the men considered fair day rates; in addition to this, a bonus was added for good work, which amounted in the case of most good workmen to 25 or 30 per cent of the ordinary wage, but in a few exceptional instances to 35 per cent. The labor time had thus been reduced by as much as 50 per cent; but, taking into account the increase in wages, and making allowance for the fact that in this industry the expense for labor is somewhat overshadowed by the outlay for raw materials, it was declared that in the total costs the system had meant a reduction of not more than 20 per cent. As the selling price had been cut 10 or 15 per cent—being figured for the most part on cost plus a percentage—the net gain to the stockholders could not have been more than 5 or 10 per cent of the selling price. In spite of this cutting away of a large part of the profits due to scientific management, the company was nevertheless decidedly more prosperous than before, its dividends having ranged in the years preceding 1910 from 5 to 14 per cent. It was also brought out in Mr. Dodge's testimony that the Link-Belt routing system had been of special value, in that it enabled the company to deliver orders with greater regularity, and that their improved methods of replenishing stock had permitted a reduction of one-third in the stores kept per unit of business carried on.

In April, 1914, Frederick W. Taylor testified before the Industrial Relations Commission that 98 per cent of the metal-cutting tasks set in this plant were accomplished in schedule time by the workmen. Before the same commission, Dodge testified that the average term of employment was more than seven years; also that the company had on file as many as 50,000 time studies.

About 1906 there was a merger of the Philadelphia company with corporations carrying on manufacturing in Chicago and Indianapolis. In Chicago, the introduction of scientific management was begun promptly; and because the management was now experienced, as much progress was made in one year in Chicago as had been made in four in Philadelphia. Later, the system was being installed rapidly in Indianapolis.

In weighing the value of these statistics in regard to the Tabor Manufacturing Company and the Link-Belt Company, and, in fact, in judging of the results due to the introduction of scientific management in any machine shop, it must be remembered that one reason for success is the fact that the management experts bring with them high-speed steel. How much of the increase in productivity was due to organization and how much to this epoch-making mechanical improvement, it is hard to say, for the reason that it would be impossible to get the full benefit of the steel without the use of the instruction cards, bonuses, and other management features. Between the two sources of profit Dodge makes no distinction, but says that the doubling of productivity was due to *scientific management plus high-speed steel.*

The prolonged studies by which the laws of metal-cutting were discovered and formulated for use in the shop, we believe should be regarded as a distinctly scientific-management activity; and specially does the system deserve credit for any saving due to the every-day application of these principles by means of instruction cards, functional foremen, *etc.*; these are a part of scientific management. But high-speed steel, though a product of scientific management, should not be confused with it; and we must, therefore, deduct something from the above estimates, to determine the true worth of the new management taken by itself.

Besides allowing for the effect of high-speed steel, it may be noted that in six years ordinary progress should account for a certain lessening of cost. The fact that prices were lower and competitors more numerous in the fields occupied by both companies in 1910 than in 1904 might indicate that other forces were reducing costs and increasing outputs besides scientific management.

It is believed, however, that after taking all these things into consideration, a good part of the three-fold productivity claimed for the Tabor plant, and the two-fold efficiency claimed for the Link-Belt works, should be laid to the credit of scientific management. The greater prosperity of the companies, both as compared with their own past and with the condition of their competitors, indicates that they now have some unusual advantage. The decision of the Link-Belt Company to install the system in its Chicago and Indianapolis plants shows that the managers, at least, are convinced of its value.

c. *The Watertown Arsenal*

On June 14, 1909, Carl G. Barth began the installation of scientific management in the arsenal operated by the United States Government at Watertown, Mass. After about two years spent in looking over the machinery and in systematizing the plant, the first bonus was offered in May, 1911. The application of the new wage system was gradually widened, so that by May, 1913, 45 per cent of the work of the machine shop was under the premium system, some of the other departments, however, running as low as 5 per cent. Altogether, during that month, 210 out of the 600 employees of the arsenal worked a part of their time upon premium jobs. Though it is thus seen that scientific management had not yet been thoroughly enough introduced to make the Watertown Arsenal a typical instance of its application, yet the fact that we here meet with official figures makes it worth while to give a brief summary of the results obtained.

In his annual report for the fiscal year ending June 30, 1912, General Crozier, Chief of Ordnance, gave special attention to the subject of scientific management. He stated that during that year it had saved the Watertown

Arsenal $49,000; but if throughout the entire twelve months there had been as much of the system in force as there was in May and June, the figures would have been $100,000. The best proof of the value of scientific management, he continued, was the fact that due to the existence of these savings the estimates for the next fiscal year had been reduced by over $240,000. Scientific management was furthermore permitting a substantial reduction in the amount of stores, $122,000 worth having been already absorbed. The productivity of the individual was on the average about two and a half times as great as it had been under day-work, as was found by a comparison of the job cards on about sixty different jobs, each of which was performed both under the old day-work and the premium systems.

In a memorandum submitted to the Secretary of War on September 6, 1913, General Crozier further stated that in the seventeen months ending May 31, 1913, $22,000 had been paid out in premiums to the men. During May, 1913, individuals had earned bonuses varying from nothing to $31. In the machine shop, the average earnings while working on premium jobs were 24 per cent above the day rate. More men earned premiums between 30 and 35 per cent than in any other 5-per-cent group, while less than 4 per cent failed to receive any bonus. These machinists constituted three-fifths of the premium workers. The averages for the other departments were generally higher, and in no case lower, than 24 per cent.

The premium system at Watertown starts with the usual stop-watch analysis on the basis of which the time required to perform work is ascertained; this time is then *increased by two-thirds* (that is, for a job that can be done in 30 minutes, 50 minutes is allowed), and then for every minute saved from the time allowed a premium of half a minute's additional pay is given. Thus if a task which can be done in 30 minutes is actually finished in 30 instead of 50 minutes, the premium amounts to 10 minutes, or 33⅓ per cent. No matter how long a man takes, he gets his regular day rate; and in September, 1913, General Crozier stated that up to that time no one had been discharged for failure to earn a bonus, or indeed because of the introduction of scientific management. Foremen are given bonuses which vary with the success of their subordinates.

The chief interest in the Watertown Arsenal case centers, however, in the relationship between scientific management and organized labor. In December, 1910, General Crozier had assembled at Watertown a board including the commanding officers of the principal manufacturing arsenals. A thorough study was made of the new methods and their adoption elsewhere recommended. By this time, the hearings before the Interstate Commerce Commission had thrown the limelight on scientific management. When, therefore, in the spring of 1911, steps were taken to introduce the system at the Rock Island Arsenal, the employees there, in coöperation with President Gompers of the American Federation of Labor and President O'Connell of the International Association of Machinists, vigorously attacked it. Hearings were secured before the House committee on labor, and an alarmist circular was issued by O'Connell.

Possibly it was because of this stimulus, General Crozier thinks, that when an attempt was made to introduce the bonus system into the Watertown foundry during the summer of 1911, the entire force walked out. Though they came back in a few days and the installation of scientific management was successfully continued, on August 21 the House of Representatives authorized a special committee to make an investigation. This committee, composed of W. B. Wilson, later Secretary of Labor, Wm. C. Redfield, later Secretary of Commerce, and John Q. Tilson, held hearings in Boston, New York, and Washington, beginning on October 4, 1911, and ending the following February 12th. On June 17, 1913, the majority of the Watertown employees, and then on June 21 their union representatives, filed petitions requesting the abandonment of the "Taylor" or "stop-watch" system. To these petitions General Crozier made an exhaustive reply (September 6).

From time to time various bills have been introduced into both houses of Congress forbidding the use of the stop watch (or other time-measuring device) and the paying of bonuses on government work. On March 3, 1915, the House forced the Senate's unwilling consent to provisions in both the Army and Navy appropriation bills forbidding the use of funds for either of these purposes. This means that, beginning with July 1, 1915, the extension or preservation of this phase of scientific management in the Government arsenals will be impossible. For a year, at least, the system will be suppressed. Indeed, the War Department has not waited for July to begin its removal.[1]

d. *The Cotton Industry*

Our last detailed description will be of a plant in regard to which there is available exceptionally valuable data respecting the effect of scientific management on health. It is a New Jersey cotton mill, systematized some time ago by Henry L. Gantt, who for five years devoted a portion of his attention to the work. The increase in the productivity of the factory amounted to perhaps 20 or 30 per cent, and

[1] Colonel Charles B. Wheeler, commanding officer of the Watertown Arsenal, and Major C. C. Williams, his first assistant, have devoted much time to the matter of pushing the introduction of scientific management; Dwight V. Merrick, a very capable time-study man, was Barth's assistant. For statement as to the objections raised against scientific management at Watertown, *cf. infra*, p. 188, n., and pp. 190-2. That the formal petitions, in fact, misrepresented the real sentiments of the employees is indicated, *infra*, pp. 192-3.

was substantial, though not at all as phenomenal as in the case of the metal-cutting shops. Wages were increased by about 30 per cent in many (though not all) of the departments, so that it is seen that the profit to the management did not lie in diminishing the direct labor cost, but rather lay in lessening the proportion of overhead expense to be attached to each unit of output, because of the increased production. As quality as well as quantity was considered in the paying of bonuses, there was a marked improvement in the uniformity of the product.

Though there was thus no overwhelming increase in the production of this cotton mill, it might not be a bad place to look for injurious effects upon the health of the workers: a large number of the employees were women; and the introduction of task-setting—though it eventually resulted in the work's being practically all performed in standard time—was at first accompanied by a marked thinning in the ranks of the employees. This would cause one to wonder whether Gantt was right in saying that those who fell by the wayside were idlers, or whether the opponents of the system could not here find a justification for their general contention that the pace set by scientific management is too fast.

We may, therefore, attach considerable importance to a two months' investigation covering the effect of scientific management on health in this and two other factories. This investigation was financed by S. S. McClure, and conducted by Miss Edith Wyatt, for many years vice-president of the Illinois Consumers' League, an organization which strives to ameliorate the conditions of women's and children's labor. In her testimony before the special House committee appointed to investigate scientific management, Miss Wyatt gave the following facts: [1]

[1] *Hearings*, pp. 592-604.

Her investigation of the cotton mill concerned only the women workers; it included one or more visits to the homes of 30 out of the 110 women operatives, and talks with the mothers of the younger girls. As to the attitude of the girls towards scientific management, Miss Wyatt said:

. . . they were almost all of them pleased with it. The only one who was distinctly displeased with it was the girl I mentioned who was living in really very tragic conditions at home . . . she complained of the entire cotton industry . . . but I did not feel her complaint was due to scientific management. And then the winder I speak of complained of the stamping on pedals, and that I felt was justified. [This latter work was afterwards turned over to boys.]

Miss Wyatt said that in all her investigations she found only one mother who objected to the system, and after talking with the neighbors and looking up the health of the children, Miss Wyatt thought that this complaint was groundless.

Her own observations, made department by department, convinced Miss Wyatt that in only one particular were conditions unfavorable to health, and that was where some obstacle, regularly connected with the work, had to be encountered oftener because of the speeding-up of the machinery—as, for instance, the stamping on pedals mentioned above. However, the management was constantly and successfully applying itself to the eradication of these obstacles; and even in spite of the burdensomeness of these difficult operations, the amelioration of working conditions in general—the better air, better light, and reduced strain—made for a net improvement in working conditions under the system.

In the course of her investigation, Miss Wyatt was perhaps struck with nothing more forcibly than the changed attitude of the employers towards hours, wages, conditions of work, *etc.* — the "mental revolution" of which Frederick W. Taylor is fond of speaking. She offered one criticism: "My feeling . . . was that if the workers had been organized, if the workers themselves had stated their grievances, that it would have been of great assistance both to the employers and to the efficiency engineers and to the girls themselves."

3. EXTENT OF THE INTRODUCTION OF SCIENTIFIC MANAGEMENT

Turning now to a more rapid survey of other plants in which scientific management has been installed, Frederick A. Parkhurst's *Applied Methods of Scientific Management* is a 325-page record of the precise steps taken to modify and expand Taylor's principles to meet the specific conditions existing in a given plant, namely, that of the Ferracute Machine Company at Bridgeton, New Jersey. The claim is made that with practically the same employees and equipment the time required to perform 275 jobs was on the average reduced to just 38 per cent of what it had been before, that after increasing the average day rate by 11 per cent, and giving to bonus workers in addition an increase of from 20 to 60 per cent, the total cost for the 275 jobs, including overhead expense, was only 47 per cent of what it had been under the old system.

In the printing line, much attention has been attracted to the reorganization of the Plimpton Press, at Norwood, Massachusetts, by Morris L. Cooke and Horace K. Hathaway, with the aid of Henry P. Kendall, manager. This well-known concern employs about 1,200 persons. The Taylor system was partially installed for the Forbes Lithograph Company of Boston, the initial work there having been done by Cooke. A start was made in the plant of the Curtis Publishing Company of Philadelphia, and in that of the Manhattan Press of New York.

The Union Typewriter Company is now accepting scientific management from Henry L. Gantt; the Pullman Company of Chicago from Carl G. Barth. The H. H. Franklin Manufacturing Company, automobile builders, are having the system installed by Dwight V. Merrick, their works manager being George D. Babcock. The Yale & Towne Manufacturing Company employed Carl G. Barth to introduce scientific management into one department some time ago, and is now extending the same to the whole plant under the leadership of J. C. Reagan. Gantt's most promising field is now the Westinghouse Electric Company, and he has been retained by the famous Cheney Silk Mills of South Manchester, Conn.

The mere mention of these great corporations shows that scientific management is now being rapidly intrenched in the high places of the industrial world. Turning our inquiry now to the proportion of industry affected, Robert T. Kent, who is the secretary of the Society for the Promotion of the Science of Management, and who excludes from scientific management everything that is not strictly "Taylor," tells us that one day he called to mind with but little effort sixty important instances of the introduction of the system. If now to the Taylor group's work be added the two hundred installations of Harrington Emerson, and also those of a great number of other efficiency engineers whose methods largely parallel scientific management, the actual results of the movement are seen to be not inconsiderable. A committee of the American Society of Mechanical Engineers reported in December, 1912, that although they could not obtain complete statistics as to the extent of the introduction of the new system, "labor-saving management" (by which they meant scientific management) had been installed in some form in the following fifty-two industries:[1]

Book binding
Building construction
Carriage and wagon building
Construction and repair of vessels (navy yards)
Fire-arms and ordnance
- Rifles
- Gun carriages

Machinery building
- Automobiles
- Agricultural implements
- Coal-handling machinery
- Electrical machinery
- Founding, iron and brass
- General machine work
- Gas engines
- Locomotives
- Machine tools
- Molding machines
- Pumps
- Pneumatic tools
- Sewing machines
- Typewriters
- Wood-working machinery

Metal and coal mining
Metal working
- Bolts and nuts
- Chains
- Hardware
- Tanks
- Tin cans
- Valves and pipe fittings

Miscellaneous manufacturing
- Beer
- Beet sugar
- Boxes (wood and paper)
- Buttons
- Clothing
- Cordage
- Food products
- Furniture
- Flour
- Glass
- Lumber products
- Pianos
- Paper and paper pulp
- Rubber goods
- Soaps
- Shoes
- Slate products

[1] *Cf.* C. Bertrand Thompson, "Scientific Management in Practice," *Quarterly Journal of Economics,* Feb., 1915. Mr. Thompson, after a field investigation covering twelve states and continued through portions of three years, amends the above list by removing sewing machines, brewing, and beet-sugar refining, on the ground that in these industries "there was merely consultation or a report which did not develop later into actual work." He further recasts and supplements the list so as to make it number eighty industries.

Printing and lithographing
Railroad maintenance of motive power
Steel manufacture
Textile manufacture
- Bleaching and dyeing
- Cottons
- Velvets
- Woolens

When, however, the area dominated by scientific management is compared with the vast expanse of American and world industry, it must be admitted that, while scientific management has made a good start, its extent is as yet far from all-embracing. Fifty thousand is a common estimate as to the number of persons employed under the system; or, to put substantially this same judgment in another form, the leaders say that probably one-tenth of one per cent would exceed the proportion of the national industry which they have reshaped. It may be noted, however, that Mr. Taylor recently raised his estimate to 150,000 or 200,000.[1]

All these estimates, however, include plants where the work is incomplete. Thus Emerson tells us that in no plant has he had an opportunity to install his system as thoroughly as Taylor's ideas have been incorporated in the Tabor shop. "In many plants our engagement was for very short periods. A limited sum would be appropriated

[1] Testimony before the Industrial Relations Commission, April, 1914. Taylor said that he regarded these figures—and all similar estimates—as pure guesses. He declared that he knew of perhaps 100 plants where the Taylor System was working, but that there were certainly others.

C. Bertrand Thompson (*loc. cit.*) has since claimed definite knowledge of 140 applications of scientific management, of which 5 are to railroad and steamship operation, 4 to public service corporations, 4 to municipal work, 3 to building and construction companies, 1 to a department store, 1 to a bank, 1 to a publisher, 1 to a professional society, and the remaining 120 to factories. He estimates that the factories employ 43,000 men, and the transportation companies 20,000. He believes that the bonus affects as many as 40,000 employees.

with instructions to do the best we could in three months or six months." And so, to a large extent, has it been almost everywhere. Not only has the system been modified and minimized to meet financial limitations, but usually peculiar obstacles of one sort or another have affected the nature of the introduction. Thus complete reorganizations on efficiency lines are not very numerous, and pure scientific management is extremely rare.

At the same time, not even the largest-sounding of the estimates given above would cover all the industry upon which scientific management has had some effect. They take into account only installations by men who have hung rather close to the original leaders. No one group of leaders, however, is now able to control the scientific-management movement. We noted in the last chapter the large number of persons who have entered upon the work professionally or taken an active part in introducing changes into their own plants. Perhaps they do not completely understand scientific management, but they have read Taylor's books, or Emerson's, or caught their spirit,—and one or another of the principles is adopted. Missionaries fresh from India and Japan have told us of their thought that these principles might be applied to mission finances or to mission industrial work. University men, next door, have proposed to apply them in the class-room. Wherever, on the train or in the shop, we have talked with factory workmen or managers, they have had something to say about new systems, different perhaps in name, but very similar in effect to those herein described. We suppose there are few important factories where the influence of scientific management has not been felt, to at least a small extent.

While America is the home of "scientific management," an important literature on the subject has appeared in German and French. In most of the other leading languages, translations of one or more American works are obtainable. According to Morris L. Cooke:[1] "There are some establishments in most of these countries in which real progress in scientific management is being made. Better still in most foreign countries one or more prominent citizens—usually of the engineering profession—are advocating the adoption of scientific management as a means toward national progress."

[1] "The Spirit and Social Significance of Scientific Management," *Journal of Political Economy,* June, 1913, p. 482.

PART II

A CRITICAL REVIEW OF IMPORTANT ASPECTS OF SCIENTIFIC MANAGEMENT

CHAPTER VI

The Productivity of Scientific Management

In discussing the productivity of a system as many-sided as scientific management, the system as a whole must be resolved into its constituent parts. The various efficiency devices should be arranged in the order of their respective importance, and the value of each estimated. We face, therefore, the leading question: What is the most profitable feature of scientific management?

I. THE VALUE OF THE INITIATIVE OF WORKMEN

Of his original publication, "A Piece-Rate System," Frederick W. Taylor afterwards stated that his chief object in writing it was "to advocate the study of 'unit times' as the foundation of good management."[1] In regard to his more mature paper, "Shop Management," the father of scientific management makes the even stronger declaration:[2] "What the writer wishes particularly to emphasize is that the whole system rests upon an accurate and scientific study of 'unit times,' which is by far the most important element in modern management." What was true at the beginning is true to-day. In 1913 Morris L. Cooke, than whom no one has done more to broaden the scope of scientific management, still felt constrained to say:[3] "Practically everything that is done in developing scien-

[1] "Shop Management," *Transactions of the American Society of Mechanical Engineers*, vol. xxiv, p. 1364.

[2] *Ibid.*, p. 1364.

[3] *Journal of Political Economy*, June, 1913, p. 487.

tific management in an establishment has for its object the setting of tasks."

The fact that task-setting is the thing towards which all scientific management is directed is of the greatest importance for the present discussion, for it indicates that the aspect of the system of which this device is the central feature is the most largely productive of all. The attainment of the initiative of the workman, through giving an extra reward for the successful completion of a task, which task has been determined by the study of unit times—this end must be regarded as the initial incentive and the moving force behind the entire development.

The contribution which the first phase of scientific management has made to the general productivity of the system may be evaluated as follows:

Before the system had been developed so as to include many auxiliary features, production on jobs in the Midvale Steel works was increased by 100 per cent, this being credited almost entirely to the setting of tasks by means of elementary time study and the application of the differential rate. Taylor tells us in "A Piece-Rate System"[1] that he has never failed to find men who are glad to unload coal from a car at the rate of forty tons per day instead of the usual fifteen tons. Beyond taking care to select strong men, there seems to have been no extensive study of the work; but reliance was placed mainly on rousing interest through task-work with liberal pay. The possibility of greatly increasing production through adjustments in the method of wage determination is attested by authorities from all quarters. Thus David F. Schloss found that by ordinary piece-work, production could be increased from 30 to 50 per cent;[2] and Frederick A. Hal-

[1] *Transactions of the American Society of Mechanical Engineers*, vol. xvi, p. 878.

[2] *Supra*, p. 32.

sey claims for his "premium plan" an increase in productivity of 70 per cent.[1] Finally, the retention of the bonus system in the plants of the Bethlehem Steel Company[2] and of the Santa Fe railway[3] indicate that it is of real value.

We may believe, therefore, that the greatest gain which attends the introduction of scientific management is the minimizing of the friction and waste which ordinarily occur when one man works for another. The more capable men do not accomplish nearly as much work as they might easily turn out, this attitude being assumed as a matter of policy. Scientific management, through determining reasonable tasks by the accurate method of elementary time study, and then adequately rewarding workers who attain the standard, is therefore capable of adding substantially to the sum total of production; nor need the cost of the additional effort be as great as the value of the extra product.

But the precise amount of gain varies, on the one hand with the seriousness with which work has been done before, and on the other with the extent to which a rigid scientific determination of tasks is feasible.

General Crozier describes an instance at the Watertown Arsenal where the time on a job was not reduced, because the man who had been previously working on it was an earnest workman. Likewise, the gains under scientific management have often loomed up in greatly exaggerated proportions, because the shops concerned had been badly managed previous to reorganization. It is probable that on jobs where a piece-rate or Halsey premium system has been used for a long time, the industry of the men cannot be greatly increased by the introduction of scientific man-

[1] *Supra*, pp. 49-50.

[2] *Supra*, p. 122.

[3] *Supra*, pp. 128-9.

agement. It follows that this phase of scientific management is of chief advantage in those fields where constant or frequent change in the work prevents or delays the establishment of reliable day-work or piece-work standards; and the productivity of scientific management, as compared with that of these other systems, may be said to vary in inverse proportion to the amount of repetition in the work.

This law, however, has to do only with increasing *material production*. The feasibility, or, better yet, the *profitableness* of the elementary analysis is affected by other circumstances. Scientific management would be out of the question unless there were running through the non-repetitive work, elements practically constant, or subject only to regular change from job to job. The cost of the system is reasonable only where the work elements are simple and extend on the average through a large number of jobs. The all-important proportion of cost to profit is favorable only where the work units—as well as the jobs themselves—are comparatively large.

In general, to obtain the greatest profit there must be a good deal of work handled, there should be a marked similarity running through considerable portions of it, and the jobs should be of large size, possibly taking a number of hours for performance.[1] A balance must always be struck between the cost of the studies and the worth of the results.[2]

[1] On a sample instruction card showing the system as it existed at Bethlehem in 1910, the analysis was in no case carried as far as work elements which could be done in less than ten minutes. The jobs in the machine shops where scientific management has been applied often take several hours. Of course, as the number of times that a job is repeated becomes greater it may become profitable to carry the analysis further; in work such as handkerchief folding, the elements are reduced to small fractions of a second.

[2] If Gilbreth's reorganization of bricklaying is thought to be an ex-

2. THE EXTENT TO WHICH PLANNING MAY BE PROFITABLY CARRIED

One could hardly imagine a great increase in production without accompanying features — as the choosing of able workmen or the taking of greater care to supply the men abundantly with work; some changes are incidental to, or necessary consequences of, greater productivity. But the features which constitute the second phase of scientific management are more than merely supplementary; they seek recognition as an original source of profit.

In the machine shop and in some other branches of industry the most important of these changes is standardization of tools and equipment, both because of its own merits and because it is the condition of progress along many of

ception to the principle that large non-repetitive work is the most profitable field for task-setting based on elementary time study, it may be pointed out that Gilbreth did not claim that he had drawn more initiative from his men, but he attributed his success entirely to motion study and changes in the methods of work. If shoveling be cited, it may be observed that, though the elements entering into shoveling are repeated, the work as a whole is constantly varying, because of differences in materials, height of pile, *etc.* Thus it cannot be brought under ordinary piece-work. As regards pig-iron handling, it is probable that a man of Taylor's energy could in the long run have obtained just as hearty a co-operation from the men without introducing elementary time study, provided he selected his workmen. Of course, without the studies of fatigue, their efforts, though quite as earnest, would have been less efficient. Our point is, not to deny that elementary time study has accomplished great results in connection with repetitive work, but to show that (if we bar the gains due to discoveries of better methods of work) elementary time study's chief superiority over ordinary methods of piece-rate fixing is in its accomplishing quickly and easily what can be done by the latter, if the struggle be long enough and vigorous enough (*cf. supra*, p. 35, n.). The full benefits of scientific management being realized at once, and those of ordinary piece-rate systems comparatively late, it is obvious that the greatest superiority of the former is in connection with jobs running for but a short time, if repeated at all.

the other lines. While standardization accompanies scientific management primarily because of the necessity of establishing uniform conditions which will render task-setting accurate and fair, nevertheless in substituting for the weaker parts of machines strong parts, and in throwing out tools of old design and introducing others of more modern make, standardization transcends its original purpose and becomes the parent of an efficiency which is no longer a part of management. The value of this gain in mechanical efficiency is apt to vary according to whether the industry involved has been the scene of little or much recent improvement in technical processes.

Second only to standardization, and in specific instances of greater value, is what is variously known as routing, scheduling, and despatching. We are told that productivity is often increased through this means alone by thirty or forty per cent, and that on occasions it has been observed to actually double the output. On the Canadian Pacific railway despatching locomotive-repair work was credited with saving three days' time or $300 in expense in the case of each locomotive sent to the shops. Miss Wyatt testified that in some of the departments of the cotton mill which she visited the gain seemed to be practically all due to routing. Good routing shows results perhaps more instantaneously and more clearly than any of the other features of scientific management. No one sees danger in the introduction of either standardized equipment or routing.

Regarding the extension of the authority of a planning department to small and seemingly personal matters—as is the case when an instruction card is issued for every job, or a workman is "coached" in the best way of picking up a brick or thrusting a shovel—it may be said, first of the *instruction card*, that its original application was in connection with very large work, where there was an important technical element involved, and where the application of science could not only save a considerable amount of the workman's time, but also reduce the operating expense of heavy machines; the work was changed so frequently that general training could not meet all of the circumstances. As jobs become smaller, the issuing of individual instruction cards becomes less profitable; as they become less technical or are repeated oftener, the cards become less necessary; until finally their value vanishes altogether. But in the Watertown Arsenal, where as in other machine shops the instruction card serves as a connecting link between an important technique and the every-day work, General Crozier declares [1] that "The saving in time results, aside from any increased efficiency of machines, chiefly from the effect of the instructions given the workmen, by which their effort is more advantageously applied, and will involve no exhausting exertion on their part, nor such as should be disagreeable." The central feature of this instruction is the instruction card.

Of intensive individual "*coaching*," it may be said that this can be carried to refinement only in cases where there is a great deal of repetition. In bricklaying, in shoveling, in carrying pig iron, there is gain in spending great effort to eliminate even a very small, useless motion. However, the public has a greatly exaggerated idea as to the importance of this side of scientific management. Its novelty has attracted attention, but in reality there is little of it. In the typical plant where scientific management has been introduced, workmen are not guarded to see whether they hold their hammers at the end or in the middle, their steps are not ordered, nor is their breathing regulated. These things are not commercially worth while, and the men who

[1] *Report of the Chief of Ordinance,* 1911, p. 673.

go farthest in this direction lose caste, more or less, as practical engineers. The more successful leaders are too busy attacking problems of first importance to give their attention to such details. There is a class of jobs where close supervision of motions pays, but of the industry of the country as a whole, they constitute only a small part. True, there is a constant tendency to simplify and standardize work to the point where it may be successfully stereotyped; but, on the other hand, at just about that point it is frequently possible to substitute machines.

Selection of workmen is of the most importance where heavy demands are made on some one faculty. Thus on heavy work, there is great gain in employing sturdy men; on inspection, in using persons of quick sight and prompt motor reaction. The kind of selection which picks out for all-around work men who are above the average, is of course practiced by every employer as far as practicable. Under scientific management, the unusually high pay makes it possible to carry this policy somewhat further. However, the idea that super-men only are to be retained is not enforced in practice as much as the literature of scientific management would suggest. The introduction of the system at the Watertown Arsenal was accompanied by no discharge. The old employees of the Tabor and Link-Belt concerns were retained under the new system. Emerson and Gantt emphasize the importance of setting tasks that any normal person can accomplish. It should be noted, though, that Taylor seems to have always been on a keen lookout for able men; and that there is considerable attention given under scientific management to transferring employees from jobs at which they are inefficient to others for which they are better fitted; promotion, too, is on a more scientific basis, because the management is in possession of adequate records of past achievements, and is also in closer touch with the men. But generally speaking, in the case of most of the plants which have installed scientific management, the selection and retention of employees is on a basis not radically different from that in other shops.

Improved methods of handling stores under scientific management not only facilitate all the other work of the shop and permit shipments to be made more promptly, but they also yield a direct financial profit in that they allow a reduction in the amount of materials kept on hand. At Watertown, $122,000 worth of materials, which had been rendered superfluous by the introduction of scientific stores-keeping, was put into use in a short time. In the plant of the Link-Belt Company one-third less of stores per unit of output was required after the introduction of scientific management.[1] The cost of interest on capital, rent for storage room, and depreciation was thus lightened.

3. THE PLACE OF ORGANIZATION IN SCIENTIFIC MANAGEMENT

The creation of a new and different sort of directing force, due to the new obligations assumed by scientific management, gave Taylor an opportunity to impress a character upon the field opened by his work. From the earliest days he first secretly practiced and then openly advocated the use of what he called a functional management, whose most striking feature is the creation of eight bosses where one existed before. Functional management has for many been identical with scientific management; it is indeed in certain important shops the most noticeable

[1] Before crediting this last entirely to scientific management, we should remember that after the system's introduction, production was carried on on a somewhat larger scale, which might naturally lead to more efficient stores arrangements per unit of output.

feature connected with the system. When the values of the different sides of scientific management are weighed, however, it seems that that part of the system which consists in giving a precise form to organization is not nearly so essential as are the prime ends for the purpose of accomplishing which this last phase was created.

As proof of this, it is only necessary to point out two other schemes of organization which bring practically as good results and indeed possess certain distinct advantages. The first is the "line and staff" system of Harrington Emerson, which, through centering authority in one boss, and drawing upon a large staff for knowledge, seeks to do away with the weakness which comes from making a workman responsible to as many as eight superiors. The second is the "departmental system" described by John C. Duncan as having come almost unconsciously into use in hundreds of plants. The work is divided between small departments, each under the absolute control of one man. In a machine shop, for instance, one department might be composed of the men running large machine tools; another, of those erecting large parts of engines; a third, of the valve-setting gang; a fourth, of those in charge of tool-rooms; a fifth, of those in charge of stores; a sixth, of the riggers or crane men; a seventh, of repair men; and an eighth of those entrusted with tool-making and grinding. Thus a large part of the functional arrangement is preserved, but there is no division of authority. Duncan thinks this latter plan superior to that of having functional foremen. "As a matter of fact, so many bosses really hinder the work. They irritate the men and are expensive to keep up. . . ." [1]

To recapitulate, the productivity of reorganization is, from one point of view, equal to that of the whole of scientific management, in that without some kind of enlarge-

[1] *The Principles of Industrial Management*, p. 192.

ment and rearrangement in the directing force the system could never be operated. But the problem as to whether that directing force shall be called functional foremen, or staff, or department heads, will probably be solved by various firms in different ways with almost equal satisfaction. The one principle which may be safely laid down is that scientific management in its enlarged organization offers an opportunity for profitable specialization along comparatively narrow lines. This opportunity has been very generally utilized.

4. HOW MUCH CAN SCIENTIFIC MANAGEMENT INCREASE THE NATIONAL INCOME?

The productivity of scientific management cannot be calculated by adding together the values of its various features. A case may easily be imagined where a given increase in output would figure in one connection as due to selection of workmen, in another as the result of a bonus, in another as rendered possible by routing, and in another as brought about by functional management. For perhaps if any one of these various elements had been missing the gain would not have been effected, and so to each belongs the credit.

Estimates as to the total productivity of scientific management have been made for various specific plants as follows: The Tabor Manufacturing Company's product is now said to be worth two and a half times as much, and to be in quantity three times as great as before the introduction of scientific management—this in spite of a reduction in the number of employees. The productive efficiency of the Link-Belt plant has been doubled. The Watertown Arsenal estimates were reduced by $240,000. In the cotton industry, productivity was increased enough to cover an advance in wages amounting to about 30 per cent. For the

Ferracute Machine Company, the expense of doing a large number of jobs was reduced to 47 per cent of what it had been, which equals a new productivity amounting to 213 per cent of the old. Under scientific management the average individual handles quantities of pig iron equal to 380 per cent of his former task. Yard laborers at Bethlehem (shoveling) increased their output to 368 per cent. Bricklayers perform tasks enlarged to 270 per cent. As many bicycle balls were inspected by 35 girls as had been handled formerly by 120. On the Santa Fe, it was estimated that $1,250,000 was saved in one year.

There are dangers, however, in taking a specific example of the success of scientific management, and regarding it as illustrative of what the system is capable of doing. The test of measuring the material output of a concern before and after the introduction of scientific management is in some cases a good criterion. In the instance of a great deal of the best work, however, the use of high-speed steel has had much to do with multiplying the product. Thus the achievements in the Tabor, Link-Belt, and Watertown Arsenal plants have been in no small measure due to bringing machines and methods of work into harmony with this technical improvement. Again, a comparison of profits is apt to be misleading, since gain varies with commercial relations quite as much as with good or bad management. Thus the Tabor Manufacturing Company and the New England Butt Company,[1] two celebrated examples of plants operating under scientific management, have recently been under a cloud. If we refrain from attributing this to their management systems, then we should be cautious about crediting the profit in an undertaking to scientific management. There is furthermore a possibility that the reason

[1] See *supra*, p. 111.

why reorganization is attempted in a plant is because efficiency is at a very low ebb. Prosperous concerns rarely desire to change so fundamental a thing as their organization. Thus the Tabor enterprise was previously unprofitable, and badly managed. Even where a plant is forging ahead, and there seems to be no question but that the increase is due to scientific management, it may well be that it was partly the individual genius of some unusually able man which rendered the reorganization successful. Other able men who know nothing of scientific management might possibly be making just as great increases in the productivity of their plants.

These considerations are not mentioned with the idea of showing that scientific management has failed to increase productivity, for they do not prove that. They are designed merely to point out the difficulties connected with accepting as at all exact many of the various estimates as to what the system has accomplished. We should profit by the experience of those who once thought that they could make such calculations with reference to the Santa Fe, but who have long since been convinced that the problem is too complicated for even a rough solution.

There are, however, certain general conclusions which may be stated with reference to the power of scientific management to increase the national income. There can be no question but that there are great numbers of men who are glad to do far more work than has been their custom, in return for extra pay amounting to 20 per cent, 30 per cent, and up. The fact that employers are eager to give them this bonus shows that their increased productivity is greater than—let us say—30 per cent. Indeed, it seems probable that on many kinds of work the increased worth of employees runs well up towards 100 per cent.

Before jumping to conclusions as to how great an industrial advance can be effected by the working-out of this scheme, one must take into consideration the fact that not all the employees in any shop can be put on a bonus. Further, only a small per cent (according to Taylor,[1] 17 per cent) of this country's industry is even a field for interest-arousing devices. Such are needed only where industry is organized on a considerable scale—"coördinated," as Taylor put it — and hence subject to the evils of ordinary wage systems and amenable to improvement under scientific management. The desirability of the speeding-up side of scientific management is further somewhat questionable. There is probably a net gain to the men, or they would not take it up. But there is a cost. And a world in which everybody exerted himself twice as much, would hardly be an ideal triumph of man over his environment.

So it is that, while the greatest gain is perhaps still along the first side of scientific management, more hopes are connected with the second phase, which aims to put brains rather than muscle into the work. Close supervision is indeed increasing the productivity of workers to a degree of great consequence in the industrial world. But when management joins hands with invention, and draws to itself talented men, who not only study the orthodox technique of industry, but also simplify, rationalize, and coördinate the activities of all the members of the working force, then scientific management becomes the architect of a technical and social mechanism which knows no limit of perfection. It adds force to the process of cumulative change, whose discoveries may carry us into regions of which we do not yet dream. Most of this is, of course, in the future, and its value can only be determined as industry after industry is conquered and re-conquered. The achievements of the past, however, suggest a lucrative development.

[1] Testimony before the Industrial Relations Commission, April, 1914.

The hope for this second phase of scientific management is in general greatest where industry is on a large scale and under a centralized authority. Specialization may then be carried farther; more widely applicable studies may be made; a more refined coördination is practicable.[1] It does not follow that all the gains of centralized industry come only when there is one financial control. Knowledge may be unified through the pilgrimages of experts from place to place, picking up intelligence here and distributing it there. The advantages of specialization and large-scale production may be attained by very small concerns, which manufacture for sale to others, much as one department of a modern factory manufactures for other departments. As business is engaged in at present, however, the different branches of an industry can be operated more smoothly under a single financial control.

If the scientific determination of methods of factory operation is found to be especially profitable in connection with large-scale production, it is possible that this very fact will cause an enlargement of the latter field. Centralization may be pushed, simply to render possible the gains of scientific management. Scientific management may further be a very potent force towards concentration, inasmuch as its extensive records furnish a check upon the faithfulness of employees in such a way as to eliminate much of the economic loss said to accompany big business. Scientific management may, in short, create its own field, and the productivity of the system may prove much greater than an estimate obtained by calculating the gain possible in each plant as industry is now organized would indicate.

Some persons, looking forward into the distant future,

[1] Morris L. Cooke says that in the past the printing industry has been slow in making improvements because the large number of small establishments fosters conservatism.

have been moved to declare that the development of scientific management will eventually prove to have been as epoch-making as the invention of machinery. This claim we would think futile if for no other reason than the fact that scientific management itself would never have come into existence had it not been for the creation of modern industry through the industrial revolution. All that the system may claim for itself must in turn be attributed to the invention of machinery. In addition to this, scientific management is not distinct enough from science, industrial technique, and the earlier forms of management, to justify its being regarded as an original and independent thing like the industrial revolution. Especially in connection with the more advanced achievements of the future would it be hard to draw a line between the effects of the new management and those of a great host of other contemporary movements. We must, therefore, be content to regard scientific management as part of a general progress, a passing form, which, long before it has realized its potentialities, will have outgrown some of its features and merged the rest with those of other systems, losing its own identity in that of a greater stream.[1]

[1] To give Mr. Taylor's view as to the productivity of scientific management: It has already "been introduced in a great number and variety of industries in this country, to a greater or less degree, and in those companies which have come under scientific management it is, I think, safe and conservative to say that the output of the individual workman has been, on the average, doubled." (Testimony before special House committee, *Hearings*, p. 1389.) In the future, "The general adoption of scientific management would readily . . . . double the productivity of the average man engaged in industrial work." (*Principles of Scientific Management*, p. 142.) Not only would this be true with regard to manufacturing establishments, but also "the same principles can be applied with equal force to all social activities: to the management of our homes; the management of our farms; the management of the business of our tradesmen, large and small; of our churches, our philanthropic institutions, our universities, and our governmental departments." (*Ibid.*, p. 8.)

CHAPTER VII

Scientific Management as a Solution of the Labor Problem

In various passages in the preceding chapters attention has been centered upon the attempt of scientific management to arouse the initiative of the individual workman. This task, it should be noted here, and not the existence of unions, constitutes, according to Mr. Taylor, the most serious problem of factory management. Thus, risk in production "arises not so much from the evident mismanagement, which plainly discloses itself through occasional strikes and similar troubles, as from the daily more insidious and fatal failure on the part of the superintendents to secure anything even approaching the maximum work from their men and machines." [1] It may be said, therefore, that in explaining elementary time study, task-setting, and the bonus, we have already discussed what the organization experts regard as the solution of the big end of the labor problem. There is, however, another "labor problem." Scientific management not only claims to better the relations between the individual and the management, but it also professes to find a solution for the strike problem, and to effect vitally the tendency of workmen to organize. This, the real "labor problem," [2] as the term is commonly

[1] "A Piece-Rate System," *Transactions of the American Society of Mechanical Engineers*, vol. xvi, p. 860.

[2] We have in this treatise (somewhat arbitrarily) subtracted from the term "labor problem" its broader significance which involves the general welfare of the working classes.

used, will be the subject of discussion in the present chapter.

I. THE VIEWS OF THE ORGANIZATION EXPERTS WITH RESPECT TO TRADE UNIONS

One can get the point of view of the organization experts respecting trade unions only by first looking, as if through their eyes, at the industrial conditions against which their system is a protest. When Frederick W. Taylor decided to develop a scientific management, his analysis of ordinary industrial relations started with the observation that antagonism amounting almost to war now separates employers and men. The primary reason for this state of affairs is the fact that both profits and wages are drawn from one fund, the excess of selling price over expense.

> Thus it is over this division of the surplus that most of the trouble has arisen . . . Gradually the two sides have come to look upon one another as antagonists, and at times as even enemies—pulling apart and matching the strength of the one against the strength of the other.[1]

The natural gulf between employers and men is widened because the men have an idea that it is to their interest to restrict output. The attempt to restrict output, Taylor declares, dates back to the introduction of the power-loom, the fear that machinery would cause unemployment having then bred bitter opposition and much violence on the part of the impoverished hand-weavers. Though the abler labor leaders of to-day hold that improvement in manufacturing technique is beneficial to all, they, too, are on their guard against the creation of high records by workmen, lest these be used as an excuse for cutting piece-rates or speeding up the men.

[1] Taylor, *Hearings before Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Management,* p. 1388.

Conflict over the division of the surplus, and this struggle to raise or lower output, together with the often inhuman policy of manufacturers towards hours and working conditions, have made it necessary for the employees to organize. Industry has been rent asunder by the warfare between employers' associations on the one hand, and labor unions on the other. Taylor recognized this development as natural under the circumstances, certainly as far as the men were concerned. He was not bitter in his attitude towards either leaders or men, as evidenced by the following typical statement:[1] ". . . while I shall have to say quite a little in the way of blame as to the views and acts of certain labor leaders during my talk, in the main I look upon them as strictly honest, upright, straightforward men." Moreover, many years earlier, when Taylor could not yet have had his later strong motive for courting favor with labor men, he said:[2]

The writer is far from taking the view held by many manufacturers that labor unions are an almost unmitigated detriment to those who join them, as well as to employers and the general public. The labor unions—particularly the trades unions of England—have rendered a great service not only to their members, but to the world, in shortening the hours of labor and in modifying the hardships and improving the conditions of wage workers.

However, labor unions were founded and owe their present usefulness to the existence of the above state of warfare, an industrial system which, according to Mr. Taylor, is entirely wrong. Mr. Taylor, therefore, acknowledged that under prevailing circumstances unions are desirable. But, in his view, the circumstances themselves need to be changed, and can be changed.

[1] *Hearings, op. cit.*, p. 1380.

[2] "A Piece-Rate System," *Transactions*, vol. xvi, p. 882.

The central idea in Taylor's new industrial system is the substitution of "harmony" for "antagonism": the development of a new "mental attitude" on the part of the employers and the employees towards the work, according to which they coöperate instead of contend with one another. The virtue in scientific management that is said to bring about this change is, first, the elimination of grounds for contention by determining through scientific analysis the proper task, wage, and working-day for each individual, the results being determined according to the laws of human nature and in a spirit of fairness and liberality; and second, the introduction of a positive teaching that the management should cultivate good feeling and mutual understanding in its relations with the men. The more obviously influential of these two means of encouraging better relations is the first; it is effective directly in that it destroys grounds for dispute; and indirectly, in that the accompanying enlargement in the numbers and activity of the management means that more personal attention may be given to the men, and more of the men may be promoted to positions of responsibility. Mr. Taylor, however, laid more stress on the second cause, and not without some justification; for the dozen or so leaders most prominent in the scientific-management movement have indeed been unusually well disposed towards their men, and it is this attitude which is partly responsible for the good feeling which prevails in their shops. But whichever be the explanation adopted, there is abundant testimony to the effect that the alleged harmony does in many cases materialize; and so it must be dealt with as a reality, and given due recognition as a possible solution of the labor situation.[1]

[1] While visiting the shop of the Link-Belt Company, the writer was strongly impressed by the cordial feeling existing between the management and the men. The superitendent, as well as the president of the

Under the system thus described, what place do the scientific-management experts reserve for the trade union? Scientific management may permit the organizations to remain; but, if so, they are at least to be shorn of all their more important former functions. As one reason for this, the experts explain that scientific management is too complicated for the men to understand; therefore they should have no control over it. But a much more fundamental reason why the unions must be devitalized is that under the new system there is nothing for them to look after. Harmony has now taken the place of antagonism. The great questions of wages, hours, and tasks are to be decided by science rather than by war. The one real problem—that which is basic in all industry everywhere—is to increase the output, to make the surplus so enormously great and the share of each individual so considerable, that there will no longer be a temptation—as indeed there never has been a use—to quarrel over the division of the profits. In attaining this one great end management and men are equally interested. The welfare of each individual is the gain of every other. All are co-partners.

Among the various persons coöperating, the scientific-management men say that the more intelligent should rule; the workmen should leave the working-out of the science of wages and tasks, as well as all important direction of industry, to those best fitted for the same, namely, the management. Is it not ridiculous to decide how a shop should be run by "counting noses"? What possible intelligence could be added through the collective bargain? In short, the philosophy of scientific management holds

company, professed to know all the employees by name. The superintendent has taken a personal interest in their individual welfare, tried to help various ones to good positions, and frequently given more thought to the men's interests than have the latter themselves.

that a good management, like a good father, directs those under its care in ways more satisfactory than the latter could themselves choose. Above all, workmen should be treated individually and according to their personal peculiarities, not "herded" together in masses.

Thus, while Taylor expressed himself as willing that unions should exist to carry on educational and welfare work among their members, he was, as a matter of fact, opposed to organizations of the type that concern themselves with wages, hours, and output. As these are the prime ends of modern unionism, we may conclude that organized labor has met with scientific management's disapproval.[1]

Another, and perhaps a sounder, way of looking at the situation is that expressed by H. K. Hathaway. He says that to organized labor in itself scientific management has no objection, but that the body of labor-union doctrine and policy is permeated by opposition to progressive industry.[2] It is because scientific management and the trade unions are seeking opposite ends that they are hostile.[3]

[1] "Mr. Godfrey. Can you say in one syllable what the relation of the labor unions should be to scientific management?

"Mr. Taylor. Of all the devices in the world they ought to look upon scientific management as the best friend that they have. It is doing in the most efficient way every solitary good thing that the labor unions have tried to do for the workman and it has corrected the one bad thing that the unions are doing—curtailment of output. That is the one bad thing they are doing." Testimony before special House committee, *Hearings*, p. 1508.

[2] It is against certain tendencies of trade-unionism most fully exemplified in England that Taylor lodged his strongest protest: He said that an investigation covering thirty trades showed that English workmen produce less than one-third as much as American workmen. (Taylor, testimony before Industrial Relations Commission [Washington, April, 1914], typewritten *Hearings*, p. 1225.) The English situation Taylor regarded as a triumph of trade-union principle.

[3] For the views of the trade unions with respect to scientific management, *cf.* H. B. Drury, "Organized Labor and Scientific Management," *Industrial Engineering*, March, April, May, 1914.

2. A SKETCH OF THE RELATIONS BETWEEN SCIENTIFIC MANAGEMENT AND ORGANIZED LABOR

The story of the actual relations between scientific management and organized labor is shorter than might be expected considering the strength and conflicting ideals of the two forces, for the reason that until recently the movements have not had many points of contact. Thus Philadelphia, the birthplace of scientific management, the home of Taylor and a group of other leaders, and the seat of the most advanced development of the system, is not a strongly unionized center. H. K. Hathaway, speaking of machine shops, testified before the Interstate Commerce Commission that he did not know of a closed shop in the city.[1] Likewise in the case of the Bethlehem Steel Company, it was said that in the early part of 1910 not a single employee was a member of a trade union;[2] and we are told that on the Santa Fe railway the bonus system does not apply to any union men.[3]

Though for a long time there was thus little or no direct contact in connection with which an issue could develop between scientific management and organized labor, the new system may, nevertheless, have sometimes been used to prevent the possibility of unions forming, or to ward off strikes. Harrington Emerson was called to the Santa Fe immediately following a strike among the machinists, boilermakers, and blacksmiths. The Tabor Manufacturing Company had been inconvenienced by labor troubles

[1] *Evidence Taken by the Interstate Commerce Commission in the Matter of Proposed Advances in Freight Rates by Carriers* (1910), p. 2672.

[2] *Report on Strike at Bethlehem Steel Works,* Sen. Doc. no. 521, 61 C., 2 S.

[3] According to Vice-President W. B. Storey, *Correspondence,* March 17, 1914.

shortly before it sought reorganization. One of the best known experts once spoke to us with satisfaction of the manner in which, in a certain factory where there had been a number of union men, the labor organization had, upon the introduction of scientific management, gradually disintegrated. Frederick W. Taylor himself told the Industrial Relations Commission (Hearings, April, 1914) that members of labor unions had left in large numbers at Midvale, Bethlehem, Tabor, Link-Belt, and to a certain extent every company where he had ever been. Thus, while for many years there appears to have been no rupture between the two movements, it is possible that from the very first scientific management was here and there retarding the growth of the union idea, through building up loyalty to the management.

It is of interest to note the effects of scientific management on the labor problem in those earlier years when its development was carried on comparatively quietly; for the investigation shows that between the system and the men who work immediately under it there is no original cause for quarrel. From 1882 (when the system was started) until 1911, a period of approximately thirty years, there was not a single strike under it,[1] and this in spite of the fact that it was carried on primarily in the steel industry, which was subject to a great many disturbances. For instance, in the general strike in Philadelphia, one man only went out at the Tabor plant, while at the Baldwin Locomotive shops across the street two thousand struck.[2] This is said to be typical of experiences which have occurred again and again.

[1] Taylor, before special House committee, *Hearings*, p. 1390.

[2] Hathaway, before Interstate Commerce Commission, *Evidence*, p. 2671.

That the early gulf between scientific management and organized labor was partly a matter of accident, or at least one not incapable of being bridged over, would seem to be indicated by the fact that with the spread of the system into new parts of the country and into a greater variety of industries, the principles have at points met with a rather favorable reception from union men. In most shops, indeed, the numbers of union men are small and their influence insignificant.[1] But in certain cases, as in bricklaying[2] and printing,[3] the leading features of scientific management have been introduced into closed shops. In one case at least the collective bargain has been utilized.[4]

In general, however, the passing years have brought intensified opposition rather than coöperation between scientific management and organized labor. Serious opposition may be said to have been begun in 1911, immediately after certain testimony presented before the Interstate Commerce Commission revealed to the country the strong movement setting towards scientific management. National labor leaders, wideawake as to what might happen in the future, decided that the new movement was a menace to their organization, and at once inaugurated an attack. The opposition reached its culmination when in 1913 and 1914

[1] The managers may state that they have a few union men, but don't know exactly how many—in fact don't pay much attention to such matters—which shows, of course, that the unions might as well not exist. See Hathaway's testimony before Interstate Commerce Commission, *Evidence*, p. 2672.

[2] See *supra*, pp. 125-6.

[3] John H. Williams, before Interstate Commerce Commission, *Evidence*, p. 2781.

[4] See *infra*, p. 187. Scientific management operating under the collective bargain, is, however, a very rare phenomenon. Mr. Taylor more than once declared his ignorance of any such cases. See testimony (January, 1912) before special House committee, *Hearings*, p. 1444, and again, p. 1508.

the annual conventions of the American Federation of Labor adopted resolutions condemning the system. The arguments advanced, having to do with the human side of industrial life, will be discussed in the next chapter. Here it is only necessary to state that the present opposition was started in very high labor quarters, that it was probably adopted more as a policy for the future than because of serious damage done in the past, and that it has centered about the installation of scientific management in the Government arsenal at Watertown. The attack there, having gained the ear of Congress, has met with at least temporary success.[1] But outside of the Government service, the opposition does not seem to have retarded very much the introduction of the system. In plants that have had a mind to install it there has usually been no serious trouble. However, the agitation has aroused in workingmen, as well as in the general public, an interest in the question as to whether scientific management is right or wrong. Especially is the public desirous of solving the problem of the relationship between scientific management and the unions.[2]

3. IS SCIENTIFIC MANAGEMENT A SATISFACTORY SUBSTITUTE FOR THE COLLECTIVE BARGAIN?

To state the precise point at issue it may be said that during the last half-century the leaders of public opinion in matters concerning industrial relations have come to look with favor upon the organization of workmen. Even

[1] For outline of the principal events connected with this struggle at Watertown, see *supra*, pp. 140-1, and for evidence as to the true situation there, *infra*, pp. 188, n., 190-3.

[2] The Industrial Relations Commission spent four days taking testimony on scientific management.

Taylor recognized a field for trade-unionism under the prevailing type of factory management. But now we are told that a new organization of industry called scientific management does away with the importance of labor organizations, and especially obviates the necessity of that wholesale method of reaching an agreement as to wages, hours, and working conditions, known as the collective bargain. Perhaps, therefore, the most important subject for inquiry connected with the entire topic of scientific management is the question as to how the new system is likely to affect the need for, and the character of, the activity of labor unions.

a. *Scientific Management Removes from Labor Some Incentives towards Organization*

Scientific management, especially of the true sort, may be expected to weaken the forces which have in the past tended to solidify the ranks of labor. In the first place, centralization of authority in the hands of the management loosens the bond of common trade secrets and craft skill, which now makes brothers of the small group of men engaged in any given occupation. Especially is this true where unskilled persons are put at work formerly requiring long experience, the men being employed simply to *work*, and not because they have any specialized knowledge.

While trade lines are broken down under scientific management, or there is a tendency in this direction, this does not mean that all the men are placed on one common footing as over against the members of the management. On the contrary, there is a greater differentiation than ever before between the various employees. In fact, instead of there being two large groups of persons, one at the top and the other at the bottom, a goodly number of employees are scattered in between. The management itself contains high positions for some of the abler workmen, a considerable proportion of the men being employed as functional foremen. The others are given specialized work to do varying in character and remuneration, payment being where possible on an efficiency basis. Thus there is a change in the center of gravity which makes the management side much heavier. Class lines by occupation are blotted out, and distinction according to individual capacity is substituted. By promotion — or the pursuit of it — overflowing energy is drawn off. Indeed the situation corresponds to that which exists in agriculture, where the relatively large number of farmers, as compared with "hands," opens a way for every one to reach the top, thus forming an effectual safety-valve against the formation of class sentiment.

As long as scientific management is installed in only a small portion of industry, the fact that the system endeavors to pay the men working under it higher wages than they would earn in competing plants makes it difficult to see what benefits could be derived by organization. It is the policy of the employer to give voluntarily whatever remuneration may be necessary in order to secure not only the time, but also the good-will of the workmen. This rate is necessarily considerably higher than the men could gain by force. Therefore the favored few working under it are apt to think it prudent to " let well enough alone."

As scientific management is introduced more generally, this last argument of course vanishes. However, it is probable that in the future, even more than in the present, the up-to-date employer will find it a paying policy to relieve some of the conditions which have in the past spurred men on to collective action. Thus the relations between the men and the management will be made more pleasant, and much of the incentive to organize will be removed.

Above all, scientific management deals with the individual, while the hope of the labor union rests upon the consolidation of the masses.

b. *Scientific Management, However, Does Not Adequately Perform the Functions of the Collective Bargain*

From this enumeration of the difficulties which a trade union meets when it tries to operate under scientific management, we turn now to criticize scientific management's own effort to solve the labor problem. It may be pointed out first that, contrary to the conviction of the advocates of scientific management, the relation between management and men is not inherently one of harmony; nor should their relationship be a pure antagonism; but employers and employees have many interests, some of which are nearly identical, others directly conflicting: it is necessary for both that the factory continue in operation; yet an employee might easily desire twice or a hundred times as big a wage as the management might desire to give.

In the second place, it is questionable whether there is a "scientific" way in which a correct reconciliation of interests can be effected. Mr. Taylor's method of dividing the surplus, even if quite satisfactory to the workman, is scientifically exact only in the sense that it gives the highest possible returns to the management. The scheme of wage payment under scientific management consists in giving the usual day rate, and then adding, for successful completion of a set task, a bonus ranging from 20 or 30 to 100 per cent, according to the kind of work.[1] Now, the "scientific" features of this plan are the determination of a proper task, and of a proper percentage of bonus. The determination of a proper time for the doing of a given piece of work may indeed be undertaken according to scien-

[1] For an enumeration of different kinds of work and their bonus percentages, see *supra*, p. 68.

tific methods. But when it comes to a decision as to the number of hours in the working-day, the day rate, and the percentage of bonus, it is misleading to apply the term "scientific." The length of the working-day should be fixed with a view to enabling the employee to get the most satisfaction out of life, as well as the greatest possible work out of his limbs. The general level of day wages is the resultant of countless bargains; there may indeed be no close bargaining under scientific management, but the process is certainly being carried on by someone somewhere. Should scientific management spread to the whole, or even to a considerable part, of an industry, these bargains would have to be carried on as a part of the system itself, and the setting of the day rate would then be shorn of even the semblance of scientific character. As regards bonus determination, Taylor explained the "science" to the special House committee as follows:[1]

Half a dozen men were set at performing certain tasks for a period of six months on a premium of 15 per cent. Another set of men were put on trial at a 20 per cent increase, another set at 25 per cent, another at 30 per cent, another at 35 per cent, and so forth. Now, of the half a dozen who were working at 15 per cent

almost all of them came at the end of the six months and said, "Now, see here, Fred, I have tried that scheme of yours, and I do not like feeling all the day long that I am tied down to any old pace, or to a new way of doing things. I should prefer going back to the old way." . . . At the 20 per cent increase almost all of the men asked to return to their old conditions and their old pay. At the 25 per cent increase more than half of them stuck to the new conditions. . . . At the 30 per cent increase all but one stuck to the new plan.

[1] *Hearings,* p. 1498.

At 35 per cent my rememberance is that all stuck. . . . It was in this way that we got at these percentages. I call that a scientific experiment. . . .

But is this science? Is it not rather a scientific way of bargaining? Has not Mr. Taylor simply asked men to do work of very large value, and then found out by trial the least amount for which they will cheerfully perform it? Would this rough-and-ready solution of the wages question, which has worked so well where all are enjoying a careless prosperity, meet the situation when neighboring concerns begin to adopt the same methods, and costs and receipts are counted more closely by both men and management? We would summarize our discussion thus far by expressing the belief that the "harmony" and "science" of Taylor's system, though very valuable, are really but the oil and skilful handling that make the machinery of wage-determination run smoothly. Possibly for a time the amazing productivity of the system has brought the dollars so fast that the recipients have been content to watch them roll in. But if the system becomes at all general, employees' ideals as to income will expand, and with the opening of more shops in which the system has been installed there will be more competition for their services — not to mention the possibility that managers' ideals as to wages may contract. Then wages will again be what the men can get and what the employers have to pay.

In the final analysis, then, scientific management's method of handling the labor problem consists in reaching an understanding between the employing corporation on the one hand and the individual workman on the other. Perhaps the management is very considerate in its dealings with the men; but whether that is so or not, the point to be noted here is that there is no appeal from the management's decision. It is a case of the individual liking his treatment by the management, and staying, or disliking the conditions of his employment, and quitting.

According to many, this relationship is a fit one for the basis of an industrial system. They think that it is fair to all, because any individual who is dissatisfied can withdraw. But does such a relationship between a huge corporation capitalized at many millions perhaps, on the one hand, and a poor workman on the other, place the two on an equal footing? Suppose that the workman does not want to work on Sundays: Is the management likely to care very much if he registers a complaint? Suppose that he feels that he is underpaid: Would it not often be a worse evil to pack up his belongings and move away from his old home to some distant place to get beyond the authority of his former employer? As a matter of fact, the individuals of to-day are too many, and the corporations of the country too few, to permit of an equal contest. Thus nothing less than the entry of the Federal Government into the parcel-post field could bring down the rates of the express companies. In the case of the railroads, the establishment of tariffs by competition has of necessity been abandoned, and control has been placed in the hands of the Interstate Commerce Commission. Of course few workmen are as helpless against their employers as shippers against a railroad. Nevertheless such a combination as the United States Steel Corporation, when unrestrained by labor organizations, has a power over the lives and welfare of its employees resembling that of a court of justice.

The question amounts to simply this: Is it wise to place so much authority in the hands of a corporation, even though it be scientifically managed and of a kindly disposition? It must be remembered that the board of directors represent the financial interests. Where there is a conflict between human and moneyed interests, is it reasonable to rely entirely on the judgment of those who represent the latter? In minor matters it might do. But it is not the spirit of the American people to tolerate such a procedure when it comes to anything that is worth while. In modern times little can be done by individuals working alone, and so for the purpose of promoting all their leading interests, men join forces in innumerable organizations. Is there any reason why matters of wages, hours of labor, and working conditions should be an exception to the general rule? Certainly these things are as important as any others. It would seem that in the case of workingmen the need for organization would be greater than in most cases. For the individuals have neither the time nor the aptitude to bargain cleverly with their employers or to keep in touch with the possibilities in competing fields: they need leaders; they need organization.

4. THE POSSIBILITY OF COÖRDINATING TRADE UNIONISM AND SCIENTIFIC MANAGEMENT

Though scientific management is based on a philosophy that is at variance with that of organized labor, and though its features appear to turn the activities of workmen into other channels than those of trade-unionism, it would be quite possible, if the necessity arose and both sides were willing, to bring the two into coöperation. Such a step could be taken much easier to-day than some years ago because of certain changes in the methods of the scientific-management men themselves. Thus instead of the differential rate, which would be rather hard to bring under the collective bargain, the management experts have voluntarily reverted to the day-rate principle, supplementing the same with a bonus whose rate is uniform for an entire trade. Both the day rate and the rate of bonus could very easily be made the objects of the trade agreement. The setting of tasks jointly would be neither so necessary nor so simple; yet this, too, could probably be brought under the system.

To the objection that the men do not understand scientific management, and therefore could not speak with reference to it through their unions, it may be replied that the unions would not need to take the initiative in putting the system into operation. Organized labor would have to go into the matter only far enough to make terms with the management; and even under the present system the workmen must be able to do as much. If men are to work under scientific management at all, an understanding must be reached regarding wages, tasks, *etc.*; and why should it be harder to do this collectively than individually?

It may be said, therefore, that the main obstacle to the introduction of the collective bargain as a part of the scientific-management system is not that the former could not possibly be applied, but that the management experts regard is as worthless. Thus Taylor said:[1] "Under these circumstances, then, [coöperation between management and men] collective bargaining becomes a matter of trifling importance. But there is no reason on earth why there should not be collective bargaining under scientific management just as under the older type, if the men want it." General Crozier thinks that scientific management should even facilitate collective bargaining. For when the time study has been made, the question as to how much is to be paid for work can be settled by agreement; and the result of the time study should furnish the workmen with a vastly better ground upon which to bargain about wages.[2]

[1] Before special House Committee, *Hearings*, p. 1444.

[2] *Report of the Chief of Ordnance*, 1912.

The collective bargain is not only capable of being applied; it has been actually tried out. David Van Alstyne is responsible for the following account: [1]

I made an agreement with the molders' and blacksmiths' union, which was the ordinary trade agreement, but the principal feature of it was that the union committed themselves to a maximum output of which the company was to be the judge, and the basis of it was the Emerson standard time system, and a bonus paid for efficiency about two-thirds in addition to a straight day's wages. . . . In order to facilitate matters, we agreed to make the standard times by means of a demonstrator, and if there was no objection to that, we put the time into effect, and it became the standard; it was provided for in the agreement that the shop committee could object at any time they wanted to, and if the shop officials and the shop committee could not agree, it was further provided that it would be officially settled by me and the head of the union.

This last method never had to be resorted to. There was no provision for reference of disputes to a third party. The above is the one example, as yet given publicity, of scientific management brought under the collective bargain.

The general public, which desires to see industrial feudalism supplanted by industrial democracy and nevertheless sees many good things in scientific management, hopes that the slight tendency to coöperation which has been thus far manifested will be strengthened, and that the better features of the two movements will eventually become the complementary parts of a single solution of the labor problem.

[1] Testimony before Industrial Relations Commission, typewritten *Hearings*, p. 1680.

CHAPTER VIII

The Human Side

A verdict as to the merits of scientific management should obviously be based on the changes that the system has itself introduced. If one sees under scientific management men working at tasks that are monotonous, or if the jobs described seem ugly and repulsive, or do not give sufficient play to ambition, those failings are not necessarily the fault of the reorganization. They may be sore spots inherent in the prevailing industrial order.

Of the changes which scientific management has introduced into industry, some need no discussion in a chapter dealing with the effect of the system upon the welfare of employees. They are recognized by all as harmless, and, in so far as they increase the productivity of industry, they clearly conduce to the public benefit. The main problems which here deserve attention are those which grow out of stop-watch time study and the giving of premiums to individuals who increase their output. One charge made against these devices is that they speed up the workmen to an abnormal pace. Another is that to have one's acts timed by a stop watch is humiliating, and that the system, in its enforcement, makes machines or automatons out of men.[1]

[1] ". . . the opponents of the Taylor system had virtually concentrated their attack upon the time-study and premium features under trial at the Watertown Arsenal, claiming that those features operated against the health and well-being of the employees . . . alleging that these features are only devices for 'speeding up' the workman and reducing him ultimately to the level of a 'machine' or 'beast of burden'." (General Crozier, in *Report of the Chief of Ordnance,* 1912.)

I. THE CHARGE THAT EMPLOYEES ARE OVERWORKED

The scientific-management authorities announce that by their system machine output is multiplied by from three to five,[1] that barehanded laborers sometimes perform nearly four times as much work as formerly,[2] that among employees as a whole the individual rate of production is on the average doubled.[3] These claims place on the shoulders of Mr. Taylor's followers the burden of proving that they do not abnormally speed up workmen.

The scientific-management leaders cheerfully assume this task. The effort of the individual, they say, is not increased in nearly as great a proportion as is the output. Especially in machine shops, much of the apparent intensification of effort is nothing more than specialization; the workman is able to get more out of his machine because he is relieved of that portion of the work which formerly called him away.[4] Much of the improvement, too, is due to the way in which the machines are operated, greater efficiency being the result of scientific study applied by the management. Instructions as to the best manner of handling everything

[1] This is so in the case of the Tabor Manufacturing Company according to testimony of Hathaway. *Evidence Taken by the Interstate Commerce Commission in the Matter of Proposed Advances in Freight Rates by Carriers* (1910), p. 2667.

[2] Pig-iron handling. See *supra*, p. 78.

[3] Estimate of Taylor. See *supra*, p. 168.

[4] "Formerly, when we started a job, he had first to frequently hunt up the foreman to find out what he would do next. Then he might have to hunt up his materials and get them to the machine. After that he had to decide how the job was to be done, and look up his own tools for it. He had to grind his own tools and all of the things that we now do in the planning department for him he had to do himself to a very large extent, while his machine was standing idle. As it is now, the machine runs along on other work while we are making preparations for his job ahead." (Description of Tabor Manufacturing Company, Hathaway, *Evidence* [Rate advance cases] p. 2668.)

connected with the work, and a careful thinning-out of strength-taxing features, have been important factors governing the increase in production.

Where the workman does put forth more muscular energy, it is claimed that this is simply due to the elimination of waiting or loafing; that is, better routing has prevented delay, or improved industrial relations have eliminated "soldiering." It is emphatically denied that the workman moves faster, or at any one moment exerts himself any harder than was considered normal under the old régime.

The student of scientific management is fortunate in being able to find evidence of a highly reliable sort as to whether or not these claims are just. In the first place, the special House committee—composed of W. B. Wilson, formerly a labor leader (and since appointed Secretary of Labor), Wm. C. Redfield, a manufacturer (later appointed Secretary of Commerce) who has written somewhat disparagingly of scientific management, and one other congressman—reported after extended hearings that the Taylor and other "systems" had not "been in existence long enough" for the committee to "determine with accuracy their effect upon the health and pay of employees," and that the committee did not "deem it advisable nor expedient to make any recommendations for legislation upon the subject" at that time. Upon this report General Crozier comments: [1]

In other words, the committee, properly zealous to protect the well-being of the employees, failed to find any ground in the representations made by the opponents of the system upon which to base condemnation or serious criticism of the methods in effect or contemplated by this department, or any conditions which called for remedial legislation.

[1] *Report of the Chief of Ordnance,* 1912.

That is, scientific management, after an ever-widening application for thirty years, could not yet be charged with having produced victims of overwork.

The irresponsible character of many of the complaints made in regard to the effects of scientific management upon health is shown by General Crozier's reply to one such charge which had been included in the petition of the Watertown Arsenal unions of June 21, 1913.[1]

Complaint No. 13.—This is a complaint that the majority of the men are failing in health. This is distinctly not true. There is no evidence of it, and no complaint of it. A number of men questioned on the subject denied it, no man being found who claimed or admitted that his health had been injuriously affected; and no man has personally claimed that he has been overworked. In regard to the possibility of overwork, it is at least extremely improbable. In machine work particularly, where as stated before most of the premium jobs are found, the machinist usually stands for a considerable time looking on while the machine is doing the work. Such a job can be divided into machine time and handling time, and the machine time can be subdivided into that in which the feed is by hand and that in which the feed is by power. It is during the time that power feed is operating that the machinist simply stands and watches the work. Ten jobs, taken at random, have been examined and the following have been found to be the percentage which the power-feed time, that is, the resting time, is of the whole time required for the job: job No. 1, 5.75 [? *sic*] per cent; job No. 2, 68 per cent; job No. 3, 40 per cent; job No. 4, 58 per cent; job No. 5, 35 per cent; job No. 6, 46 per cent; job No. 7, 78 per cent; job No. 8, 71 per cent; job No. 9, 80 per cent; and job No. 10, 54 per cent. Of course during the power-feed time the machinist has to fix his attention upon his work; but it is not strained attention,

[1] *Memorandum for the Secretary of War,* submitted by General Crozier, Sept. 6, 1913.

and is not of a wearing character. These figures coupled with the facts of moderate working hours, frequent holidays, and generally good working conditions show the practical impossibility, in the general case, of overworking a machinist.

Perhaps the most direct way of arriving at the facts as to overwork—though it unfortunately involves an analysis of conflicting claims—is to sound the attitude of the Watertown and Frankford employees. Though it is alleged that the "worst" features of scientific management have not yet been introduced at Watertown, and no one claims that the system as a whole has been introduced at the Frankford Arsenal, yet official reports show a great decrease in cost of operation; and if, therefore, the type of scientific management known to these arsenals is unobjectionable—and even attractive—to employees, the system evidently has a great and proper field.

The surface facts are, that in June, 1913, the Watertown employees petitioned for the abolition of the Taylor system, and in January, 1915, several hundred employees of the Frankford Arsenal petitioned for its continuance. In both cases, however, the employees' action was almost certainly inspired from above or without, and the question has therefore been raised as to the genuineness of the verdict. The discussion pro and con in the House (February 5, 1915) and Senate (February 23) may be summarized as indicating (1) very strenuous opposition to the system on the part of general labor officers, (2) no certain evidence of a prevailing sentiment against it on the part of actual employees (though a few were shown to be opposed to it), and (3) a considerable measure of local enthusiasm for it.

Senator Weeks, whose home is three miles from the Watertown Arsenal, presented evidence [1] to the effect that

[1] *Congressional Record,* vol. 52, pp. 4890-91.

while he had originally received a great many complaints from his constituents on this matter, on February 12, 1915, the very man who had been retained "to act as their counsel in the matter of their petition for the abolishment or change of the Taylor system," wrote to him his discovery that the workmen were "opposed to the amendment to the Army appropriation bill providing for the practical abolishment of time study and premium in Government shops. . . ." The senator had himself received letters from constituents, employees in the arsenal, containing passages such as these: (1) "I have heard of no one that has been injured by a 'stop watch,' nor from over-work. The few agitators (shop lawyers) that caused this bill to be sent to Congress . . ." (2) "There has been some opposition made by a few self-constituted labor leaders who take it on themselves to regulate matters to suit themselves without any consideration or regard for the rights of others." (3) "It seems that this gigantic move to abolish the system is backed by some outside selfish crew . . ." And again by the same writer: "There were 349 employees of this place who signed a petition to abolish the system. If the number who did not read that petition, and consequently did not know what they were signing, together with the number who signed it just to be agreeable, were deducted from the 349, there would be nobody left but the framers. It is proven beyond a doubt that after three years' experience with the premium system the conditions here are far better than any place of the kind in this country." On the other hand, the senator had received no complaints for a year, except from outside labor organizations.

There was, furthermore, little proof to show that the Frankford employees had signed under pressure, or through ignorance, and considerable to show that their attitude was spontaneous.

The evidence as to strain under scientific management which the public can most readily avail itself of, however, is that furnished by a number of magazine writers, who—like Miss Wyatt — have visited this or that establishment operating under scientific management, thinking that they would find men and women overworked; but after making personal observations, and conducting a more or less thorough inquiry among the workers themselves, have reported that conditions in the shops investigated contrasted favorably with those in other plants.

There are, however, certain developments of scientific management which one hesitates to approve. Mr. Taylor states that of the men who formerly handled pig iron at Bethlehem, only one-eighth would have had endurance enough to complete the tasks set under scientific management. This extreme situation was of course due to the fact that human beings differ greatly in their aptitude for this kind of work, and the task was designed for only those who were the fittest; and there is no evidence that any of these men were any the worse physically for their unusual exertions. Nevertheless, the specialization of certain men to do as much heavy work as their physical capacity permits is a thing that one would dislike to see carried very far. There must be a cost of some kind, even for the fit—a considerable cost; otherwise they would not refuse to do the work except for a sixty per cent addition to their pay. The question arises whether the cost—which may be the dwarfing of part of the higher life of the men—is not one that it is a loss to the community to allow them to bear. Perhaps only good has resulted in the specific instances in which men have undertaken these jobs; but it is a side of scientific management which would not form a part of an ideal civilization, and which most people would prefer to see curtailed.

There is reason to believe that the scientific-management experts themselves hold much the same opinion, and that the enforcement of extremely difficult standards is not as common now as formerly. Thus that powerful incentive to maximum production, the differential rate, has given place to the milder stimulus of the Gantt bonus system, and the still more flexible modifications in use at Watertown (until 1915), and in the plants reorganized by Harrington Emerson. There is now less emphasis upon the selection of none but unusually able workmen, a growing precedent in favor of retaining practically unchanged the former staff of employees, and a vigorous insistence on the setting of tasks that any normal person can accomplish.

To conclude this discussion, scientific management means for most persons an increase in the energy which they put into their work. There is, however, no evidence that employees are injured physically, or that the effort is especially disagreeable. Still most men would not choose the new system for its own sake. It is the association in thought between larger production and greater pay that makes men glad to turn their wits away from side issues, and concentrate them on making their movements count towards output. When transformed by this thought, work under the new system is perhaps not as tedious as work under the old; for it is not the effort, but the spirit, that makes work heavy or light.

2. THE CHARGE THAT MEN ARE MADE AUTOMATONS

An objection to time study in itself would be trifling. An athlete does not feel humiliated because a stop watch records the seconds and fractions thereof which it takes him to make a run. And so with the workman, it is not the making of the studies, but the purpose for which they are to be used, that appears odious.

The first fear respecting time study, that it will be used to speed up abnormally the employee, has been already covered. The other indictment against it is that it is the first and most powerful instrument in the introduction of a new order of industry, in which skill, initiative, and life itself, are divorced from the workmen, and radiate only from a central planning department, the men becoming mere machines or automatons. Some young college man measures the time taken for each swing of the arm, considers the necessity or uselessness of every turn of a bolt, decides, perhaps, how long the workman should rest after an exhausting move. Then there is made out an instruction card which tells the workman exactly what to do without relying on his own judgment. Eight functional foremen stand over him to guide him at every turn so that he can use no independence. In short, work is no longer the self-expression of the worker's individuality, its wholesomeness is destroyed, and life becomes a monotonous, unhealthful routine.

With regard to these charges, we should first remind the reader that, as we have pointed out elsewhere, the extent to which planning is carried under scientific management is not nearly so great as the public sometimes imagines. In the second place, there was considerable monotony and subordination of one individual to another before Mr. Taylor began his work. Nevertheless, if the introduction of scientific management is even a small step in the direction of increasing the drudgery of work, it is a matter in which the public should feel concerned. What are the facts?

In the first place, a word should be said as to the likelihood that control over a man's movements by a higher authority will lead to nervous and physical discomfort. One would almost imagine, judging by some of the attacks made on scientific management, that men are held in a vise and that a boss standing by pulls the strings to let the workman know when to move the one arm and when the other. A little reflection, however, is enough to convince any one that men who are paid high wages for rapid, spirited work will not be interfered with in any way that is disagreeable to them. To carry motion study to such a point would not only involve prohibitive expense, but would defeat its own end. One could imagine a greedy employer giving a man too difficult a task; but it would be nonsense to imagine him fettering his hands or grating on his nerves.

While it would be unreasonable to think of scientific management as carrying its supervision of work down to an automaton level, where movements would be directed to the point of physical discomfort, or men would take on a slave-like lack of spontaneity, it is not so self-evident that the system will leave unimpaired the higher intellectual life. Actual monotony, indeed, is probably not as great under scientific management as under other systems; and the evidence bears out the assertions of Taylor and others that the "mental revolution" carries with it a sympathy and fellowship between men and management, which makes conditions in a shop unusually attractive. Nevertheless, men of enterprise, men who would not only chafe under restraint but who are also ambitious to exert an influence in the outer world, would probably hesitate to enter the lower ranks of a system where they would be given little liberty to try things their own way; they would shun a job which meant constant work at a narrow range of activities and no more than a very vague comprehension of the industry as a whole. The thirty per cent bonus would be purchased at too dear a price.

We are inclined to think, however, that scientific management is the more practical, and, for the present at least, the more commendable, in that it has adapted itself to a state of civilization in which men as a rule are obviously not of this ambitious, intellectual type. Mr. Taylor, in his unflinching and rather uncanny way, classified men into groups as distinct from one another as are the different breeds of horses: Thus, corresponding to the dray horse—or, better yet, the ox—there is the man with the muscle suitable for handling pig iron and the mentality incapable of understanding percentage; corresponding to the grocery-wagon horse there is another type of man suitable for a somewhat higher grade of work; the trotter has his human counterpart; and so on up to the top. This distinction, while unpleasant, is not altogether fanciful: there are differences between men; and it is probable that the majority of workmen would prefer to avoid the trouble of systematically planning complicated work. They need guidance. They are perhaps better off for remaining at one employment and confining themselves to a limited range of activities.

Yet it is probable that many of these men, if they had enjoyed better opportunities earlier in life, would not now be of the "type of the ox." While scientific management does well to adjust itself temporarily to human nature as it finds it, possibly with the more general extension of educational advantages much of this analysis of men into types will eventually break down; and a socially meritorious scientific management must take this possibility into account; it must soften, not perpetuate nor intensify, class distinctions. So it is to be hoped that in the future, rules in regard to work will be imposed only where there are clear advantages to be gained; and finally, that as rapidly as possible men may be led to follow good methods on their own responsibility, because they realize that they are the best, and not because they are forced to do so.

3. PROMOTION—SKILL—WAGES

It is the policy of shops operating under scientific management to fill the higher positions by promoting able men from within the ranks. Inasmuch as the proportion of good positions under this system is much greater than in the case of the ordinary forms of management—because of the functional foremen and planning department—the chances for promotion are decidedly better. Furthermore, such promotion as there is should be on a more just basis under scientific management than elsewhere, because its more adequate records covering the work of each individual enable the head men to know just who are the most capable workers. The capable but rather unobtrusive man in fact ranks higher under scientific management than he would elsewhere; he is worth more; for the things that he needs for his work are supplied as a matter of course; and it is not necessary, as in some shops, to use personal pressure to get others to treat one fairly: hence true efficiency —and not audacity—counts towards output.

One of the objects of having functional foremen — as well as certain other of the features of scientific management—is to enable inferior men to do what was formerly regarded as skilled work. Thus we are told that at Bethlehem ninety-five per cent of the rough machine work was done by low-priced men under expert guidance.[1] For the inferior men who are put at such work this means higher wages and greater skill than they would otherwise attain. For the class of persons who formerly performed the jobs it means that that much of their field has been lost.

The elimination of the need for skill is one of those changes which benefits the race at large, but is apt to work

[1] *Hearings before Special Committee of the House of Representatives to Investigate the Taylor and Other Systems of Shop Management*, p. 1488.

hardship upon individuals. For of the on-coming generation, those who seek special training can pick out some other field, while those who can not or do not prepare themselves for any definite work will be very glad for the increase in the demand for unskilled men. There is thus little loss, and the public gains because of the reduced price of the finished product. The thought of the future gain is, however, a poor consolation for those who already have their training in the abandoned line. These persons are apt to be thrown out of employment and to suffer greatly, and for no fault of their own.

So much for the antedating of skill in the abstract. As a matter of fact, up to the present time the share that scientific management has had in this process has been accompanied by little if any inconvenience to workmen. One reason for this is the fact that the new system requires a long time for its introduction. Changes in the personnel of most shops naturally occur comparatively rapidly, so that if the scientific-management men exercise a little care, they are able to contract the field for skill without a discharge of any former employees. Moreover, the better workmen must be retained to do the work which still requires special knowledge, and to serve as functional foremen. We may conclude that while scientific management is ever seeking to get along with as little skill as possible, at the same time it takes skill to accomplish this very end; so that it is rather hard to say whether in the long run there will be required a widened or lessened distribution of it. We may be sure of this much, however: that there is a shifting of the points at which skill is applied; and that of the higher grades much more is required. In all probability, the changes will continue to go on without much unusual suffering to anyone.

As to wages, Taylor claimed that the men working under scientific management receive from 20 to 100 per cent more than men of equal caliber working under the ordinary types of management.[1] Except for men doing very strenuous manual work, however, we may remark that the great mass of employees seem to be at the lower end of this range: 25 per cent would, perhaps, be a typical average for the increase in machine shops.[2] The rise in wages, even at the latter more moderate estimate, is seen to be a considerable one.

This point being settled, there next arises the more important question: Will the high wages of scientific management prove permanent, or are those critics of scientific management right who say that after a little these rates will be cut, and eventually workmen will receive, in spite of their increased speed, wages no greater than in the first place?

It is not probable that the near future will witness a radical reduction in the wages paid under scientific management; for certain companies which have tried such a policy have found to their sorrow that the men would not turn out the enlarged product unless their rewards were kept at about the above figures. The whole situation may be quite different, however, if scientific management is ever introduced generally throughout the country. The workmen would then have no alternative system which they could fall back upon; and they might be compelled to work in the new way if they were to obtain satisfactory employment of any kind, and to do so regardless of whether wages had been substantially increased or not. On the other

[1] Testimony before the Industrial Relations Commission, April, 1914.

[2] See statistics for the Tabor Manufacturing Company, *supra*, p. 131; for the Link-Belt Company, p. 135; and for the Watertown Arsenal, p. 138.

hand, it is equally possible that if the number of plants using scientific management grows until there is a scarcity of workmen able to turn out these large outputs, their wages may be forced up still higher.

At any rate, the present method of fixing wages under scientific management is a transitional one, and the forces lying behind the wage-determination of the future will probably be more complex. There is no reason why the workman should fear that scientific management will bring anything but favorable changes in the level of wages. Yet his greatest gain will probably come, not in the form of higher pay, but in that of cheaper commodities.

4. THE HUMANIZING OF MANAGEMENT

The discussion should by this time have alleviated, or cleared away altogether, most of the fears which have been entertained regarding the effect of scientific management upon the welfare of employees. As a matter of fact the movement is in the very opposite direction: as far as there is anything distinctive about scientific management, it represents a shifting of thought from machines to men. Whether rightly or wrongly, the claim of the system for special merit is based upon its seeing more truly the deeper motives that actuate men; upon its adaptation of factory conditions to conform more perfectly to man's comfort, productive efficiency, and satisfaction; upon its coming down more intimately to the temper and capacity of the individual worker. Scientific management is thus, first of all, a study of man, of his nature, of his ideals. It is based upon the principle that cheerful workmen are more profitable than sullen ones, that to fit the work to the man is better than to try to fit the man to the work, that the individual is a more satisfactory unit of study and administration than the mass.

As long as scientific management retains these ideals as the essence of its program—and the lives of the leaders testify that they have practiced them up to date—it is hard to see how the system could be anything else than agreeable and beneficial to the workmen. If step number one is the humanizing of industry, step number two a response on the part of the men to this change, and step number three the realization of profit by the management, then if the system is to work at all, it is only because in the first place the shop is made to appear to the men a *better* place to *live* and *work*.

But fifty years from now, when Taylor, Gantt, Barth, Cooke, Dodge, and the others will have been followed by men who know not the kindly spirit of these pioneers, when shop management is once again regarded only as a money-making proposition, and when the new men look about them to see whether Taylor was right in saying that money-making and harmony and human welfare are not incongruous, what then will be the situation? An enlightened self-interest, reinforced by the demands of a growing public sentiment, will probably dictate that as working machines, men be kept in good condition, that hours and tasks be reasonable, that the work be varied and pleasant. But when it comes to a fair division of the profits between employer and men, when it comes to the things that will make for the larger intellectual and social life of the workingman, it may be doubted whether scientific management will in itself offer anything better than other systems. Its contribution will be an increase in productivity which will make better conditions possible. But the hope of bringing these better conditions into actual existence should in the future, as in the past, be founded upon something more substantial and equitable than the altruism of the factory manager. While scientific management is thus hardly a complete solution of the problem of human welfare in factories, the influence of its leaders should nevertheless prove to be an exceedingly powerful force in the right direction.[1]

[1] After explaining that he had been putting into scientific management every cent of surplus income and a little more for a good many years, including payment of "the salary of quite a number of [men] for several years while they [were] learning the introduction of scientific management"—all this without hope of profit—Mr. Taylor then declared himself as follows:

"And I want to make it perfectly clear, because I do not think it is clear, that my interest, and I think the interest of every man who is in any way engaged in scientific management, in the introduction of the principles of scientific management must be first the welfare of the working men. That must be the object. It is inconceivable that a man should devote his time and his life to this sort of thing for the sake of making more money for a whole lot of manufacturers." Testimony before Industrial Relations Commission, April, 1914.

Scientific management's vision of leadership is rich in promise for the future. The unexplored possibilities of this field are nowhere indicated more clearly and profoundly than in Professor Edward D. Jones' resourceful paper on "The Relation of Education to Industrial Efficiency," read before the American Economic Association in December, 1914, and published in the March, 1915, supplement to *The American Economic Review.*

CHAPTER IX

Other Criticisms and Conclusions

1. SCIENTIFIC MANAGEMENT BUT ONE FACTOR IN SOCIAL LIFE

If our criticism has on the whole been favorable to scientific management, it is because we believe that there is a large amount of good in the system. To maintain that it is perfect would be to overlook the fact that it is hardly yet beyond its formative period. Since Mr. Taylor first began its application, about 1882, there have been numerous and important changes. There is no reason why there should not be other alterations in the future.

While scientific management seems to us a force for good, it should not be regarded as a panacea capable of curing all industrial and social ills. On the contrary, it should be supplemented by social agencies whose field of operation is wider than a single shop or a single management. Especially along the lines of industrial and cultural education, of regulation by the state of the conditions of employment, and of other movements designed to round out the lives of workmen, to better their surroundings at work, at home, and during recreation, is there a possibility of solving directly many of the problems that scientific management approaches only through the roundabout road of increasing output. We must not forget that the end of production is consumption. We must not think so much about running our factories at full speed that we neglect the simpler and more direct methods of increasing human satisfaction and welfare. It would be demanding too much of scientific management to expect that it make the most of development along all of these broader lines. Through making industry more productive the shop manager may furnish the materials for, but others may be better qualified to superintend the reconstruction of, our social life.

Furthermore, if other agencies be permitted to become strong, so that scientific management is held in check, it will not be necessary for the public to be greatly concerned as to exactly how far scientific management should be permitted to extend its operations. The future may be trusted to solve that problem. Grant that it is a loss to have men work harder; but that, on the other hand, it is a gain to swell the volume of output. If there are well-organized movements backing each of the opposing interests, we may safely leave to their interaction the determination of precisely how much of one advantage may be surrendered for the sake of the other. Throughout life, men are confronted by situations in which they realize that they cannot have everything that is attractive, but must give up one profit to attain another. Is it desirable, for instance, to live in a city? The city man longs sometimes for the freedom of the wilds or for the quiet and beauty of the country. But that, on the whole, the opportunities of urban life more than make up for the unquestioned sacrifices which are involved is attested by the fact that people continue to live in cities. So with scientific management. On the one hand it demands effort, on the other offers reward. The extent to which it will be carried will be the result of an equilibrium of these two, as well as of many other forces.

2. THE LARGER SIGNIFICANCE OF SCIENTIFIC MANAGEMENT

Scientific management's first great significance is in connection with the problem presented by the size and complexity of modern industrial organization. There would not have been much of a field for scientific management in an age when all men worked for themselves or were associated in groups of ten or twenty. But the system is an outgrowth of the concentration under one ownership and control of operations carried on over a large stretch of territory and participated in by thousands of employees. Scientific management may do for work what money has done for exchange; as the one fixes the values of commodities, so the other establishes labor values, values that are definite and that can be traded in throughout world industry. The Eastern capitalist can know that he is getting his money's worth when he pays an Arizona section hand to drive a spike; the foreman of an excavating gang can quote the market value of the dumping of a scoop; the heads of great corporations may be sure of a proper return from their smallest and remotest working unit. In an age when industrial relations are becoming ever more complex, the coördinating value of a system such as this is full of high promise. It strikes at the root inefficiency of big business. It opens up new worlds for industrial integration.

Scientific management is again significant because it is teaching the world a new way of gathering wealth. In the past the way to become rich has too often been that of exploiting one's fellows. But under scientific management—perhaps more consciously than in the case of any other of the rising modern movements—one notes a shifting of emphasis towards efforts to increase *total* wealth. Scientific management's method of increasing total output is in part, to so adjust the inner workings of the factory, that much of the old activity is rendered unnecessary, while the remaining tasks are rationalized and coördinated so that output is disburdened of much of its human labor.

It is perhaps true that the scientific-management men overemphasize the capacity of this phase of their system to rid the age of its pressing social problems. It is not so much the lack of wealth as the pitiable unevenness in distribution that is disturbing modern tranquillity. The invention of the past has already given the present, resources adequate enough to enable all men to live in a certain degree of comfort and with considerable satisfaction, provided the social income were more equally divided, and the one half of the people were not rendered discontented by observing the more fortunate lot of their betters. The people of to-day lay a false stress upon the possession of material wealth. If individuals could only cease vying with each other in the amount of expense which they display in their living, is it not possible that they could easily attain to a greater happiness than would follow an augmentation, at great effort, of the stock of material commodities?

Yet, generally speaking, material welfare is the foundation of culture. Wholesome food, comfortable lodging, freedom from long or exhausting labor, and opportunities for travel and education, are the requisites of art, literature, science, and the beautiful in life and thought. In seeking to produce material things at less cost, scientific management is sounding the keynote of a new campaign, in which all should join, and in the success of which lies great hope. Men have hitherto thought that there was certain *work* to be done. Scientific management may in years to come show that this is a myth—that a new spirit of study and enterprise may reduce human toil to an inconsiderable minimum,—perhaps eliminate the toilsomeness altogether.

Scientific management may also be said to present an object lesson in the gains which follow coördinated effort. If it is possible in a shop which has already been under one management to effect such great savings through giving more attention to routing, to planning, to instruction of workmen, and so forth, how much more could be achieved if the various branches of industry now competing were managed scientifically in their relations one to another. If not an argument for socialism, scientific management at least suggests the promising field open to those who would devote their lives to a study of how industrial life as a whole may be operated more economically and satisfactorily.

Scientific management can not, however, accomplish all or a part of these things without introducing problems of its own. The system means concentration of authority and subordination of the individual. It means that the value of the clever man will be greatly increased; that there will be more very high-salaried men; and that all the way down to the bottom, there will be a new differentiation as to pay. This situation is rather disturbing in a country of democratic ideals. Yet, inasmuch as the system calls for a closer coöperation and a more complete understanding between persons occupying different levels, the actual evils will probably not be great, and may be atoned for by a considerable good. Such regrettable consequences as follow must be excused as almost inevitable when a world in which the capacities of men are so different is stirred to really vigorous action.

3. THE ORIGINALITY OF SCIENTIFIC MANAGEMENT

There is a tendency in some quarters to regard scientific management as not different in kind from common sense and skill applied to industrial undertakings. Thus to quote one opinion:

> There have been no new discoveries in scientific management of industrial institutions. Common-sense men have used common-sense methods always. The term "scientific management" is a catch-word which assumes that industrial institutions have not been scientifically managed—which is not the case. My experience and the experience of my friends has been that there has been no new element injected into the art of management.

Now, of the mass of efficiency devices associated with the Taylor system, a large proportion are, to be sure, traceable to this or that extraneous source; Mr. Taylor, himself, was inclined to minimize the originality of his own system. But the observer who has noted how this man has inspired followers, and who has studied the testimony of manufacturers who have introduced his system, must be convinced that, in addition to the minor devices, there are certain great unifying principles which are as original with Taylor as is an invention or a masterpiece of literature original with its author. These principles have been explained in one place and another in the foregoing chapters. The foremost are the setting of a "task" for each employee, and the determination of what this task shall be by making a very careful analysis of just what enters into the work—preferably using the stop watch to discover the "unit times" required for the various work elements. This alone is enough to form the basis for a system—especially when it is coupled with the idea of carrying the study down to the humblest worker, to his simplest jobs, and to their minutest details. The "science" of the Taylor system may indeed be nothing more than ordinary intelligence and common sense; but it is because the intelligence is applied to these new and distinctive ends that scientific management may be pronounced original.[1]

Of course Mr. Taylor was not independent of his age. The opportunity for his work was presented by the conditions which followed the industrial revolution, and, more recently, by the rise of large-scale industry and specialized manufacture in this country, coupled with the growing differentiation into social classes which by the eighties was already alienating the interests of workmen from the success of their employers.

In several respects, too, scientific management may be characterized as having simply fitted itself into the prevailing currents of industrial evolution. Scientific management emphasizes the importance of steady, consistent *work*; but in this, the system is surely not a pioneer. We are told that among primitive peoples, sustained labor was entirely unknown; but that conquest and slavery first imposed upon a portion of the population the necessity of application.[2] The rigor of work under

[1] For a more detailed study of the originality of scientific management, *cf. supra*, Chapter II, pp. 30–52, where the earlier systems are described; pp. 54–63, where Taylor's central philosophy is given at length; and pp. 64-5, where, in conclusion, Taylor's system is contrasted with those antecedent devices which come the nearest to being its prototype. Upon these passages, the conclusions in this chapter are in part based.

[2] "And it may be safely inferred from all that is known of actual savages and primitive peoples that prior to the period of social integration, and at the beginning of the period of conquest, mankind, both of the conquered and conquering races, were utterly incapable of sustained labor and had no conception of it." Lester F. Ward, *Pure Sociology*, 2 ed., p. 277.

the earlier industrial systems was slight; but its intensity has been constantly increased as society has become organized on lines more and more modern; in the last century the tendency has been to make work more regular and more solid. The rapid pace set by American workmen and their almost perfect concentration upon the work at hand has certainly paved the way for the advance of scientific management.

If there is any originality in scientific management's ideal as to work, it is in its emphasis on *efficiency* rather than *strain*. Scientific management is the culmination of a progress towards the utilization of scientific, rather than drive methods. The human machine, which was before blindly urged on until it broke, is now analyzed, and given work in accordance with its strength and special characteristics.

Again, when scientific management proposes to reconstruct the way in which work is done, it is but following in the footsteps of such movements as the introduction of labor-saving machinery, and the establishment of chemical and physical laboratories. It has been possible to arouse interest in scientific management only because it has come to life in an age when men are filled with the idea that there is no limit to the wonderful things which they may achieve, if they only go about the task in the proper way. Mr. Taylor would have met with but slight success in a country where everyone believed in following the precedents handed down by his great-grandparents. Scientific management is the product of an age of daring and innovation in industrial processes.

Scientific management was foreshadowed, too, by the emergence of the specialist in matters of management. It would be possible to apply it only in a period when factories were being standardized to conform to the best existing practice. Scientific management has been brought in by the age of "system."

It follows that, while Mr. Taylor's system is as a whole original and unique, it borders at many points on competing ideas suggested by similar stimuli. Especially is this noticeable as time goes on and the world at large has been benefited by the earlier suggestions of the founder of scientific management himself. Others, both within and without the immediate Taylor following, acting under the impulse of his inspiration, have developed the technique of shop management in this direction or that to a more advanced point than Mr. Taylor had opportunity to attain. Giving Taylor due credit for both his direct and his indirect influence, it would yet be folly to attribute to the one man the entire modern drift towards efficiency and analysis of work; just as it is usually a superficial verdict that gives to an inventor the sole credit for having started industry along channels which but for his life would never have become known.

Mr. Taylor's contribution consists in having seen more clearly, attacked more persistently, and solved with greater success problems of whose existence most other persons were but dimly aware. Among those who have been intimately associated with Taylor, there is manifest a stanch loyalty and respect for his leadership, that is ever strengthening his title to rank—if not as the creator—at least as one of the foremost spirits behind the modern efficiency movement.[1]

[1] Elihu Root, for instance, (*Congressional Record*, Feb. 23, 1915, vol. 52, p. 4887) deprecated the use of the term "Taylor system," inasmuch as the effort in this direction "was begun in our Ordnance Bureau long before Mr. Taylor was generally known." In support of the principle

4. THE FUTURE

The possibilities latent in scientific management have already been discussed in the chapter on the productivity aspect. How far such hopes will actually be realized in practice and to what extent the achievements will be regarded as "scientific management,"—that is, of course, another question. It is at present evident that there will be many obstacles which will impede progress. The unfriendliness of organized labor has been noted. The scientific-management men, strange to say, complain more of the opposition of employers. Besides being sceptical as to the merits of the system, those in authority generally hesitate to permit outsiders to reorganize their plants; the result is that the innovations introduced, whether by the regular management themselves, or in a sporadic way by efficiency specialists, are apt to fall far short of conforming to any regular type. Even in plants where scientific management has been installed by the most skillful experts, as soon as the leaders are out of sight there is a tendency to drift back into old habits. Hence the growing insistence on having an "up-keep man," someone permanently connected with the staff, who will supervise efficiency features. Many go so far as to urge that the consulting specialists be eliminated entirely. Each plant, it is maintained, must solve its own problems.

In view of these practical considerations, it would be very strange indeed if the scientific management which we have discussed is not in the future greatly transformed and differentiated. One may say that this or that thing

involved, however, Mr. Root, who has been interested along these lines ever since he was Secretary of War, made one of the strongest appeals that has yet been presented.

seems good and that the indications are that it will come into wide use; but to maintain that scientific management, as it is now known, will one day dominate the industry of America or of the world, would be to make a hazardous prediction.[1]

Nevertheless, it is certain that industry is in a general way moving in the direction of scientific management; and there is a strong belief on the part of many intimately acquainted with present conditions that it will eventually arrive at many of the things described in this treatise.

[1] For instance, the fundamentals of the Halsey "Premium System" frequently find a place beside elementary time study, motion study, routing, and other scientific-management features, in a highly composite system.

INDEX

(NOTE: Consult analytical Table of Contents.)

VITA

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