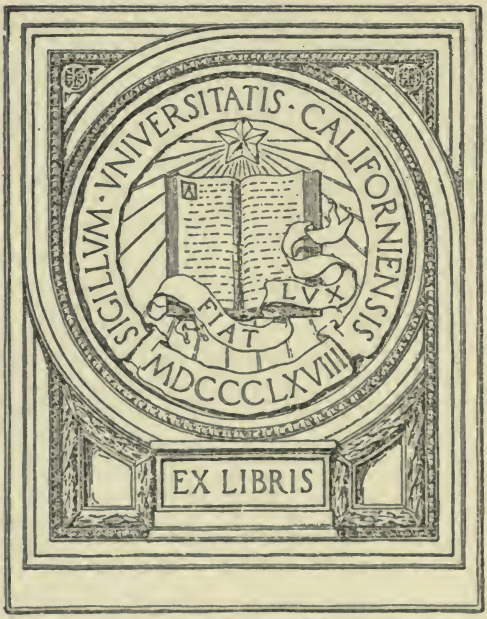
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EFFICIENCY METHODS

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AN INTRODUCTION TO SCIENTIFIC MANAGEMENT

By
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With 6 Illustrations

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PREFACE

THE authors desire to express their very sincere thanks to Mr. F. B. Gilbreth for permission to use four of his photographs as illustrations, and to Mr. J. F. Butterworth, Mr. Gilbreth's general representative in England, for considerable assistance and helpful criticism. They are also glad to record their gratitude to Mr. H. W. Allingham, M.I.M.E., to whom they owe their introduction to Efficiency Methods, a good deal of information, and the opportunities they have had of seeing the system in operation, and (one of them) of working under it.

Practically all the important books of reference on the subject are mentioned in the text. A Bibliography of books and magazine articles, up to 1914, will be found in C. Bertrand Thompson's collection of papers published under the title of "Scientific Management." This collection includes many original documents otherwise difficult to obtain, and forms an excellent historical sketch of the subject, considered as a movement. H. B. Drury's "History and Criticism of Scientific Management" appeared in 1915, and was followed in 1916 by R. F. Hoxie's "Scientific Management and Labour," for the most part very searching criticism.

All books so far published refer to the movement in America only.

A student of Efficiency Methods is advised to read first and foremost Dr. F. W. Taylor's "Shop Management" (the later edition, quoted throughout this text, was published in 1911), and his "Principles of Scientific Management"; also Mr. H. L. Gantt's "Work, Wages, and Profits," and "Industrial Leadership," and Mr. F. B. Gilbreth's "Motion Study," "Fatigue Study," and other books. Some of Mr. Harrington Emerson's writings should certainly be read to get his different and interesting point of view, but his two books on Efficiency are unfortunately very diffuse and discursive.

It is not at present very easy to obtain these American works; but readers in London should know that a collection of the relevant books and periodicals is being made at the London School of Economics Library, Clare Market, W.C., and that almost all the American periodicals mentioned in the text are to be found in the Patent Office Library, as well as some of the books. The *Engineering Magazine* (U.S.A.) may indeed be said to be the organ of Scientific Management, and several important works have appeared in it as serials. *Industrial Engineering* takes very much the same attitude. The *American Machinist* and *Machinery* have printed a good deal more criticism.

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CHAPTER I

INTRODUCTION

At the present time no apology is needed for bringing to the notice of English business men some brief epitomized account of certain methods recently suggested for increasing efficiency in industry. Every article or essay dealing with the situation which will follow immediately after the war begins by raising this cry: Improve efficiency, increase output, make the very most of men, materials and equipment in industrial organization. The two things considered essential are increase of production and elimination of waste.

There is a surmise in many people's minds that the American organizers, often known as Efficiency Engineers, have something to tell us which will contribute to the solution of our problem. Their suggestions on these very essentials have brought them to the front in business affairs across the Atlantic, and most countries in Europe are beginning to find the ideas interesting.

But it has not been easy to discover precisely what the new ideas are; and what assistance they

can render. The original literature which explains them best is not readily obtained in England, and is often costly. No works manager is inclined to acquire a small library of expensive books when he is extremely doubtful whether they, or indeed any written treatise, will be of any use to him. Meanwhile the subject has become, in the United States, violently controversial; the reports and the periodical literature dealing with it are voluminous, and it may be added that they are often verbose to weariness, and display a tendency to diffuse abstract discussion which is most unattractive to the British business mind.

It is not, then, surprising that a habit has sprung up in the British Press of referring to the new so-called efficiency methods in a way that betrays much ignorance of their nature. Valid criticism of them and of their pretensions must come from closer acquaintance. They have gained adherence, and enthusiastic adoption in some establishments, where they seem permanently rooted; in others they prove failures. In the latter cases the reasons of the failure are themselves often worth study. Many individuals find in the methods a complete new gospel for industry; others dismiss them as either worthless, or injurious, or already known and practised. As the attitude of the American Trades Unions has been generally hostile, the English ones are disposed to follow suit without much investigation; although the President of the recent conference of the Workers' Union has said that "scien-

tific organization would come, and they should ground themselves in its principles so well that they could take advantage of any proposals put forward, and get the best possible results for the worker when occasion placed him in a position to assume any part in the control of industry." [1]

The result of enquiry into the methods is certainly to show that they have to be reckoned with in the future, and that no person with position and influence in British industry—employer, manager, Trades Union official, consultant or economist—can afford to be ignorant of them, and what they undertake to accomplish. The pressing needs in our industrial world during reconstruction have been summed up as " vigour and enterprise and adaptability in management, the application of science to industry, and hearty and friendly co-operation between management and labour." [2] For more than ten years past the disciples of Taylor's ideas of management have advocated these three requisites, not only as necessary, but as attainable by the proper and complete use of their methods. It is of further importance to us that the ideas emanate from America, and are being closely studied and tried in Germany, as well as in other nations, including Japan. After the war American and German industrial developments must have the same powerful influence on ours that they had before it. We must

[1] See whole Report of Presidential Address in *Birmingham Daily Post*, June 12, 1916. It should be noted that the Workers' Union is one of semi-skilled workers.

[2] *The Round Table*, Sept., 1916.

not neglect to investigate any new use of scientific knowledge and systematized action which they may adopt, even if we conclude that we can ourselves find other and better ways.

Naturally the principles in the new sort of management cannot be defined fully in any limited and precise way, or referred to as forming a " system " ; if they could they would have but little value. The originator of them, the late Dr. F. W. Taylor, was aiming at reform which would give " high wages with a low labour cost." He knew that if this paradoxical combination could be accomplished it would go far to satisfying both employers and employed in industry. To reduce the cost of labour he must eliminate every possible source of waste, in power and in time. Every person and thing in the works should be used in the best possible way at the best possible rate. This would stand for a definition of efficiency, though the word was not greatly used by the man who was wholly bent on its realization. It should be noted at once that " the best possible rate " never meant to him and never has meant to any of his disciples " the greatest speed attainable." This will constantly be seen in studying their work. An optimum rate, not a maximum, is always desired.

Although he had had scientific academic training, Dr. Taylor began as a workman (at twenty-two years of age), and was promoted gradually through all grades till he became manager. He realized at first hand that the workmen with whom he worked

were as a rule not putting forth their best powers, because they had no incentive to do so. The incentive he proposed was high wages, to be offered as a reward for some definite achievement in work in a definite time. How was this reward to be computed? He realized again that the "fair day's work," so often spoken of, was an undetermined quantity, apparently impossible to determine when the two kinds of people who had to estimate it had each a strong personal bias in the matter. Could he discover in any impersonal and scientific way the actual time necessary to perform a particular job? This would seem to have been already tried, *ad nauseam*, but the attempts had failed to give any satisfactory and available result in the form of an average time; mainly because when a job taking several hours was repeated, there would always be some change of conditions among the many variables—the machine, the surroundings, the tools, the supply of material, the man's state of fatigue. These changes might and usually did invalidate the comparison between two jobs. Besides these, an acute observer was constantly seeing more possibilities of variation as little adjustments and rearrangements occurred to him.

At this stage most people have relinquished any attempt at accurate determination, ascribing failure to the mutability of nature, human and otherwise. Mr. Taylor did not relinquish his conception of his "best way," his ideal; although he saw that he might never achieve it absolutely, he saw, never-

theless, that something might be created which approached it more and more nearly. He had learned two lessons. First, that before you could ask a man to do a " fair day's work " you must see that all the conditions of shop, machine, supply of materials, the man's health, bodily position and comfort, and mental attitude towards his work, were made as good as possible, and as *uniform* as possible. They were in effect to be made *standard.* (See chap. vi. for the use of this word.) Secondly, that the way to compute the proper time for a job was to divide it into a succession of elementary operations, and observe the time for each singly. A large number of observations on each item can be made and a useful average obtained. Time can also be allowed for rests, and for delays that cannot be eliminated.[1]

What were the direct results of the development of these ideas in the works where they first took root ? First, the putting of one's house in order—getting the whole equipment into a better and more uniform condition, before one could invite a workman to show what he could do. As the American language would put it, " It's up to the management,

[1] All delays are to be eliminated as far as possible. The material and the tools must be always ready to hand, and to use. This means that the programme for the work of every person each day *must* be approximately carried out, otherwise other workers cannot get standard conditions. But that involves that the time that ought to be taken for each piece of work is previously known. It begins to look like a vicious circle ; but the gradual side-by-side solution of all these problems is just the work of an intelligent and indomitable organizer.

first, to do the managing." Secondly, the institution of minute time-study of brief operations, study which required the use of a stop-watch and of a skilled observer. Another element in the time-study was the ascertaining of the proper time and interval in which to rest, without which inefficiency in execution must set in. Also, the best and most promising men were chosen as subjects of study.

The details of these results, the changes and reforms which they brought about, will be given in later chapters.

The next fact of primary importance is, that the originator of the new principles for management was not only trained as a scientific man, but had already attained some eminence for scientific research. Through all his best years of engineering work, both at the Midvale and at the Bethlehem Works, he was carrying on an investigation on the " Art of Cutting Metals." This has been a contribution of almost inestimable value to engineers all over the world ; and a special outcome of the work was the discovery of a process for producing a high-speed steel.

It will therefore be understood that he had every reason to believe in the application of scientific observation and expert knowledge to the problems of a mechanical shop.

He himself was delighted and encouraged to the utmost when he discovered a mathematical expert who could solve problems in the art of cutting metals which had transcended not only his own

powers, but those of many mathematicians. This expert, Mr. C. G. Barth, constructed a slide-rule which can be used by a mechanic to adjust his machine-tool in the best possible way for a given job, instead of depending on a guess or on general judgment.

Dr. Taylor was, then, a trained worker in science. With his men he was shrewd and severe, but just, and certainly personally successful. His method of payment will be discussed and compared with others later ; but it included penalty for not executing the given task (in the form of lower pay) as well as reward for executing it. He openly selected good men only for his specified tasks ; those who fell behind were transferred, and tried on other work. He was reasonable, considerate and friendly with the workmen he trained. Among the individuals who assisted him in observation and in general administration he created a remarkable outflow of zeal, enthusiasm, originality and initiative ; and during his later years he had the same effect on many men with whom he came into only brief personal contact. Besides these traits, he showed a breadth of view and openness of mind most unusual in a man who had also such tenacity in carrying out his work under difficulty. This quality is very well shown in the change of attitude on certain questions which will be seen by comparing carefully the " Shop Management " of 1903 with the " Principles of Scientific Management " of 1911 ; and must cause the greater regret that he should have died (in 1915),

when only fifty-eight years of age. His earlier work has been translated into French, German, Dutch, Russian, Italian, Swedish, Lettish, Mexican and Japanese; the later one into the four first languages.

The names of the leaders in the efficiency movement are now many. A few may be selected, perhaps, without being invidious, for the reason that their work has been more expressed in published writings, though this may very easily fail to measure their actual contribution to achievements on the new lines. Mr. H. L. Gantt, like Mr. Barth, may be called a direct pupil of Dr. Taylor. He modified Dr. Taylor's method of payment to a bonus system, in which there was no penalty for falling behind time—an arrangement which has been more generally popular. He has been the means of introducing the system into a considerable number of diverse establishments. Mr. Sanford E. Thompson has not written much besides his excellent study of "Concrete Costs" (with the co-operation of Dr. Taylor), but his records and explanations of time-study and setting of tasks, also of negotiations with workmen, are extremely valuable. On the subject of time-study, however, Mr. F. B. Gilbreth has done the closest and most scientific work, and it is still proceeding. He begins with motion-study, where the nature of motions is studied, as well as their time, by means of moving pictures and other ingenious devices. He has combined with motion-study very sound and serious fatigue-study.

He is assisted in both activities by his wife, who adds to other qualifications that of being a psychologist.

Mr. Harrington Emerson has not been so directly as the others under the Taylor influence. His first important work was in reorganization of a railway; and since then he has installed "efficiency methods" in various other plants, and written two text-books on Efficiency. He makes more use of this word to describe his innovations than the Taylor disciples do; they speak usually of "management," qualified by the terms "scientific" or "functional." Mr. Emerson has a system of payment for efficient work quite different from Taylor's or Gantt's.

The main characteristic, then, of the new ideas, which should emerge at the outset for the student, is the application of scientific method to the *whole* industry. All its activities are to be separately observed and minutely analyzed, the results recorded and classified, and improvements gradually introduced with the idea of getting a standard "best" form, but still always susceptible of betterment. The use of the whole achievement is also according to the ideals of science—pool your results, make them known as widely as possible, avoid the waste due to an individual starting out to find again what has already been recorded, make every worker's skill, experience and observation available for his fellow-workers and the whole business; also, ideally, for all kindred businesses.

The next characteristic follows on this—the adoption of educational methods and ideals. When

a standard best method for an activity has been worked out, as in the art of cutting metals, it must be taught; the people who wish to impose it on workers must be teachers and demonstrators instead of drivers. The organization takes on what may be called an academic aspect. Specializing becomes valuable, a foreman or overseer may be chosen for special instead of general capacity, and the fostering of a special skill in the worker is the first aim of the management. Inevitably the worker is brought in contact with more than one authority, and the reply to the objection that a man cannot work under half a dozen masters is that he can certainly be helped by half a dozen teachers, each attending to a different part of his activity.

The scientific method aims at creating a management well informed as to the best thing to do, the best way to do it, and the best rate at which to do it. The transference of this information is a matter for demonstration as well as instruction, and therefore sound educational method calls on the management to *do*, as well as to give carefully-planned orders. Whence a committee of engineers in their report [1] on the new methods epitomized them as, finally, a process of " transference of skill " *from* management *to* worker. A management, therefore, should initially include skilled workers, as well as observers, and men capable of scientific analysis and generalization.

[1] " The Present State of the Art of Industrial Management." Majority Report. *Trans. of Amer. Soc. of Mechanical Engineers*, 1911.

As is usually the case with men who make great changes in industry, the pioneers of the new sort of management have been themselves practical men who could demonstrate. But a skilled workman, with intelligence and capability to reconsider and modify his methods, is certainly an essential foundation in the structure to be built up ; and if he has the power to lead he will be the more useful in passing on his improved skill to other workers.

It will be seen later that the adoption o educational ideas entails a concern with the mental and bodily condition of the worker, so that the study of hygiene, sanitation, fatigue, and general physiology and psychology become necessary. But the distinction may be made that the education of workers in methods of work is of a college rather than a school type—if one may assume that at a college the teacher has the definite intention of making the learner as capable as, or more capable than, himself whenever this can be done, and in the shortest time possible.

In most Press discussions these aspects of the subject have not come fully to the front. Quotations could be given from the original exponents of it to show that these aspects are essential to their programme ; but the conclusion will emerge naturally in the sequel.

We shall now discuss in detail the changes in management proposed to make it " efficient."

A few final remarks may be made here on the word " efficiency." The Americans have over-used

it, so that we have become rather weary of the sound of it. Indeed, our old friend Humpty Dumpty would say that they owed it extra wages; and they certainly owe " scientific management " extra wages too.

Harrington Emerson, who has made it the key-word for his whole system of organization, has done us the service of defining it quantitatively, and making it measurable, as it is necessary to his system that it should be measurable. He says[1] it is " the re ation of what is to what ought to be " ; and gives an illustration. A train ought to perform a journey in 16 hours, and carry 125 passengers. It actually performs the journey in 18 hours and carries 100 passengers. Its time-efficiency is therefore 90 per cent. ; its carrying efficiency 80 per cent. Perfect efficiency, then, is, or ought to be, 100 per cent. ; but Emerson's men and machines seem often capable of exceeding that. On the other hand, he does not say below what percentage the achievement becomes inefficiency.

Professor Marshall in " Principles of Economics," uses the word in a context which is singularly in keeping with the new ideas, as we shall see later. He speaks of the possibility of workers' earnings being " measured, not as time-earnings with regard to time nor as piece-work earnings with regard to output, but with reference to the ability and *efficiency* required of the worker " (p. 547).

The *New York Times*, commenting on Mr. L. D. Brandeis' very brilliant advocacy of scientific

[1] Article in the *Iron Age*, vol. lxxx., p. 1150.

management before the Interstate Commission on Railway Freights, observed: "After all, efficiency is not a moral duty." Is it not? For ourselves before 1914 this might have remained an interesting academic question in morals, if taken quite generally. In the England of to-day we have no choice in our answer. In a time when everyone's work, when real work, has the burden and privilege of being in its small or great degree national, to be inefficient has become a national crime.

CHAPTER II

MANAGEMENT: A PRELIMINARY DISCUSSION

WHAT is "management"? When a word is as much over-used as this one now bids fair to be, a new definition may be helpful. Many attempts to define it could be quoted. American writers on the subject are nothing if not explicit, and the mist of words that results is bewildering to the British manager, who prefers doing his work to explaining what he thinks he is doing to the world at large.

Nevertheless, the modern conceptions of management may give him occasion for thought. A writer in the *American Journal of Political Economy* recently defined it as the "science of human labour" (with some digression as to its being also an art and a philosophy). Mr. Taylor's power of admirably direct expression is shown in "the art of knowing exactly what is to be done, and the best and cheapest way of doing it." Now the fault charged by reformers on the old ways of managing, that have evolved gradually as a business grew larger, is that the employer or manager had finally come to hiring people who were supposed to know their job already—what was to be done and the best way of doing it. The assumption was that nearly all the

skill had passed over to the machines, and the workmen just tended them. The system of apprenticeship was extinct ; boys picked up anything of instruction that they could in the first years in the shops ; " hands " were hired, and the foremen were to see to it by any rough means that the hands acquired some knowledge of what they were about. In certain trades the men have kept up a traditional form of skill and an all-round acquaintance with the use of tools which is still extremely valuable. But the introduction of a new machine has been apt to interfere greatly with their methods ; and the directors of a business have often been eager to adopt new machines which promised a cheaper rate of production without making any systematic attempt to provide operators with the necessary training to wor these machines. " Hiring or firing " is the Yankee, brief description of this relationship with workpeople. The modern management finds that the study of their workmen and the ascertaining how to use their capacities properly is as profitable as the study of the machinery or of the markets.

The authors have been struck by the resemblance of the " hiring or firing " method in factories to that prevalent in domestic service. As conditions in the latter are familiar to every reader, it may be worth while to compare the two methods briefly. Obviously the great differences between the cases are due to the unorganized condition of domestic labour.

The tradition has been that a servant is trained by

a mistress or by an older servant. In our own time, however, till very recently, the majority of mistresses have expected a cook or a housemaid to be already a good cook or a systematic houseworker when engaged; and many do so still. They have not enquired very closely how she had learned to be any such thing, or whether she had had any real training at all. They were most often unable to teach her anything themselves, and only helplessly annoyed if she was not able to cope with modern adjuncts to housekeeping, such as gas-cookers, electric lights or vacuum-cleaners.

A movement of reform has set in, and is called "scientific" housekeeping. It believes in training both mistresses and servants by people who have made a proper study of housekeeping and of training. And what emerges from scientific study is the need of ascertaining a standard best way of doing any particular work. This way is subject always to possible improvement, but can be imparted to others as the best known. All resources are used to determine the standard best—past experience, experiment, general scientific knowledge. The attitude entirely discouraged is that of the mistress or servant who has her "own way" of doing each specified thing—a way hoary with tradition. Quite often these people are even reluctant to impart their "own way," and like it to be their own secret.

It would be irrelevant to carry comparison further. The creation of a standard best method in each operation of industry was mentioned in the last

chapter. The point of comparison here is that the new attitude of the scientific housekeeper is the same as that of the scientific manager. Another feature, however, appears which will be found of primary importance when we deal with the attitude of organized labour to the new ideas. It is the radical difference between the craft-spirit, the desire to keep experience and knowledge within a limited channel of communication, and the science-spirit, which gives open access for all to the increasing river of knowledge.[1]

The reformers of management like to contrast the old with the new, describing also an intermediate stage. The old is referred to as unsystematic or traditional; the intermediate is systematized or transitory; the new is scientific, labour-saving, or functional management, or industrial engineering, or efficiency engineering. It will be noted that they consider management as more of an engineer's job than has been previously conceived. This is because he is supposed to be scientifically trained, and also because he should understand the operations to be performed in the shops; but he must be a rather special kind of engineer if he can grasp the commercial and educational aspects as well.

It is easy to make out unsystematized management as generally bad. Records are usually kept

[1] See M. L. Cooke, "Spirit and Social Significance of Scientific Management." *Amer. Journal Pol. Econ.*, June, 1913. It is true that most people have characteristics of both spirits, and that the pure science-spirit, incorruptible in all conditions, is rather rare.

of merely the money aspect of operations as a whole. Detailed analysis is ignored. Instances are known to every accountant of businesses where one department has been steadily losing money while the whole has prospered. But it is not so often realized that, for want of proper analysis, it frequently occurs that some part of a process is steadily becoming less efficient, and the fact is not detected until an actual break-down happens. The financial results of a year or half-year of business are known only weeks or months after the close of the period, and as a rule there is no regular comparison of details for one period with previous similar periods. When a comparison is made it is of useless quantities, *e.g.*, total wages, total fuel (steam produced not considered), total oil, and so on. Yet here one finds the manager afflicted with "that most hopeless of all industrial diseases, called 'knowing his own business.'"[1]

It is hardly fair to call the systematized management only "transitional," as is done by devotees of the new methods. A well systematized concern is the very one in which alterations will not readily be adopted, as the authorities can point to work well done, and to a great contrast with the looser organizations. Records are kept, even records of individual workers, so that there is opportunity for personal contact with the men; costs are carefully calculated; reports are to hand quarterly or monthly; the purchasing and storing of material is

[1] W. C. Redfield, "The New Industrial Day."

well arranged ; good machinery is used. Altogether strict criticism may be able to find few or no traces of bad work, and no serious errors. Different establishments will naturally differ in the degree of systematization. But manuals of factory organization and management are published in America as well as in the United Kingdom which make this use of " system " the central idea, and hardly admit the possibility of improvements.

What does the " efficiency engineer " want beyond this ? He wants developments definitely directed towards saving labour by ordering it properly. His demands have been expressed thus :[1] (1) The systematic use of experience. Traditional knowledge, actual experience, and scientific study are to be combined. Records are to be fully kept, and standards evolved from them. (2) The economic control of effort. Operations are to be analyzed, and then replanned, definite tasks and instructions given, and workers trained. (3) The promotion of personal effectiveness. Everything possible is done, in the way of creating incentives and clearing away obstacles and delays, to make the best use of the powers of each worker.

These new demands are not made only on the factory ; they are made on the office and on every department. The first comment most people make is that the demands mean a great increase in the work of the office staff, for the activity entailed in

[1] See A. H. Church and L. P. Alford, " Principles of Management." *Amer. Machinist*, vol. xxxvi. p. 857.

arranging these details of production will be much greater.

Under new management a planning department is likely to become a very important part of the office. The heads of the firm see at once an increase in the amount of "overhead charges," a greater proportion of "non-productive workers." Whether any worker is really non-productive can only be judged by the result of his work. Taylor contended that "planning" was always being done in a sporadic way throughout a works—mostly at the wrong time in the wrong place, and usually in the wrong way by the wrong person—really a much more expensive way. Yet it has been said bitterly that certain managers would be prepared to hire ten new machinists rather than one new clerk; whereas instances are given of works where a large increase in the proportion of non-productive staff to productive had actually increased the output. Thus a plant mentioned by C. B. Thompson[1] as in a bad way had 100 men in the shop, six in the office. It was reorganized with 75 men in the shop, 25 in the office, and has since done well. Though probably this was an exceptional case, it does seem to justify the productivity, under certain conditions, of the work of "Johnny Pencil Pusher," as the American workman calls him. But it was of this new kind of directive planning that Taylor said it needed to be "75 per cent. analysis, 25 per cent. common sense."

[1] Article on Classification and Symbolization, by the Editor, in C. B. Thompson's collection of documents on Scientific Management, p. 482.

It may be useful at this stage to quote, almost in full, the sketch of the three kinds of management given verbally by Mr. H. L. Gantt to the Interstate Commerce Commission on Industrial Relations.[1] It is colloquial, but very graphic and convincing, although we must allow a little for the prejudices of an enthusiast.

"The unsystematized business is where the order is issued from the office to the shop, and the office feels that their entire responsibility ends when they have issued the order to the shop . . . until the date on which they wish goods to be shipped passes; and then they feel that it is their duty to go out and raise row with the shipping clerk first, and then with the one next higher up . . . and so on.

"The systematized business . . . is where they have a regular routine by which these orders shall proceed, from the office to the different departments . . . and in many cases they have a proper sequence worked out, so that the method of filling the order is not entirely left to the subordinates.

"The scientific management comes . . . when each of the steps has been investigated by the best expert available, be it a mechanic or . . . other person. . . . When that has been done, when each of the steps through which the work has progressed has been studied in detail, and a specific definite route has been laid out, reduced to writing, and the returns come to the office to show how this work has

[1] Docket No. 3400. *Re* "Investigation of Proposed Advances in Freight Rates." L. D. Brandeis. Counsel, 1911.

progressed each day, . . . and when any failure to live up to these instructions is immediately reported back to the office, and a proper person who knows how it should be done goes out and helps the work along—does not wait till it is three or four . . . days late and then go out and make a row—but as soon as it is one day late he goes out and tries to remove the obstacle so that it can proceed and perhaps catch up . . . That is scientific management."

Another activity which comes to the front in new management is the Costs Department. The much more detailed analysis of operations makes the separation of costs more detailed. Working out costs will apparently be more lengthy, but will be certainly much more accurate. The greater simplicity of each item will bring its costing within the capacity of less expensive clerical labour. Moreover, the data are obtained incidentally from documents that emanate from the planning department, for use primarily by the foreman or workmen. This brings to light a new aspect of the planning and analyzing—that a single instruction or record is used in more than one department. There is direct connection and interdependence between departments. It would strike even a casual observer that in scientific management, besides organization from top to bottom in each department, there is cross-organization from one to another. The "system" here is interwoven, warp and woof. Somewhat with the same idea, Harrington Emerson has urged that one of the "principles of efficiency" is that

everyone in the business should have the same "ideal," *i.e.*, be working for the same end. In industries with many departments it has been possible to find individuals so remunerated that they would gain personally if some item were increased or decreased in amount, although their gain might ultimately prove the firm's loss. In a concern closely interwoven by scientific management everybody can have the same aim—getting the work done—and will desire to promote efficiency and eliminate waste.

Why did Taylor call his system "functional management"? He pointed out that the old system involved the selection of a number of men as supervisors or foremen who had to combine different qualifications in an almost impossible way. He speaks of the "nine qualities which go to make up a well-rounded man"—

Brains
Education
Special or technical knowledge
Tact
Energy
Grit
Honesty
Judgment or common sense
Good health.[1]

An ordinary foreman is responsible for so much that it is hardly possible for him to oversee every-

[1] See F. W. Taylor, "Shop Management," p. 96, *et seq.*

thing thoroughly. Taylor was proposing to increase the supervision over each activity, therefore he classified and divided the functions of supervising, and arranged for different men to take each class. Wherever he desired special knowledge of and attention to a certain activity, he placed a competent man with special qualifications in charge. His motto for assigning work was "function, not position." A foreman, described by position, is a general intermediary for all purposes between shop-superintendent and workman; a functional foreman's duty may be the starting of each man's job and seeing that he has everything he wants, or the regulating of the speeds of the machines, or the repairing of them, or so on.

The idea of function, or some amount of specialization, is to be carried through every department. Mr. W. Kent, in his book "Investigating an Industry," sketches the application of the scheme to the formation of "functional directors," who, in very small committees, undertake to keep in touch with certain aspects of the business, and to be responsible for paying them proper attention.

It is not difficult to keep functional management clearly distinguished from the other type, which Taylor called "military." But this is not an accurate description of it nowadays. By "military" he meant an organization in which each man had his exact position, and discharged manifold functions of a somewhat similar kind for each position, merely differing in range; whereas army

organization in most countries has been greatly modified to admit of the utilization of the expert; though it is not graded or arranged according to function.

Mr. Harrington Emerson advocates a type of management very much resembling this, under the name of "Line and Staff Organization." It is a notable departure from Taylor principles. The "position" sequence is followed in a "line" of delegated powers, and "functional" assistance is supplied by a staff of experts, who advise but do not issue orders. Mr. Emerson, indeed, considers that the modern German army was created by Bismarck and von Moltke departing somewhat from the old form of army organization and adopting the "principles of efficiency."[1]

We must now remind the reader that this is only a preliminary survey of what is meant by management, and that he should read the following chapters before he criticizes the new methods in detail, and discusses the extent to which they are applicable to different types of industries. But the first criticism that is naturally made of Taylor's conceptions is that the workman has no freedom to select his own methods; he is merely to obey with precision detailed written instructions. The "efficiency men" do not countenance "rule of thumb" methods. This new conception of management brings a new conception of the connection between employer

[1] "Twelve Principles of Efficiency," chap. i.

and employed, between overseer and subordinate. It cannot be essayed without a large amount of previous constructive thinking and of hopeful patience. It must come to pass gradually, for it has to gain the consent and free co-operation of one personality after another. Yet the parts of the scheme are so interdependent that one cannot select one innovation recommended and discard the others as distasteful. Its founder has said, "Do not start by saying you will give the idea a fair trial; you must begin with a determination to see it through."[1] That there is something worth trying for may be urged, perhaps, more forcibly in the words of an English economist who has just passed away, than by quoting the ardent testimony of its advocates:—

"It is at once the employer's self-interest and his social duty to find for his workers the place and conditions where their labour tells most. . . .

"To him, in the division of labour, has fallen the high duty of organizing labour to earn its own wages."[2]

[1] See F. W. Taylor, "Shop Management," p. 136.

[2] Smart, "Second Thoughts of an Economist," p. 169.

CHAPTER III

MODIFICATIONS IN ORGANIZATION DUE TO THE NEW IDEAS

It has been said that the new sort of management means more managing and directing, and thereby enlarges the activities of the employés working in the office rather than in the factory or shop, though at the same time the relations of the office and the factory are somewhat changed. The arrangement of most departments in the office, and the routine work, may in many cases be much the same, except for the differences to be noted under standardization. But in certain features there will be vital changes in the work. The chief of these are, first, the creation of a separate department for "planning," *i.e.*, dealing with progress of work; second, the development of the work of the costs department by reason of its connection with the new one; and, third, the modified nature of the work of foremen.

A. The Planning Department

It is not easy to indicate the nature of any typical planning department, because there is considerable variation in the practice of efficiency engineers in the matter, according to the type of industry. It

may be said that the only absolutely essential function of the department is to "keep things moving"—to assign the work of every machine and every man each day, and follow things up to see that the work is done. Thus the department is responsible for the initial decisions as to *when* and *where* work is done, and for records of these particulars, and of the progress of the whole. Taylor included the detailed written instructions of the *methods* of performing the operations, as soon as these had been properly worked out, in the activities of the department; and in this he has been followed by other organizers. As the scientific investigation of methods precedes instructions of the kind, time-study and all that it entails should then also become part of the department that issues instructions. Further, the clerks in charge of costing have to make use of the documents issued by and collected by the planning department; and the latter must be at the same time in close connection with the clerks in charge of the supply and storage of material. Therefore cost clerks and stores clerks are often found in the same room as the planning clerks.

A practical reason for making the department rather complex is that in a small works the supervision of a single activity, such as planning, instructing, costing, or store-checking may not be enough to occupy the time of one superintendent, and therefore two or more activities are accommodated in a single office under the same supervision. At the other extreme we may find a large concern in which the

planning alone is so extensive that it has to be subdivided to deal with different sections of output.

The best general description of a planning department will be found in Taylor's "Shop Management," pp. 111-126. He enumerates in detail seventeen functions. But these may readily be cut down; first, by separating the costs department, and also by omitting his headings Employment and Insurance, which will be differently treated and assigned in British industries. The other functions may be epitomized as—

1. Investigation of processes and operations.
2. Provision of material and tools, and their transport.
3. Planning and controlling the progress of the work.
4. Inspection of the product.

These are, in fact, the practical outcome of the three principles of management that were afterwards formulated by Church and Alford. (See p. 20.)

In an industrial plant where a uniform product is being turned out in large quantity, the amount of planning will naturally be very simple when all is running smoothly. But it will be worth while in this case to investigate and analyze the operations very thoroughly indeed, and to subject each item to time-study. Also constant enquiry should be going on into possible improvement of methods, development of new activities, manufacture of the necessary tools and accessories, and so on. The

opposite of this instance is that of a large engineering shop which undertakes the making of a great variety of appliances on special orders. Here the actual amount of planning will be much greater. Superficially it seems that one might go on to say that the time-study activity should be much less, but, as we shall see later, when different operations are analyzed, the same constituent movements appear over and over again, and are thus worth close study and record.

It will be found generally that a planning department is likely to absorb more workers during the period of its installation, and the establishment of standards, than will be necessary when the apparatus has begun to work.

We shall now describe briefly the procedure of an ordinary planning department, leaving out the activities which only in particular works are combined with it. We may begin with the planning clerk, who will be the first assistant to the head of the department. He must be a semi-technical man, fully conversant with factory conditions and methods. He receives from the drawing-office a document which is variously known as a " specification," " part list," " bill of material," or some similar title. This sets out in detail the necessary parts required for a certain order that is to be executed, the drawings to which these parts are to be made, the kind *and amount* of material required, and the processes through which the various pieces have to pass before completion. Of course, as a rule

this information has all been recorded when the article in question was originally designed, as it is, for the most part, of permanent value. Therefore in any repetition order the specification sheet is produced by copying, not by working out. It is extremely important that the exact material and required quantity should be specified ; for experience constantly shows that there is waste of material if decisions on the point are made rather hastily in the workshop. Further, the planning clerk can at once satisfy himself that the necessary material will be available, and that there will be no delay owing to its not being in stock.

Thus it is the first duty of this clerk to see that all the material needed is ready to be sent into the shops. He proceeds to write on the specification sheet the departments in which each process is to be carried out, and the date by which it is to be completed. This may seem at first sight to take much labour and time, but only a few weeks' experience in the routine will give a capable man great facility in writing up these sheets, and will enable him to issue them at a rate which would not initially have seemed possible. Facility produces speed without extra effort—a fact which must be remembered constantly when we study any aspect of the discussion of efficiency.

But the clerk in this position must have a good deal of technical knowledge and common sense beside his routine facility. Otherwise there is sure to be " fool-planning," which always causes trouble, and which must of all things be avoided in the

instructions issued by a planning department. Operations in heavy engine work often require days or weeks for their completion, and it is very possible, if time presses, that the planning clerk might place the time for one of these operations below the minimum, if he does not know very thoroughly what he is about. The issue of such an instruction to the shop would not only cause confusion and delay in the execution of that order; it would create a distrust of the planning clerk, as an ignorant person whose instructions need not be followed—a state of things which produces deplorable results.

The specification sheet is finally gone through carefully for the purpose of designating each part with its classification symbol (see chap. vi.), so that the sheet may be used properly, with each item identified, by all the members of the staff who have not sufficient technical knowledge (see p. 42).

Then copies are made (usually by hektographic ink and a duplicating machine, if the number is considerable). A copy is sent to each department which has to deal with any portion of the work. The arrival of the sheet is the formal intimation that work for execution is coming along; it gives the date when it is to be expected, the nature of the work, the date at which it must be finished, and where it is then to be sent.

Progress is now in the hands of an "order-of-work" clerk who makes detailed arrangements for

carrying out the work in the various shops, and reports daily. This clerk may be a single individual in charge, with various clerical assistants under him; or there may be one such official for each department of activity, in a large works.

The copy of the specification sheet which remains in the planning department has the reports of the order-of-work clerk or clerks entered upon it, so that it becomes a detailed account of the progress of the whole order, and the condition and position of the parts at any time. Some simple device is put into use as a reminder (the Americans call it a "tickler"[1]) —some way of calling attention, in the right quarter, to any failure to keep up to time directly it occurs. Then it becomes possible usually to recover the lost time before the delay has become serious; that is, before the part or parts are due in the next place for the next operation.

The use of the copy of a specification sheet to a costs clerk will be discussed later on; but it may be pointed out at once that its records and details are of the greatest help to a man who has not technical knowledge, but is merely concerned with accounting. For it enables him to check quite accurately the actual processes performed on any order, when he comes to charge expenses on that order. Otherwise a misdescription of a job, the quoting of a wrong order number, or some similar slip which charges an operation to an order to which it

[1] See an article by R. T. Kent in *Industrial Engineering*, Jan., 1914.

does not belong, would in all probability go undetected.

Three examples will now be given of the *personnel*, in each case, of three rather complicated planning departments. The complication really arises from the facts that (1) the planning office is arranged to accommodate men with whom the purely planning activity must be in close contact; (2) the time-study and study of detailed methods of work is placed there too; and (3) that in two of the three cases the product leaves the factory from the planning department, having returned there when completed.

List A is taken from H. K. Hathaway's "Planning Department," published in *Industrial Engineering*, vol. xii., and reprinted in C. B. Thompson's Collection already mentioned, p. 372. It belongs to an unspecified plant where 100 men were directed by a planning force of 20, as "the concern manufactures a great variety of products."

List B is from Parkhurst's "Applied Methods of Scientific Management," and represents the usage of the Ferracute Co.

List C is from Lieut. Sterling's "Successful Application of Scientific Management" (*Journal of the American Society of Naval Engineers*, vol. xxiv., p. 167, and reprinted in C. B. Thompson's Collection, p. 300). It refers to an unspecified engineering shop "in many ways analogous to a naval yard." Printed forms, cards, and tabs used in this shop are given in much detail in the same article.

A	B	C
Production clerk.	Shop engineer.	Production foreman.
Route clerk.	Route clerk.	Route clerk.
Foundry or special material clerk.	Costs clerk.	
Balance-of-stores clerk.	Stores clerk.	Balance-of-stores clerk.
Instruction card men, including time-study and slide-rule men.	Schedule clerk. Time clerk.	Rate-setting clerk. Piece-work and time-study clerk.
Route file clerk.	Shipping clerk. Receiving clerk.	Production and shipping clerk.
Order-of-work clerk.	Order-of-work clerk.	Order-of-work clerk.
Recording clerk.		
Time and cost clerk.		
Mail carrier and tickler.	Mail boy.	Boy-clerks and assistants.
Stenographer.	Time boy	
Messenger.		

In each of the articles details are given of the work done by each individual. The general nature of most of their work, particularly stores and instruction cards, will be discussed under Standardization in the various chapters devoted to that subject.

The very simple planning department used at the Link Belt Works, Philadelphia, was described in *System*, vol. xxi. (and reprinted in the popular handbook "How Scientific Management is Applied"), by C. Willis Adams. It consisted of five

clerks under a production clerk, who was responsible for the shipment of orders. There were a—

Route clerk.
Instruction-card clerk.
Rate-setting clerk.
Order-of-work clerk.
Balance-of-stores clerk.

Those interested in the historical development of the idea of planning as a separate activity will find the first suggestion of it in print in Mr. H. R. Towne's now famous article, "The Engineer as an Economist."[1] He speaks of proper shop management and shop accounting, and says the control must be exercised by persons able to "observe, record, analyze and compare essential facts." A very clear account of an elaborate system which seems to attain almost all the aims of a planning department is that given by John Nelson, of the Bullard Machine Tool Company's dispatching system.[2] The charts seem excellent and are very clear, and the methods chiefly those of Taylor or his followers. The writer claims that every day "the dispatching department has ascertained inside half an hour the exact cost to date of every machine in process in the works, and the estimated amount of money which would be required to complete all orders."

He adds that "charts and cards do not bring results in themselves. They are the reminders which insist constantly that the management shall

[1] First printed in *Trans. of Amer. Soc. of Mechanical Engineers*, 1886; reprinted in *Engineering Magazine*, April, 1916.

[2] *Iron Age*, vol. lxxxix., p. 1.

carry through a system which will produce economy and expedition. The personal equation is the great factor in all efficiency work."

This point has to be emphasized at all stages in our discussion. It has been once again expressed with great earnestness in one of Mr. H. L. Gantt's most recent articles, when he urges that "authority to issue an order involves responsibility to see that it is properly executed."

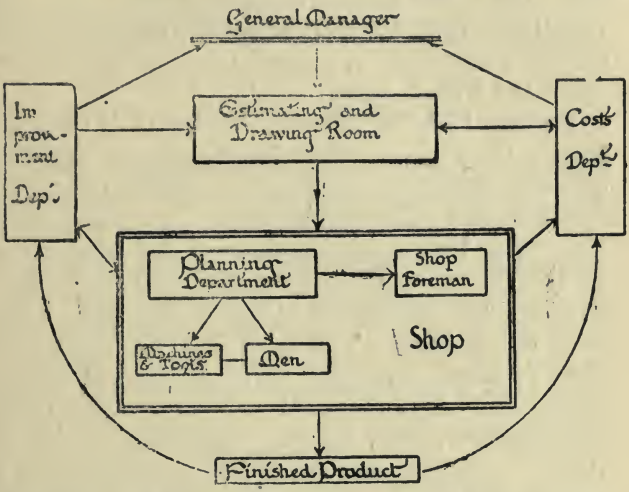
In the discussion on Standardization emphasis will be laid on the importance of every individual of a works receiving a written specification of his duties. It is especially necessary that the work of each person in the planning department should be clearly laid out and efficiently performed each day. In fact, one of the numerous places where scientific management may be said to begin is in this department. The physicians must heal themselves first.

The actual position of the planning department in the works is a very important consideration. It must be close to the shops or operating buildings; planning cannot keep in touch with execution if it is in an office some miles away from the plant. It must be also in close connection with the general manager, with the drawing-office, with the stores, and with the costs department.

The plan given on opposite page is from Lieut. Meyers' paper on the Science of Management (*American Society of Naval Engineers*, vol. xxiii., reprinted in C. B. Thompson's Collection, p. 152). It is not

meant, of course, to give geographical location, but merely connection with other departments.

As a summary, what can be said to be the essential immediate *aim* of all this coil round the planning



activity? That the direction what is to be done, and the record of what has been done, should coincide.

Anyone who has been the admiring spectator of the prowess of a notable golf- or billiard-player may have experienced the particular pleasure of hearing him say, "Now I shall strike the ball *so*, and it will do *so*, and then it will do *so*." And the ball does! It seems miraculous. It puts one out of patience with ordinary activities, chiefly, perhaps, because of the waste of energy consequent on bungling.

When it is an industry and not a game, one may add waste of time, waste of money, and waste of material. The human element will doubtless keep the result always somewhat short of the ideal, especially when more than one human being's frailties enter the equation. But we can perceive the same vivid certainty of action in trained teams of men, above all in the British Navy.

The ideal of the efficiency engineers is certainly to have things "according to schedule"; and they quote for example, to show how possible this is, the precision of a railway time-table. As a rule, within quite small limits, each locomotive and each driver do exactly what they are intended to do each day; although the number of auxiliary activities which must be marshalled and controlled to produce the effect is barely imagined by the public. Moreover, no diminution in the quality of this work can be contemplated, with all the momentous issues at stake. It is true that the actual administration of many railways is much criticized by the efficiency reformers as being wasteful. But the idea of running to scheduled time as an essential stipulation is the one which they wish to extend to other industries. And they are able to quote notable examples of its having been effected.

This is the prime reason for all the careful storage and examination of materials and tools, followed by equally careful conducting of them through the establishment, to arrive at the right time at their destination.

CHAPTER IV

MODIFICATIONS IN ORGANIZATION

(Continued)

B. The Costing Department

We have remarked already that when a planning department, with its detailed records, has been established it will have a very close relation with the costing department, with which it may often be actually amalgamated. This would seem to be rather confusing the functions of a department which is mainly technical with those of a department mainly clerical. But the reason will be quite clear if we consider the nature of the planning records. One of the chief innovations in scientific management is the specification, in detail, of the processes which any and every piece of product is to undergo before work is commenced on it.

It is obvious that when this information is fully available it is possible to plan out and to follow up the progress of work with a very high degree of accuracy. This in itself is a great asset in modern business conditions, where the delivery is often a more important item in a tender than the actual price.

But the value of the information is not confined to its use to the planning staff. A copy of the

"specification sheet," with the processes and departments responsible for them detailed, is passed over to the costing department. The staff there are then in a position to enter in their records the full processes which should be charged to each item of the order. A simple sub-divisory arrangement is used to enable each separate part and its manufacture to be charged, wherever possible, in a separate manner; while it is at the same time possible to obtain the total cost of the complete product quickly.

Provided with these blank process records the costing staff is in a position to detect errors in charging with considerable speed and accuracy. If, for instance, the specification sheet states that a certain part requires to be turned, milled, hardened and ground before fitting, a cost clerk without any technical knowledge can enter these processes on his costing sheets, and knows then that until each of these four items has had some cost charged to it, to that particular job number, his recorded cost is incomplete. This certainty eliminates a great cause of error.

If a more detailed method of costing of this kind is introduced into an organization of the old-fashioned type it will call for immediate reconstruction of the statistical methods used. The cost of the work performed by machine-tools often bears no close relation at all to the wages of the machine-minder which are charged to the work. As an instance of this, the case of automatic gear-cutting work may be cited, where the workman's time may

be occupied only for a few minutes in placing the blank wheel in the machine, making a few adjustments, and starting the machine. The rest of the work, except for occasional scrutiny, occupies no workman's time at all, the process being entirely automatic, and therefore the cost of the order is very incorrect if it is charged on a basis of wages. To obtain the actual cost the expense of running the machine is really the important item; and it is obviously very inaccurate to add a "flat rate" percentage to the value of the workman's setting-up time, and charge this as the cost of the work.

The determination of the cost of running machine tools is a difficult and highly technical business which cannot be dealt with in this context. Enough has been said to indicate the importance of these and similar statistics in the costing office. Various methods of computation are now in use, and the subject is still in a very controversial condition. Special attention may be drawn to the articles of Mr. A. Hamilton Church during the last few years in the *Engineering Magazine* (U.S.A.), to his book, since published, entitled "Proper Distribution of Expense Burden," and to another valuable American treatise by Mr. Holden Evans, of the U.S. Navy, "Cost-Keeping and Scientific Management."[1]

[1] The American journal *Machinery*, of which there is an English edition, had several good articles on Costing in 1915 and 1916. The Harvard University Bureau for Business Research has drawn up a system of Cost Accounting for Shoe Manufacturers, and issued it as a bulletin. See C. B. Thompson's Collection, p. 550.

The American engineering periodicals have lately contained many articles, both theoretical and descriptive, on costing, and frequent advertisements are to be seen by individuals offering expert help in the work. It has been the subject of much discussion both in technical and commercial circles. It has not so far roused anything like the same interest on this side the Atlantic ; a fact which has been very largely due to the smaller proportion of automatic machinery in use in this country. But now the need for huge supplies of munitions of war has resulted in an enormous increase in the number of automatic and semi-automatic tools, which entirely alters the state of affairs, and puts British manufacturing in much the same position as American.

But even in a business not using automatic or semi-automatic machines at all, it is essential to accurate costing to know the cost of running each separate machine in the factory. If running expenses are added as a " flat rate " on the workman's time cost, as is frequently the case, the resulting figure is bound to be inaccurate. On this system, an hour's work on a small drill which costs a few pence per hour to run is charged at the same price as an hour's work on an expensive heavy lathe, with an actual running expense six or seven times greater—if we assume, as we well may, that the wage-rates of the two operators are the same. The inaccuracy which results is obvious.

A method often used as an improvement to the flat rate is to make the percentage charge different

for each individual machine, but still a percentage of the man's wages. This is more accurate, but loses its validity if there is any possibility of working the machine at different times with workmen paid at different rates. During any period of dilution of labour the figures will have little value, and any wholesale change of rate of wages would also invalidate them.

It may be asked whether the manufacturer can expect to gain very much from the more accurate knowledge of his costs, which, it is claimed, he will get by using efficiency methods. The expenses in the department for clerical work are almost sure to increase. Deplorable results of inaccurate costing have manifested themselves in the injury done to trade generally by the existence of firms who cannot estimate their costs properly—an injury very prominent in America, though less so in England. Under stress of keen competition, manufacturers lower their prices to the lowest possible tender, and it frequently happens that the estimate given by the firm is reduced to below the actual cost of the goods, though they are not aware of the fact. Ultimately, of course, this practice will lead the erring firm into liquidation, but that is a protracted process; whereas the more immediate result of their action is loss and dismay among the competing firms whose methods of costing have been better, and estimates therefore higher. In America it has been pointed out by many writers that the rough averaging methods of costing and estimating are survivals of

the happy days for manufacturing industries, when profits were so large and left so comfortable a margin that any extra expenditure to ascertain real costs was quite unnecessary.

The days of easy profit-making are evidently over. The tendency in all modern costing systems is towards greater detail, towards careful following up and comparing, not only the cost of individual parts, but even of isolated operations on individual parts. However, firms engaged in the manufacture of a highly-varied product find themselves at a disadvantage with regard to their costing analysis, as variation in product means variation in processes, and the analysis becomes highly complex and expensive. At the same time there can be no doubt here of the necessity for accurate costing, if the concern is to be commercially and financially stable. The efficiency engineer, faced by the question of expense, finds assistance first by developing that aspect of Taylor's idea of functional foremanship which puts all machines of a similar nature together, and so simplifies analysis (see the next chapter). Secondly, by adjusting and altering the routine in the cost office, and using various labour-saving devices, he is enabled to use unskilled labour, usually that of girl clerks, to a great extent there; which will mean considerable economy. (Of course at the present time any devices to use female instead of male clerks will be obviously popular.)

However, the strong position of the efficiency engineer here is not in any claim to economy in the

working of the department, but his claim that he can determine the cost of labour and the cost of product to a degree of accuracy which has never before been reached. Taylor and Thompson[1] have put forward this claim very emphatically. They contend that when a workman is treated in the ordinary way it is always difficult to tell how long he has taken over a given job, the records being casual and careless, and often taking no account of delays or interruptions. Nor is it possible to say that another man would take the same time another day, while no part of the conditions, materials, tools, methods, have been standardized or perhaps even specified. Estimates of time for labour are often made just by rough guess. Mr. Hathaway speaks[2] with humorous scorn of the "foreman who will shut one eye, go into a trance, and fix the proper time for a job." The cost charging may and often does follow a similar course. It has been said that in some British firms the chief occupation of the estimating staff is to give quotations for "actual" costs.

Far more care is taken in considering cost of material, far more trouble is taken to allow for possible variation in material; labour, waste of labour, and variation in labour are never properly taken account of. Taylor and Thompson say that in concrete work labour cost is from a quarter to

[1] "Concrete Costs," chap. iv.

[2] "Time Study," an article in *Industrial Engineering*, vol. ii., p 85. In C. B. Thompson's Collection.

one-third of material cost. A variation of even 25 per cent. in the estimation of the former would then be only 5 per cent. on the whole. But in many forms of product the labour cost will be considerably greater than the material cost, and the effect of error very much greater.

Taylor says that the contractor in concrete work does not know with any degree of accuracy the time or proper cost of doing each kind of work. And also that when the fundamental data are determined, it is "possible to determine in advance how fast each element of the work ought to be done." [1]

The allocation of all indirect or overhead expenses is, of course, a problem of extreme importance, and this applies to the distribution of administrative charges as much as to any. The reader must be referred to treatises on costing for the newer methods of performing this distribution. Most recent literature on the subject in the United States contains constant reference to scientific management; and, conversely, several important contributions to the literature on scientific management are to be found in journals devoted to accounting.

To the engineers who make efficiency their primary object the first test of a good costing department is that it should produce results which are reliable very promptly. Monthly summaries of certain facts and comparisons are essential, but

[1] "Concrete Costs," p. 54

many are made weekly, and quite a large amount of reporting is done daily.[1]

In conclusion it may be emphasized that a good system of costing is necessary to the modern aims in management, as these cannot be compassed unless "the net results of all endeavours," as Emerson called them, are displayed and compared. Also the good system is to be attained by the modifications introduced by the new management, for the latter ensures close examination and record of all the operations in an industry.

The general benefits of good cost-accounting may be summed up as—

Possible economy in use of material.

Location of losses, leakage, and unused equipment.

Records of individual work by men and by machines.

A sound basis for right judgments in the sale of the products: which lines are profitable, which should be dropped, when adjustment of price is advisable, and whether the volume of product should be expanded or contracted.[2]

[1] See H. L. Gantt's paper, "A Daily Balance in Manufacture," reprinted in C. B. Thompson's Collection. Also see the article on the Bullard Machine Tool Co.'s Dispatching Department, *Iron Age*, vol. lxxxix.

[2] See a paper on Costing, by C. H. Scovell, read to the Indiana Engineering Society, 1916, in *Engineering Magazine*, April, 1916. He says that this department should be the "eyes and ears of the Executive."

The President of the Federal Trade Commission stated in his recent report that the most urgent need in American trade is better cost-keeping. America cannot be the only country of which this is true. All problems of efficiency in production must entail costing problems.

CHAPTER V

MODIFICATIONS IN ORGANIZATION

(Continued)

C. The Foremen

We will begin with an account of Functional Foremen as Taylor planned their functions. Much attention has been attracted by his views on this question, as they involved from the first a radical change in the conception of a foreman's work; but it must be remembered that his ideas are only a special feature in functional management, and that the common practice of his disciples often diverges considerably from them, according to expediency.

Dr. Taylor [1] visualized an ordinary foreman as a person continually harassed by conflicting duties; trying to superintend the whole work of a dozen or more other people, trying to look ahead and see what is going to be wanted next in every corner of his shop, always responsible for the quantity and quality of everybody's work, and for the methods of making the workers keep up to the mark; ready to act promptly and effectively in every sort of emergency, and, finally, finding time to put down brief notes of all the things to be done and items which ought to be reported. Taylor contended that the

[1] Taylor, "Shop Management" p. 94, *et seq.*

combination of qualities needed to make a good foreman of this description was such that only a most exceptional person would be satisfactory; and, further, that when he was found his actual value in a works was so great that he would deserve an exceptional position with greater authority. As the foreman's routine work was too heavy and too varied, he proposed to substitute for him eight men with specialized functions. Whereupon his hearers or readers, quite accustomed to the idea of a single foreman, and not believing his work to be so complex, visualized eight men tumbling over one another in the shop, each haranguing or disciplining the workmen on one subject or another, each wanting to stop a machine constantly in order to rearrange it; and, finally, eight more or less discordant reports going up to headquarters daily. An arrangement of this kind seemed more like pandemonium.

However, on reading carefully Taylor's description of the specialized work, we discover that of these eight foremen three are usually in the planning department, and communicate with the workers by written directions and forms; four are active in the shop among the machines; and the work of the eighth is likely to be peripatetic for the whole establishment. It is true, in works where the planning department itself is kept small and with limited duties, the three "foremen" whom Taylor located there as clerks may be put back into the shops again; but they still communicate with the men chiefly by writing; they may indeed form a

miniature planning department located in a single shop. (See Lieut. Sterling's paper in C. B. Thompson's Collection.) These men, with chiefly headwork to do, are the order-of-work and route clerk, the instruction-card clerk, and the time and cost clerk. The first named writes daily charts assigning work to the machines and men, according to the directions from the head of the planning department; the instruction-card clerk produces written information for the individual workers, or for the foremen working in the shops, in all the details of their work—the tools, the speeds and feeds, the time, for each operation. The third clerk issues time tickets, and collects information as to the time taken for each job, whereby he may calculate the earnings of the workmen. These things are done in accordance with Taylor's idea of removing brain-work as far as possible from the shop. It will be obvious that in a small works one person (with perhaps one assistant training under him) will perform the duties of each of these clerks for the whole establishment, instead of for a single shop.

With regard to the four foremen regularly in the shop, Taylor himself says, "it was preferable to use" them in his own works (see p. 100, "Shop Management"), which looks as if he were prepared for modifications in other works. The American term "boss" is used for them. It is strange in English ears, and disagreeable perhaps in the "indefinite fringe" of meaning which psychologists say words often bring with them. It is apt to

suggest a person with great power of arbitrary interference. Yet it would be difficult not to use it in this context.

Taylor's "gang-boss," then, "has charge of the preparation of all work up to the time that the piece is set in the machinery." He has to see that materials, correct tools and full directions for each man's next job are ready in good time before his present job is done; he waits on the worker as well as directing him.

The "speed-boss" takes over responsibility while the work is in the machine. Taylor chose an unfortunate name for him, in its "fringe" of meaning. His chief concern is with the correct speed of the machine—a matter of the first importance to the man who had spent twenty years investigating it, and discovering rules by which to operate. It is true, he says that the speed-boss "must not only advise the men how best to do the work, but he must see that they do it in the quickest time." This looks very like driving; but the context shows that he is to assist, and to demonstrate how the speed can be attained, by doing it himself if there is any doubt, and indicating the whole procedure.

The work of the inspector who inspects the quality of the work when finished is obvious; and it is also obvious that it is an advantage to have a separate individual for this supervision, if possible.

The repair-boss can hardly be said to "boss" anybody in his proper activities, except by declaring

that a machine must go temporarily out of use ; but he does direct the men in the proper oiling and general care of the machines while in use. A very important feature of his work is the care of the belts which connect the machine with the power which drives it. Here once again we encounter the outcome of Dr. Taylor's habit of careful investigation on any point bearing on efficiency. The result of nine years' observation and experiment on belts was the conclusion that " belts properly cared for according to a standard method by a trained labourer would average twice the pulling power, and only a fraction of the interruptions to manufacture, of those tightened according to the usual methods." [1]

The eighth individual in this formidable array is the disciplinarian. It would certainly be more euphonious to call him the peace-maker, as has been suggested by Mrs. Gilbreth and others. He is responsible for exacting fines, or any other form of penalty for breaking rules, or for insubordination. He should therefore be in charge of the men's records, and it would certainly be advisable that he should engage them in the first instance, though Taylor himself does not suggest this activity for him, merely assigning it generally to the planning department. However, he does contemplate only one person in the establishment, if not very large, acting in the capacity of disciplinarian, so this last

[1] " Shop Management," p. 125. Paper to *Amer. Soc. of Mechanical Engineers*, 1893.

foreman can hardly be considered the eighth authority in each individual shop.

Before describing any modifications of this plan, which have already been tried, it will be as well to return to Taylor's essential contention—that specialized men for these different functions are much more easy to find than is a foreman of the old-fashioned type. The best-laid schemes for organization of a shop may well go wrong if they depend on securing an unusual man, who might well be said to be "born, not made," and even then requires some years' training. And it is a remarkable fact that apart from the modification of the foremen being a feature in scientific management, it has been the theme of many other suggestions in the industrial world, proposals of various kinds to relieve him of some branches of his work. Bosses with much fewer essential qualifications, who can compass more specialized work, are to be found in most establishments without difficulty, and they can be trained to their special work in much less time.

The number and nature of the foremen recommended in Taylor and Thompson's "Concrete Costs" is not exactly the same as the above. Certain engineering establishments working on the new methods have found it more convenient to specialize the machines first, and to collect in one shop or part of a shop machines of the same kind and size. One foreman can then be put in charge of all machines of the same type, and he can act for these as both

gang-boss and speed-boss, as his scope has been thus narrowed and intensified.[1]

Another modification is that the rather difficult work of the disciplinarian should be done by a superintendent with a good deal of weight and authority, whose decision cannot be discussed or resented by the bosses of the shop. This is perhaps the best place to suggest that one very grave difficulty connected with the ordinary foreman's position and authority in works would disappear to a large extent with any plan for dividing his work among functional foremen. That is the undue influence he can have over a workman's position or career, and still more the undue influence he may have when women are under him instead of men. He is in a situation with a great temptation to favouritism or persecution, and many abuses may creep in. If the key to getting on in works is by "standing well with the foreman," the methods resorted to occasionally for the purpose, as also the foreman's methods of dealing with people who do not stand well with him, are aspects of the foreman's work that touch not only industrial efficiency, but deeper social problems.

To return to other modifications of foremen's work. Mr. A. H. Church, in an article on the subject, advocates keeping a single general foreman over a section of workers, but removing a good deal of his old work from him—particularly the order of work and the rate-fixing. This is somewhat more after the idea of Mr. Emerson's line-and-staff organiza-

[1] See Duncan, "Industrial Management," p. 192.

tion. Mr. Church thinks that the foreman's first concern should be with the *costs* of the operations, and that he should be able to locate very quickly an unusually high cost, whether due to one of his men or one of his machines.

The same idea is emphasized by a writer in *Machinery*,[1] who does not avow allegiance to Taylor's methods, and adheres to the plan of a single foreman. He considers it worth while to keep each foreman fully informed of the exact cost in working of all that he is responsible for, and has the costing records arranged to give him the complete returns. The man's efficiency is measured primarily on an accountant's basis. However, this is taking us rather far from Taylor's ideas, though certainly a foreman with this sort of responsibility would have to be relieved from other work. Various writers in the American periodicals would at least remove clerical work from him, on the obvious plea of economy—that a clerk at far less wages could be employed on it to spare the time of the higher-priced, more skilled man.

The question of giving bonuses to individuals in the "boss" position will be considered under remuneration.

The whole of the discussion on separating and redistributing the duties of a single foreman in a functional way, and on the manner in which the men are to be chosen for the new jobs, is of the utmost importance to all people concerned for the

[1] J. C. Spence, "Efficiency through Co-operation of Employer and Employee." *Machinery*, American edition, 1914.

status of the worker. There is no doubt that the advocates of functional management count on foremen's places being filled for the most part by the skilled workmen of the shops. In fact, they find here the chief use for skilled employés, in cases where semi-skilled workers can actually tend the machines, under direction and training. This is indeed in accordance with their general aim of using the skilled man exclusively for skilled work as far as possible. According to Taylor's central idea different qualifications are demanded from different men, but he has really added a new attribute to each —he makes a special demand for the man who can teach and show others rather than for the man who can drive them.

Then stress is laid by more recent writers on management on the advantages of having fortnightly meetings of the various foremen, so as to discuss present activities and possible improvements. Foremen's meetings are occasionally the custom in works where the foremen are of the old type; but where the idea of functional foremen has been developed, opportunity for mutual discussion will be even more valuable. It has frequently to be pointed out in describing the new management that its advocates urge constantly the value of genuine co-operation between employer and employed. Trades Unions should give special attention to the attitude taken by the employer to the new type of foremen, remembering from the first that a larger number of overseers of the kind, in proportion to the rest of the workers, will be required.

CHAPTER VI

STANDARDIZATION AND CLASSIFICATION

THE word "standardization" is hardly yet familiar to English ears, though it is a very common one now among American writers on business methods, in discussions on industries of all kinds. Unfortunately the word "standard" has more than one accepted meaning, so that its new derivative is likely to be ambiguous. It should be said at once that standardization has a rather different meaning in scientific management from that in which it is used in general American discussion. In the latter case it refers usually to the indication and definition of some article of product, by size, weight, or some other criterion, so that it may always be exactly identified. The article may be tubing, or wire, or some small part manufactured to be fitted into a large machine or engine; and to say it is standardized means that exactly the same thing can be obtained if the order is repeated, so that there are no troublesome adaptations necessary. For instance, we hear that the American Society of Automobile Engineers, finding that 1,100 sizes of seamless steel tubes were being made, prevailed upon the manufacturers to reduce the number to 160; again, finding that

600 sorts of lock-washers were in use, they similarly reduced the number to 20. The advantages of this reform—having specified sizes and makes of article always manufactured—are that the articles should be cheaper because produced in greater quantity, and that there should be an easier interchangeability of small parts in different machines.

The movement towards standardization of *product* has been going on for some time, especially in the United States. One of its chief effects has been the encouragement of "quantity production," *i.e.*, production on a very large scale, making for cheapness. The phrase always brings the natural enquiry as to how quantity production affects quality. The pursuit of this subject, though interesting in its bearings on all industrial affairs, is not relevant to the Taylor system. Experience has certainly shown that by the use of proper methods it is perfectly possible to keep up, or even improve, a standard of quality when an article is manufactured in much greater quantity.

In Taylor's programme the standardization is not of the products from the works, but of the material, the equipment, and the methods used within them. The new management has sometimes been called "measured" management; it is in the present context that we shall begin to see the significance of the term. Taylor's standardization is a system of definitely prescribing or measuring everything connected with the work—every tool provided, every

material sent out from store, even every duty performed. At the same time he meant the attainment of the best *quality* possible in each. In the colloquial language dear to some of his exponents, he aimed at the " one best way."

We have referred to the fact that standard is ambiguous in meaning. The attribute of good quality was not introduced by Taylor. We find on consulting either English or American " standard " dictionaries that the word has long been used either as basis of comparison or normal amount or size, or as " exemplar of correctness and perfection." [1] As soon as the word is introduced here it is necessary to lay some stress on the two different meanings, for they will be seen to have a new significance when we come to speak of the standard task.

Efficiency engineers have had standard very carefully defined for them by Morris L. Cooke [2] in the following paragraph. This has been referred to by Mrs. Gilbreth as the " classical definition " :

" A standard under modern scientific management is simply a carefully-thought-out method of performing a function, or carefully-drawn specifications covering an implement or some article of stores or of product. The idea of perfection is not involved in standardization. The standard method of doing anything is simply the best method that can be devised at the time the standard is drawn. Stan-

[1] " The New English Dictionary."

[2] " Academic and Industrial Efficiency," Bulletin No. 5, Carnegie Foundation for the Advancement of Teaching.

dard specifications for materials simply cover all the points of possible variation which it is possible to cover at the time the specifications are drawn. Improvements in standards are wanted and adopted whenever and wherever they are found. There is absolutely nothing in standardization to preclude innovation. But to protect standards from change which are not in the direction of improvement certain safeguards are erected. These safeguards protect standards from change for the sake of change. All that is demanded under modern scientific management is that a proposed change in a standard must be scrutinized as carefully as the standard was scrutinized prior to its adoption, and further, that this work be done by experts as competent to do it as were those who originally framed the standard. Standards adopted and protected in this way produce the best that is known at any one time. Standardization practised in this way is a constant invitation to experimentation and improvement."

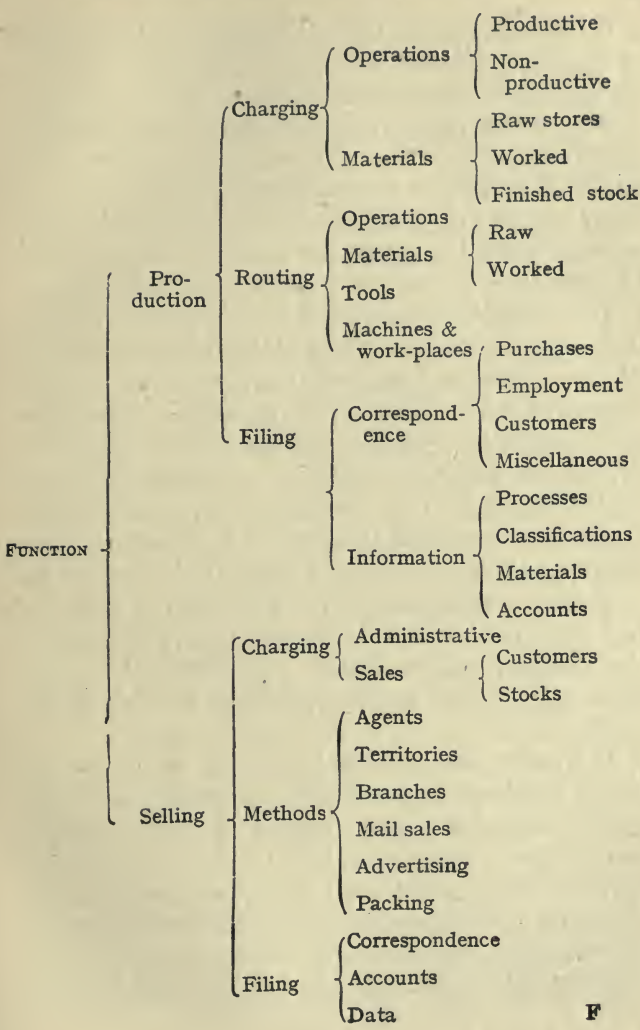
This definition forms a line of defence against the accusation that the standardized becomes the stereotyped, and is not susceptible of improvement.

The programme to which the new management is committed is that everyone should be doing the best work he can in the best possible way. For management itself the best way is through *classification*, both for attaining complete knowledge about, and for thorough organization of, all the resources. It

has been pointed out by C. Bertrand Thompson in his paper, "How to give a Business a Memory," [1] that classification leads at once to standardization as ordinarily understood—the establishment of definite normal amounts or sizes or types of the things classified. A Government department finds by classifying that 76 kinds of pen-nibs are used by its clerks; direct economy and the simplification of storage follow by reducing these kinds to seven or eight, with little or no inconvenience to anybody. A printing plant finds, by classifying, that it has stocked 200 types of paper, whereas 85 will cover all possible needs. In fact, the process of identifying carefully all material in store tends to get rid of all non-useful variation. The same is true of non-useful processes, or even persons. Mr. Thompson urges, with much weight, that to classify functions first is the best way to proceed, and gives the diagram reproduced on p. 65 to illustrate his method.

He says that every practical man must, finally, superintend and adjust his own classification to suit the needs of his business, but that the work entails a high degree of ability, both in mastering and in modifying other people's classifications. A general distinction is made in the essay between the systems necessary for the assembling industries, in which different parts are made and finally put together, and the systems, for the industries in which the product is built up in successive operations.

[1] "Classification and Symbolization," *System*, vols. xxii. and xxiii. See also his Collection. Classification is Mr. Thompson's special subject, to which he has made great practical contribution.


FUNCTION
Production
Charging
Operations
Productive
Non-productive
Materials
Raw stores
Worked
Finished stock
Routing
Operations
Materials
Raw
Worked
Tools
Machines & work-places
Filing
Correspondence
Purchases
Employment
Customers
Miscellaneous
Information
Processes
Classifications
Materials
Accounts
Selling
Charging
Administrative
Sales
Customers
Stocks
Methods
Agents
Territories
Branches
Mail sales
Advertising
Packing
Filing
Correspondence
Accounts
Data

A management can certainly proceed much more easily to standardize through a classification of this kind than by proceeding vaguely without a plan. Duties can be defined, then equipment and material described, and, lastly, methods of procedure outlined. Equipment, material and methods are to be made as good as possible, and then, by the use of a suitable incentive, duties are to be performed as well as possible. This is the programme for efficiency.

The essential feature about the classification, when developed, is that it should be used throughout the whole organization for every purpose by everyone at work, and that it therefore must embrace everything in the factory. When an item has received a certain symbol or figure in classification, it must be known by that symbol in the drafting-room, the operating shops, the costs department, the document-filing department, the stores and stock-room, and so on.

The next question will be, What sort of a symbol to use? It should be mnemonic, or suggestive to the memory, also isolated and distinct for each item, and as brief as is compatible with these two needs.

The effort of classification, and in particular the use of symbols, is fascinating to many minds as a mental exercise. They delight in elaborating a wide elastic scheme to suit all contingencies. While schemes of this kind are a necessary basis for constructing a classification in any particular concern, the manager who introduces one has to make his own modifications and selections for his own business,

as this will certainly not include all contingencies. It is worth noticing that the Universal System for classifying knowledge, now generally accepted in libraries, and departments filing documents, emanated from an American. This is the one known as the Dewey or Decimal system. It has been recommended by the U.S. President's Commission for Economy and Efficiency for filing records in Government departments. Mr. Thompson's essay discusses among other topics the unsuitability of the Dewey system to works management, although he expresses the aspiration that a Government committee should be created to classify and symbolize " all business " as Dewey undertook to do for all knowledge. The Dewey system uses figures entirely. If one uses letters there are 26 (more usually 23) alternatives in each entry, or spacing, of the symbol, where a figure gives only 10 possibilities. Secondly, letters can be arranged so that mistakes are more easily detected if they are read or copied wrongly than figures can be. Thirdly, letters can be made of more assistance to the memory, initial letters being used to a very large extent. The two last considerations are important in a works where, as we have sa d, all sorts of people are to use the symbol for all sorts of purposes, whereas Dewey's system is primarily only for filing.

Good management seems to require some form of symbolization for the matters with which it deals—some form well thought out and carefully adapted. Dr. Taylor evolved one for himself in the early stages

of his own management. It is another instance of his astonishing power of seeing exactly an essential factor to secure success in any plan, and then proceeding to supply it by his own investigations and efforts. The pioneer, however, in this instance, was Mr. C. Oberlin Smith, then the President of the Ferracute Co., who read a brief suggestive paper on the Naming of Machine Parts at an early meeting of the American Society of Mechanical Engineers in 1881.[1]

Mr. C. G. Barth, the mathematician, assisted Dr. Taylor in the development of his classification scheme, and Mr. Thompson contributed important additions. The details of the system may be read, by those interested, in the two articles in Mr. Thompson's Collection, the second being entitled "Scientific Management in Retailing." There is no occasion to elaborate them here.[2]

Anyone who wishes to instal symbolic classification is recommended to study the Taylor and the Dewey methods before setting to work to evolve one

[1] *Trans. of Amer. Soc. of Mechanical Engineers*, vol. ii., p. 366. Reprinted in C. B. Thompson's Collection before his own paper.

[2] The letters I, O, Q are not used. Some systems omit also J and U. We will merely give, as an illustration of the method, the result of an explanation by Mr. Thompson, whereby the written instructions for operating a certain machine in a small printing-plant are discovered to be catalogued as D, C, M, M, K, P,—the operation (P) of the keyboard (K) of the monotype (M), which is a machine (M) in the composing-room (C), part of the manufacturing end (D) of the whole business. (The letter D is the only one arbitrarily chosen without reference to initial letter.) Figures are used at the end of an item to signify particular size or colour, where there are several; they are also used at a specified position among the letters to convey information about dimensions where necessary. The system can claim to be self-expanding and self-indexing, like Dewey's.

suited to his own circumstances. The advantages of classification of some kind are described by Mr. Thompson in the expression that they "give a business a memory." We would rather say that the records form the memory, but that records are simple waste of time if they cannot be found promptly and used readily. Further, records should be made as brief as possible, just as instructions should be made as brief as possible, consistent with clearness. A system in which symbols cannot be easily interpreted, above all a system in which documents for reference are difficult to find, will become more of a burden than a help, more of an expense than an economy.

We have said that classification leads in good management to standardization; that is, to the selection of a few definite types instead of many scattered items differing by a few details, and to the constant aim of getting each type to conform more exactly and perfectly to its purpose. We must now enquire how standardization affects: (*a*) the store-room, and (*b*) the stock of tools. Next in order will come the standardization of methods of work, where the human element enters, and makes all the problems more difficult and elaborate. But before closing this chapter we may refer to the effect of standardization in the designing and drawing departments.

For the most part we are assuming that the drawing department would not undergo any very vital changes when efficiency methods are being installed, because it is usually the department where

for years past the most scientific and expert knowledge has been brought to bear on works problems.

However, the duties of its various officials may have to be more clearly defined, if not increased, and also their relations to other officials. The use of a symbolization well known throughout the works will help the designers very much in making specifications, but standardization will help them more. It has been said by writers urging standardization of the ordinary kind as an aim in itself, that lack of uniformity in specification is often the chief factor accounting for delays in production. If those individuals responsible for the designs have no clear list of the standard finished parts used in the works, they are likely to issue instructions for the execution of which special work is required, while stock sizes and types might perfectly well have been used with a little adaptation. The drawing department should also have a list of the appliances available, and keep as far as possible to those in general use. When small parts, such as bolts and nuts, have been properly standardized, they need not be fully drawn, or described on the specification at all, but expressed briefly by their symbols.

For castings of all kinds in an engineering shop the work is greatly facilitated by standardizing, so that stock patterns, or stock parts of patterns, can be made in good time ahead, and stored for future use. An order is very often delayed by the casting not being ready, as that operation in the foundry is liable to take more time than anything in the shops

CHAPTER VII

STANDARDIZATION OF EQUIPMENT

A. The Stores Department

THE question of how to keep effective control over stores is one to which managers have lately given much attention. If a business is counting its costs carefully, and at the same time trying to get work done more expeditiously, it cannot afford on the one hand to have capital locked up in, and space occupied by, superabundant supplies, nor, on the other hand, to have work delayed for lack of material. A manager aiming at general good order and control desires to store his material systematically, and to give it out with due formality, rather than to leave supplies about the works for all and sundry to help themselves. We shall see that the same sort of reform is usefully applied to the treatment of tools.

Two things are insisted upon in proper management; first, the keeping of store records in such a form that they constitute a "perpetual inventory," *i.e.*, an arrangement by which the quantity in stock of each sort of material can be ascertained at a moment's notice; and, secondly, the predetermination of the maximum and minimum quantity desired for each sort—these quantities being a guide to

the store-keeper and the purchasing agent when more is required—and how much to order. Generally the reduction to a certain quantity, something above the minimum, is marked to form the "ordering level."

The primary ideas which obtain in scientific management are certainly of assistance in attaining these two aims, though it would seem at first sight that the carefully kept store-room is a necessity, easily installed in any systematically managed works. But where the idea of function is developed, it follows that a certain individual will have store-keeping assigned as his work, and that he will be allowed to issue stores only according to the written instructions of a few other individuals. He will very likely have clerks under him for ledger entries, and these will probably be located in the planning department rather than the shops. He will also have a "move material boss," with a gang under him, to take the stores issued to their proper destination. The stores sent out will be always approximately the correct quantity needed, so that there can be little waste; and by being entered on some form of material order-sheet they can be debited at once to the job for which they are required. There must be at least three copies of the material order-sheet, one going with the material to its destination, in order that the individuals by whom it is received should know the purpose for which it is intended; the second to the planning department for their records of progress; and the third to the costing department.

What seems at first to be more a counsel of perfection than a plan which is easily realized can, in fact, become simple and straightforward if it is part of a large design in which many co-operate, rather than being an isolated effort. Moreover, when all the details of a job are thoroughly planned in advance all the different materials that it requires can be set aside also in advance, and there will be no unexpected run on any particular item.

A good deal of sub-classification is advised in storing, *e.g.*, that different sizes of the same article should be carefully sorted out, and have each a separate card or tag recording the quantity, even if this seems rather elaborate. A store-keeper with no other work to do can keep count of a very large number of separate records of the kind.

There are two recognized ways of securing a perpetual inventory. The one most in favour is the preparation of a card index with a card for each item. On this is permanently inscribed the symbolic description of the article, and the maximum and minimum quantity to be carried. Entries are made on this by the store-keeper or his clerk every time some quantity is issued, and every time some is received.[1] The balance is also entered each time; and all that remains to be done is some simple arrangement, as nearly automatic as possible, to

[1] It is usual for the stores record clerk to make two entries for each item issued, the first being a temporary memorandum that a certain estimated quantity will be required for some order number; the second, a permanent memorandum of the actual quantity which has been issued.

notify to the purchasing department as soon as the ordering level has been reached. No elaborate overhauling of the stores-room is ever necessary, nor need its daily operations ever be stopped. A return of the whole stock carried can be obtained from the card index monthly, or as often as required, by a single clerk in a few hours' work. The card index is often called the " stores ledger."

Another method is to attach a " tag " (a label, made of very tough paper, resembling a large luggage-label) to the bin or other receptacle which carries the material. Entries are made on this tag similar to those described above. The entries are readily made on the spot when any change is made, and the balance can easily be read by anyone visiting the receptacle. Besides the obvious drawbacks that the tag will get very dirty, and that the entries may often be carelessly written by the different hands making them, the weak point is that if any report is to be made in the office the tag must be removed, and sent there, which is risky and troublesome. In some stores departments the removal and despatch of the tag is the form of requisition for more material, as soon as the ordering level has been reached ; a temporary one of a different colour takes its place, and serves as a reminder of the condition of things.

Details of this kind have been fully discussed in papers on the subject in recent numbers of engineering magazines. The extent and the general arrangement of a store-room will vary a good deal according to whether it has to carry finished *stock* as well as

stores; also whether the storage includes finished parts which are manufactured on the spot, finished parts which are purchased ready made, or consists of unworked materials only. Where a concern is very large there may be three separate store-rooms for these divisions.

With regard to the location of the articles in the stores it may be remarked that a good system of classification facilitates arrangements very much, and makes it easy to find an item quickly, as there will be some logical sequence in the distribution of the articles stored. When one comes to the last sub-divisions, size or length will make better criteria under which to arrange than quality, if space has to be considered.

There seems to be real unanimity among works managers as to the advisability of a carefully-kept store-room (to which few people have access), while they differ on other essentials urged by efficiency engineers. It is now admitted on all hands that there is most inexcusable waste of time if a foreman or workman has to hunt for material when he wants it, and is tempted to make any wrong sort "do," rather than prolong his search so as to get exactly the right kind. Also that a management which is careless in keeping account of its own material cannot expect workmen to have much concern about wasting it. And, further, that the practice which grows up so naturally when stores are difficult to obtain quickly, of keeping back all sorts of materials or stock parts in the shops so that they shall be at

hand if wanted at some future time, is entirely destructive of good stock-keeping and of economy.

Any attempt to establish good habits with regard to storage and requisitions for things stored will naturally be met with the usual complaints about "red tape,"—with the gibe, for instance, that a written order is required for a bolt or a pen-nib. But an establishment which sets out to foresee and forecast needs will not have occasion to requisition any trivial or casual quantities. Considering the matter from the psychological standpoint, "red tape" really ought to be given its due, for it certainly tends to produce care and respect for articles which are the property of the firm, but are meant for general use. Everyone knows the annoyance of going to a post-office, where pens or pencils are supplied, with free access to them, and finding that as a matter of course implements of the kind are quite unfit to use. The moral is that people never have any respect for common property which is quite freely supplied, and everyone falls back on his own property as the alternative. In many cases some slight formalities, some indication that the articles are valued and counted, will alter the whole state of affairs.

CHAPTER VIII

STANDARDIZATION OF EQUIPMENT

(Continued)

B. The Tool-Room

THE model tool-room is the subject of even a larger number of recent articles in engineering periodicals than the store-room, articles well illustrated by photographs. Many establishments are pleased to call attention to their beautifully-ordered tool-departments, which indeed form good advertisements.

The idea of having a store of tools, of which careful account is kept, is comparatively new. It is obviously very unsystematic for the workman to be left to hunt up any tools he wants somewhere in his workshop, to bother the foreman for them, or to borrow them from his neighbour. All that has been said about the muddle and waste caused by having materials squandered applies still more to tools. While the workman is hunting for a tool the machine stands idle. Again, the want of system leads to making the wrong thing " do," which plan is the worst enemy of efficiency.

The first reform would be to put each man in charge of a complete set of the tools he needs, to give him a proper place to keep them, and to make him responsible for them. Then, at least, he will

have some respect for them; and he will not have to waste time trying to procure them at the moment he ought to be using them.

But this solution of the difficulty does not meet the case of modern tools. These are the appurtenances of a machine rather than of a man, and it is not easy to assign them for personal use. Also, using the wrong tool, or placing it in a wrong position, may cause very extensive damage to a machine. Therefore each tool is put under the control of a skilled tool-setter. There are many appliances, such as jigs and gauges, which now have to be considered as tools, and these differ for different kinds of work.

But probably the most important factor in this change in the way in which tools are regarded has been the discovery of high-speed steel, of which cutting tools are now made. This steel is very expensive; the number of tools kept in stock is therefore more limited, and it would be unnecessary extravagance to give every man or machine a complete set to meet all possibilities. More significant still is the fact that the grinding of high-speed steel tools is a special art. It has been said that not more than one in ten workmen, even skilled workmen, grinds the tools properly, as it is essential for economical working that the form of the tool should be accurately ground to a gauge. A specialized function of tool-grinding has arisen, and is conveniently carried on in conjunction with the storage of tools. Once again, the special new function and the

systematic storage and distribution are both the direct outcome of Taylor's work and experience; in this case on the art of cutting metals.[1]

The workman is now to receive for each job the correct tools in a proper condition; when the job is over his tools are taken away, and his responsibility for them is over. One consequence of having tools thus in perfect condition and readiness is that the costly machines are able to be kept at work almost continuously. This is a very important consideration for management, and equally so, in a different aspect, for workmen. It will be seen that this change of the disposition of tools will bring about very serious alterations in the attitude of the worker to his work. These will be discussed later in their full bearings. At first sight it would seem that an individual should be greatly pleased to get tools that are beyond reproach [2] just when he wants them—treatment which certainly indicates a respect for his specialized capacity. But we must not overlook the reverse aspect, that he is no longer trusted with the grinding, the care, and the storage of his tools, and that may have great significance for him. He is apt to consider it a reflection on his skill.

The importance which cutting tools have in the

[1] The whole object of the careful study and standardization of the exact form of tools is defeated if the workmen have access to grindstones, and have the opportunity of "touching up" the tools they are using.

[2] Surely most of us have often felt sympathy with the proverbial "bad workman" who "complained of his tools." One of the first steps towards efficiency is to secure suitable tools.

evolution of a tool-storing system must not lead us to forget that good management takes over the supervision of *all tools*, all appliances which are in use in the works. A demand cannot be made on any worker to do his or her best work if the implements supplied to them are not in good working order, even if the implements are only paste-brushes or scissors. Nor can one person's work be fairly compared with another's if the equipment is not uniform. This is of the utmost importance in all forms of piece-work rates. A great many small tools get quickly blunted and out of order, and it should be someone's special business to inspect and repair them, even when it is found convenient to keep them in the working-room instead of a tool-room.

The actual arrangement of a tool-room has been the subject of as much excellent planning as that of a store-room.[1] Descriptions have been published, with illustrations, in American periodicals, of the tool-rooms at the Link Belt Co. in Philadelphia,[2] and the Tabor Manufacturing Co.,[3] both of which are managed on Taylorian methods.

There are two separate departments in the room, one for grinding and repairs—the maintenance section—the other for storage. The first is, as a rule, under the charge of a thoroughly capable foreman,

[1] For instance, Mr. Gilbreth has a handy device of marking a set of tools and their receptacle with paint of the same colour. See "Motion-Study."

[2] J. Ashford, *Engineering Magazine*, 1904.

[3] R. T. Kent, *Industrial Engineering*, vol. ix.; reprinted in the Thompson Collection.

as he is responsible for important executive work. Parkhurst (Ferracute Co.) makes him one of the functional foremen. The stores-keeper does not need the same technical qualifications.

Stress must again be laid, as in the last chapter, on the necessity of proper communication between the designing activity and the tool-room. A copy of the card-index which gives a full detailed list of tools should be in the drafting-office. It will be obvious that a designer should be completely aware of what is practicable at the time on the various machines.

Sometimes the inspection of tools on their return from use is made a separate section, with an inspector who issues them, for grinding or for re-storage, after they have passed under his review. The number of men needed in a tool-room will vary greatly according to its scope ; there must always be one or more tool messengers to carry the tools to and fro. There are careful systems of checking the issue of tools to workmen, so as to make them responsible.

A point that must not be forgotten in considering the importance of proper care and inspection of tools is that statistics of industrial accidents bring out the fact that a considerable percentage of them are due to defective tools : those that were out of order, or of the wrong size, or of unreliable quality. One writer [1] states that 25 per cent. of American industrial accidents in one year were due to defective hand-tools.

[1] Cardullo, "Industrial Betterment," *Machinery* (American edition), Nov., 1915.

CHAPTER IX

STANDARDIZATION OF METHODS

A. Time-Study and Motion-Study

THE men who represent scientific management have continually to disclaim the erroneous conception that there is any single root idea in it beyond that of the application throughout of scientific methods in thought and work. There is, naturally, no simple prescription to attain efficiency; its realization, like that of most ideals, demands the practice of eternal vigilance. At the same time the systematic study of methods of operation is perhaps the greatest innovation in the new management, and is an essential plank in the platform. The Trades Unionists in America, who have recently tried to bring in legislation which shall simply and crudely prohibit time-study in Government works, are no doubt aware that they would actually cripple the work of scientific managers by such a prohibition; though it may be very difficult for them to make out a reasonable, logical case against the mere observation of the details in a man's work, and the time each detail takes, by a person representing the employer.

The chief moral to be drawn at present from this recent development in United States politics is that

this application of scientific method to human labour is the step for which the most careful preparation must be made, and that it will generally be advisable to make it one of the last items on any programme of reform establishing methods of efficiency. Nevertheless, no programme is complete without it ; and to a large extent the standardization which we have previously been discussing is merely paving the way for the standardization of human effort as far as that may be. H. K. Hathaway says in an article on Time-Study[1] that it would be almost as difficult for modern chemistry to exist without quantitative analysis as for scientific management to exist without time-study.

Is there anything novel in saying to a workman, "You have taken two hours to do that job ; I believe that you could do it quite easily in less than half the time" ? The innovations are, first, that the person making the statement is in a position to demonstrate its truth ; second, that he will demonstrate it under the ordinary conditions with which the workman is to be surrounded ; and third, that he will prove it can be done without undue fatigue. To ensure the validity of his statement, then, a large amount of observation and experiment is necessary, followed by certain changes and modifications in the conditions, designed to eliminate waste of time and waste of energy.

The men who are to make these observations, experiments, and final modifications must be chosen

[1] *Industrial Engineering*, vol. xi., p. 85.

very carefully, or their efforts will make the management look foolish, and produce a harmful effect on the workers. Wherever possible more than one observer should be set to work, as the statistics will be much more valuable if personal idiosyncrasies can be eliminated by comparison and repetition. Each observer should be a man already trained in scientific method, but he must not be a novice with regard to the operation being observed. The workmen must feel quite sure that he already knows a good deal about their work. He should then stand beside each workman as a colleague and co-operator, not as one having authority over him, but still less, emphatically, as an ignorant person whose sole equipment consists of stop-watch, pencil, and paper.[1]

[1] The later exponents of time-study methods insist very strongly that no workman should have the details of his work studied and timed except with his fullest consent and co-operation. It seems that friction and ill-feeling have been caused by surreptitious time-observation, as must be, indeed, natural. It would be a very tactless mistake to put the observer in the position of a spy who is noting something which the worker is assumed to wish to conceal. Taylor and Thompson say in "Concrete Costs," that the practice of observing a workman's time of doing an operation without his knowledge is to be deprecated generally, but may occasionally prove useful or necessary. The main thing, apparently, is not to be detected in the act! Of course, only the very simplest apparatus could be used for observations of this kind, and the more recent workers favour rather elaborate machines and methods, which must be in evidence.

Detailed advice as to the actual use of a stop-watch is given in the articles on time-study mentioned in the text, in Taylor's "Shop Management," and in Parkhurst's "Applied Methods of Scientific Management"; while the more elaborate machinery is described in Mr. Gilbreth's "Motion Study," and in recent magazine articles on his work.

When the proper kind of observer or observers has been installed, the next matter for careful choice is the workers to be observed. The foundation of the approved method is very often some method by which an individual, or several, has obtained notably good results, when all have been left to choose their own way of working. It may then be said that the best worker (or workers) is taken as the basis of observation. A choice of the kind seems *a priori* obvious, and to entail a compliment to the worker; but those who know the history of piecework rates will realize at once that this is thorny ground.[1] When starting on adjustment of methods the management must have a thorough intelligent grasp of all the previous events in the works that are relevant to the matter, and the effect that has been produced by them in the workers' minds.

In Mr. Sanford Thompson's article on Time-Study,[2] he states that workers under observation by the investigator were always paid a 50 per cent. increase on their ordinary wages. Dr. Taylor speaks also of paying men twice their usual wages when observations were being made on their work.

[1] See chap. xiii. Even in cases where there have been no previous disputes, a very bad impression can be produced if it should appear that the best worker is chosen, and is then given unusual and special facilities to speed him, just for the purpose of getting a short-time record, which, it is presumed, will afterwards be enforced on all. It will be clear to the reader that this is not the programme of real time-study, but if the workers should get the idea that it is, almost ineradicable bad feeling would result.

[2] *Journal of Political Economy*, May, 1913.

At the Ferracute Works 25 per cent. extra is paid.[1] The custom of making it worth the worker's while to have "the stop-watch put on him" (as the workers who have been irritated have phrased it), seems fairly well established, and worthy of imitation —though with some forethought and caution.

Mr. Sanford Thompson's article is one of the best that can be read on time-study; he analyzes the job of making a mould for concrete into its elements in a clear and lucid way which makes it quite a model for a time-study beginner.

Now as to the investigation. There are really two distinct processes necessary for each industrial operation studied, and the first must be fully carried out and completed before the second is attempted. The confusion of the two, in theory and in practice, has been another fertile source of the unpopularity of time-study.

The first process is primarily analytical and critical. It consists of dividing the operation into small elements, each a single motion, or two or three combined if they cannot be parted. The average time taken for each motion will be incidentally noted where feasible, but not much stress is laid on such time observation, as the motions themselves are about to be modified. These separate actions are now carefully studied in order to ascertain whether they can be simplified, rendered less fatiguing, or even omitted altogether. Time observations will be useful for purposes of comparison,

[1] Parkhurst, "Applied Methods of Scientific Management."

i.e., to discover which of two ways of lifting or pulling or placing will take less time, but the actual record of the times taken at this stage will have no per manent value.

The first stage of work, as outlined, is better described as motion-study. All sorts of changes in condition are suggested and tried, with the object of simplifying the motions. The position of the worker may be changed from standing to sitting ; from a low seat to a high seat. The material supplied may be put in a different place, or arranged so as to be taken up in a different way. The same applies to the tools used, and to the product as it leaves the machine or the worker's hands. Every general condition should be studied, at the same time, with a view to improvements ; the lighting of the work-place, conditions as to heat or damp, the dress and attitude of the worker—all have their share of attention.

The most interesting examples of this sort of work in the early pioneer days of Taylorian management will be found in the details of Dr. Taylor's work on shovelling, and Mr. Gilbreth's work on bricklaying. In the first case the best *weight* that can be carried in the shovel at a time, for continued work, was ascertained ; and then the size and shape of the shovel for carrying different materials were adjusted.

In the second case the changes made were chiefly in the way in which the bricks were supplied to the worker, the height at which they were placed in

reference to his body, and the rearrangement of the motions by which he spread the mortar and put the bricks in place. The trowel and the mortar-carrier were also constructed according to a new device. The actual number of necessary motions to lay one brick was decreased from 18 to 5.

The effect of Dr. Taylor's study of shovelling was to increase the number of tons of material handled per man per day from an average of 16 tons to an average of 59. Mr. Gilbreth's bricklayers, after being trained in his methods, could lay as an average 350 bricks per man per hour, whereas 120 bricks per man per hour had been the average.[1]

While acquainting ourselves with extremely interesting results of this kind, emphasis must continually be laid on the new feature in these studies of operations—the " taking the job apart " into small elements. In older methods of time determination the whole time of an operation was observed ; and a shorter whole time proposed, usually by guess-work. Taylor found that the only way to establish a case for the possibility of quicker work was to take each action separately and constitute a just and right time for it. This was the great innovation ; but Taylor found also that it was of the utmost importance to see that everything in the situation was helping towards quick work, and nothing hindering.

[1] " Principles of Scientific Management," pp. 71 and 81. It should be remarked that the bricklayer received a little more help from his labourer by Mr. Gilbreth's arrangements than he did before ; *i.e.*, the labourer arranged his bricks for him more elaborately than before.

I. Study of the motions of a Champion Golf-Player; his head, right hand, and the end of the club being outlined. The clock and the squared background are to be seen.

Photo by Gilbreth]

[*Face p. 89.*

Just as in machine motion ordinary friction must be eliminated to the greatest possible extent, so all little frets and hindrances, and awkwardnesses that clog human motion must be smoothed away as far as possible, if there is to be no waste of energy.

Mr. Gilbreth has perfected designs for reproducing small and rapid motions with almost incredible accuracy. In one method a small electric light is fixed to the moving hand or tool, and a photograph is taken of the path described. In Illustration I. the motions of the head, hand, and end of the club of a champion golf-player are reproduced. By placing an interruptor in the electric circuit an intermittent line of light is obtained which will give the time of the motion, and can be arranged so as to give its direction also. Wire models can be made of this kind of photograph.

A second way is to use a kinematograph, with stereoscopic adjustment and taking forty-eight pictures a second, to record the successive attitudes of an operator's whole body. Time is recorded by including in the photograph a clock showing hundredths of a minute, and distance by a background marked in squares, which need not be *behind* the operator, but may occupy any plane in the picture if *previously* photographed. The motions taken by these means can be shown to workers at a slow rate as model operations. A point that is very remarkable in the photographed motions of an expert of any kind is the precision with which they are repeated, the successive curves being often

indistinguishable in position; whereas the motions of a less expert person are liable to diverge considerably each time the action is repeated.[1]

The reader may be inclined to pause here to ask, Is this close study of motions really worth while—worth the time of a skilled man and worth the expense entailed? With regard to the expense of taking moving pictures, Mr. Gilbreth has evolved a method of making the ordinary sized film serve four or five times over by using only a strip of it. (See Illustration IV.) However, what has to be ascertained carefully, when an installation of instruments for time-study is made, is that sufficient use can be made of the results. To begin with, operations are classified generally into those which are somewhat monotonously repeated many times, and which are undertaken by a large number of operatives—the regular routine work in the industry, in fact. Most people would admit the value of making a somewhat elaborate study of motions and conditions here, so as to get "the one best way" of proceeding.[2]

Other operations are classified as "miscellaneous"; there is much variety about them, and each

[1] See F. B. Gilbreth, "Motion Study." Also articles in the *World's Work*, July, 1916. And Illustrations II., III.

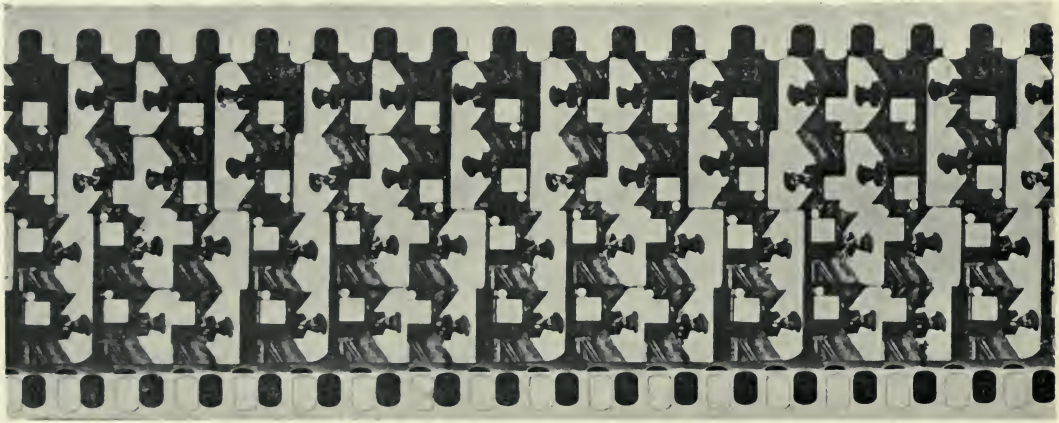
[2] Suppose that six seconds can be saved on an operation lasting 60 seconds, a gain of 10 per cent. An operator who did 50 in an hour could now do 55. If 100 workers were working 8 hours a day each, each would do 40 more in a day, and the general increase in output would be 4,000 per day, on a previous total of 40,000. Assuming that each article is worth only 1d., the result of this single study would be a saving of some £600 per annum, which might very likely cover the expenses of the time-study staff.

Movements entailed in loading 16 boxes on to a "move-truck."

II. Old method. III. New method, after elimination of wasteful movements.

Photo by Gilbreth.]

[*Face p. 90.*



IV. A Cinematograph Photo, showing how one film is used for four sets of movements.

Photo by Gilbreth.]

[*Face p. 91.*

may not be performed many times in a week or month, and not by many people. Is it worth while to put the time-study men on to these? It is here that the value of analyzing operations into small elements appears. Many miscellaneous jobs are made up by combining a comparatively small number of elements differently; and if one knows the time for each of these, the time for even a new miscellaneous job will be almost determined by putting them together; just a few special observations on the combination may be needed, and possibly a few new element determinations.

This way of regarding different jobs as to a large extent made up of the same elements has strongly impressed itself on all workers at time-study—so much so that the permanent value of getting the best possible way for each of certain elemental motions has been recognized. Since Dr. Taylor first made the suggestion in his article on a Piece-Rate System in 1895[1] there have been numerous appeals, by those interested, for a pooling of the results obtained in timing the elements of industrial operations; so that all manufacturers should benefit by the records made in one establishment. It has been hoped that the United States Government would start a Bureau of Information on the subject. Unfortunately, so far, very little has been accomplished towards this end; it still remains an

[1] To be read in C. B. Thompson's collection of papers; see also "Shop Management," p. 177; and, on the same subject, the closing paragraphs of Gilbreth's "Motion Study."

unrealized aspiration. But the amount of literature on the subject of time-study which is now published brings the possibility distinctly nearer, and a large number of workers have constantly followed Dr. Taylor's excellent example by making their results as widely known as possible. There is still, however, the struggle of opposed temperaments, and of opposed incentives; between the impulse to keep a discovery from one's competitors and the impulse to let a good piece of work accomplish all that it can in increasing human knowledge and capacity.

Mr. Gilbreth's published work on Motion-Study is a very considerable contribution to the stock of general knowledge on the subject, and presents facts of the greatest importance in industrial matters, [1]

[1] In the preface to the book an interesting anecdote is given of Mr. Gilbreth's rapid diagnosis, criticism, and improvement of an observed motion. He saw a girl worker at one of the Industrial Exhibitions in London putting paper covers on small round boxes filled with a polishing material. She was pointed out as an unusually rapid worker; he timed her as doing 24 boxes in 40 seconds. He ventured to suggest to her a new disposition of the material and motions, which she tried with much scepticism. At the first attempt she did the 24 boxes in 26 seconds; at the second attempt in 20 seconds, and she was not, she admitted, "working any harder."

Mr. W. Ennis gives, in *Industrial Engineering*, vol. ix., p. 462, a very interesting record of elementary motion-study in a college where the students were put to arrange in proper order sets of mimeograph notes when they had been received from the apparatus with sets of the duplicated pages. The operation was first performed in a haphazard way; and then repeated after a sensible plan of action had been thought out—for the sake of comparing the times. The adoption of a careful method of distribution thoroughly justified itself. Operations such as stamping envelopes, or inserting folded papers in them, will occur to everyone as worth systematizing. But Illustrations V. and VI. will show how much can be accomplished by ingenuity in devices.

V. Showing parts of Braiding Machines in bins. This was the method before motion study was introduced by Mr. Gilbreth. Output, 13 machines a day by one man.

VI. Showing improved method of keeping loose parts hung on a "packet" on wall—table at proper height—and other parts in sloping rack on same. Output, over 60 machines a day by one man.

[*Face p. 92.*

although we may not be able to follow him in considering that the application of criticism, followed by reform, to all our motions is the next really important step in civilization. It is, of course, very easy to turn this idea to ridicule. Nevertheless a moment's thought will lead us to conclude, from everyday experience, that the exact method of manipulating an ordinary tool or machine has a great effect on our efficiency in using it.

A typewriter is a striking example. Most modern forms are planned to minimise and facilitate the motions of the operator, and one of the essentials in learning type-writing—in fact, the thing that makes it worth while to have lessons at all—is to acquire, from the first, the correct method of fingering the keyboard. And here we may note at once that greater speed does not necessarily mean greater fatigue, but rather the reverse, when the speed is attained by long practice in the best sort of motions, *i.e.*, those most economical of energy. It is palpably absurd to conclude that a professional typewriter typing 60 words a minute is four times as tired as the amateur who gets down one-quarter of the number, on home-grown methods. Doubtless the latter becomes considerably more tired in the same time. It is not practice only; it is practice in the least tiring motions.

On a higher plane than mechanical work, in artistic work, there has rarely been any doubt as to the value of learning the right motions. It is a commonplace among music teachers that the right

motions for the piano and violin must be used from the first, if the pupil is to attain real facility. For facility means minimum effort, and the best motion is the one which produces the desired effect with the least fatigue.

Returning to the industrial plane, stress is naturally laid chiefly on the fact that the best motions are generally the quickest motions, and therefore produce the best output. But stress is also laid by the instructors on the value of adopting the right motions *from the first.* The work of Mr. Gilbreth and others has established results so marvellous in saving time that it is no wonder that employers who hear of them are tempted to try the new methods of management by taking time and motion-study as a first step. Then, owing to too great haste in their experiments, and to beginning in the wrong place, they have often found scientific management a complete failure, and have brought the Taylorian methods into bad repute. Brief statistics have already been given as to the saving of time effected in shovelling and in bricklaying. Many people also must have been fired with emulation after reading of the operation at the Watertown arsenal. The making of a mould which used to take 53 minutes was reported by the time-study expert as easily made in 24 minutes. After some practice the average time taken by the men was 20 minutes, and one man turned them out during a whole day at an average rate of 16 minutes to each.

But we have already been tempted into statistics

of this kind before we have finished outlining the procedure by which the standard method of work is evolved. Indeed, we have divagated considerably from the direct path of describing the studies necessary. However, these wanderings from the mark will point the moral that the establishment of these methods is a long business, particularly for the first two or three operations that are undertaken, and involve the consideration of a great many side issues.

When the first stage of analysis is over, and the consequent modifications have been made in the motions, and in both the particular and the general conditions under which they are made, the *standard method* can be formulated, and the real time-study, on that method, can be made. That is, it will now be worth while to discover as accurately as possible what time each element in the standard best way ought to take. Either the simple stop-watch equipment or one of the photographic methods may be used.[1] All time-observations done previously will have been only for comparison of different ways. Now the time for each element will be precisely determined by taking the average of a good many observations, and these added to produce the whole time for the operation.

[1] Mr. Gilbreth urges that the older stop-watch method is not good enough, particularly for results to be permanently kept and universally used; that the photographic method gives the only reliable statistics, which are not open to dispute.

CHAPTER X

STANDARDIZATION OF METHODS

(Continued)

B. Fatigue-Study

But a very important new feature usually appears as a part of the grand total—the allowance for rest. This, again, is made as far as possible after careful collection of experimental data, and these experiments and observations are known by the title of Fatigue Study.

When Dr. Taylor's attention was first drawn to the necessity of some allowance of the kind, he was not able to find very much information in the literature then published which dealt with the question of fatigue, especially as very little work had been done on industrial fatigue. He set on foot experiments which he planned himself, with the object of discovering "some rule or law" to enable one to "know in advance how much of any kind of heavy labouring work a man who was well suited to his job ought to do in a day."[1] No information that he was able to get in French, German or English gave him a clue to any "law," and his two first series of experiments brought him no nearer. After he had taken a third set, all the data were given to

[1] "Principles of Scientific Management," p. 53.

his mathematical friend, Mr. C. G. Barth, who finally evolved a numerical expression which was as much of a "law" as Taylor wanted—a working hypothesis at least which lent itself to computation. It gave the percentage of the working-day during which the man's muscles might be under strain. For very heavy work, such as handling pig-iron, the percentage was 43; if the work was lighter the percentage of time under load might be increased.[1] Besides being applicable only to severe manual labour, this method of computation will seem generally very crude; but it served its immediate purpose very well—except that the duration of continuous time for work before a suitable rest-time was given seems to have been at first left to the individual instructing the worker. We shall see that this is an important point.

Since this original investigation by Taylor a good deal more attention has been paid to fatigue by both physiologists and psychologists; and there is now a good deal of valuable information accumulated, and accessible to all. But there is still something to be said for making a special study of the fatigue phenomena on the spot, and for each important industrial operation. Mr. Gilbreth points this out in his little book on Fatigue Study, in which he urges that managers should give some of their own time and energy and thought to first-hand observations in their works, and should also endeavour to

[1] 'Principles of Scientific Management," p. 57; see also note, p. 112.

get every worker to take a personal interest in the subject, as a duty to their employers, as well as to themselves.

Among publications which are specially valuable to employers and managers, we may mention Miss Goldmark's "Fatigue and Efficiency," which contains, among other matter, a summary of the most important general physiological work on fatigue; and Muensterberg's "Psychology and Industrial Efficiency." Both these are American, and Miss Goldmark's own researches were carried on entirely in the United States. In England a British Association Committee is now working on industrial fatigue, and has published a first report in 1915, and a second in 1916. More recently the Ministry of Munitions has initiated enquiries into the health and the fatigue of munition workers, and reports are now (1917) being published.

The value of all these investigations is far-reaching. Probably the most important questions to which it contributes are, the proper number of working hours in the day, the necessity of the week-end rest, and the effect of overtime. We shall refer to these again later on. But the bearings of the study of industrial fatigue on the setting of a time-rate will be seen by quoting a few generalizations from these books and reports.

We learn from the physiologists that tired muscles pass into the blood certain products of their activity, which are poisonous, in a mild degree, to the whole organism; and thus the effect of tiring particular

muscles is distributed, giving a general sense of weariness. These products must be eliminated before the weariness can disappear. Meanwhile, if the tired muscles are still used, greater energy is required to make them contract properly, and the fatigue-products accumulate at a greater rate. There is great waste of energy in continuing work after fatigue has set in. Whereas a rest of half an hour will be sufficient after a certain amount of exertion, twice that exertion will need more than an hour's rest, very likely two hours. There is no simple proportion rule between exertion and rest. Therefore rest periods must come betimes, and not be postponed.

The question of nervous fatigue is much more complex. Feelings of weariness, being partly nervous and partly muscular, cannot be taken as sure guides to the actual amount of fatigue.

The estimation of actual amount of fatigue is not, indeed, a simple or direct matter. In industrial investigations two methods have been adopted to indicate numerically in some way the accumulation of fatigue. One is the diminution of output per hour; the other is the increase in the number of accidents per hour. It has been established, with at any rate a large degree of probability, that relaxed attention due to fatigue is responsible for a considerable number of accidents.

Both methods show that fatigue usually sets in very notably after two or three hours' consecutive work; though it should be added that the nature of

the work affects quite definitely the duration of the spell before fatigue effects are noticed. Some very light and monotonous work can be carried on more consecutive hours than the average. Two quite remarkable phenomena have also come to light: one is, the lag behind at the outset of work—hardly anyone succeeds in getting their best output in the first hour of work; the other is an unconscious increase of alacrity in anticipation of a break in work, shown very clearly before the dinner-hour.

After fixing what is to be done in a certain time—what is known to American writers as the standard task—it is usual to allow and to map out definite rest periods. These are, as a rule, exactly prescribed to the worker, as Taylor prescribed them to his men carrying pig-iron, and are not allowed to depend on his feelings. The old-fashioned type of management has been accustomed to dispose of the question of fatigue to a very large extent, by giving some "change of work," which was believed to be "as good as play." It allowed, indeed expected, the workman to stop his work to hunt up some implement, to grind a tool, or to carry something somewhere. These forms of relaxation are certainly not part of scientific management. The workman tackled the matter of fatigue quite simply and naturally by slacking when he felt inclined; but the votaries of efficiency disapprove of slack work at all times, and particularly when expensive machinery is running. The new plan is to give a definite break, with real cessation from any duty or occupation, and

as much ease of body as possible. To rest just when told to is perhaps not easy to most temperaments, but if the plan is obviously successful it will no doubt be accepted on its merits in each case.

Mr. Gilbreth urges in his "Fatigue Study" the provision of quite generous rest allowances even before there has been any attempt to determine by scientific methods what rest is necessary. He believes in the practice of general maxims of this kind: Give rest wherever there seems need. Provide a resting-chair for every worker without exception. It is the worker's duty to take rest. And so on.

In the well-known instance of the amazing improvement made by Mr. Sanford B. Thompson in the work done by girls inspecting bicycle balls, the girls' hours per day were gradually decreased from 10½ to 8½, and recesses of ten minutes were given in the middle of the morning and the middle of the afternoon. The shorter hours and the prescribed rests certainly increased the girls' power of working in a marked degree. Finally, 35 girls did the work of 120, and the accuracy of their inspection was meanwhile notably increased. The 35 girls were, however, the picked ones of the whole set, and doubtless had special physical qualifications which made for quick and unerring judgment. They practically doubled their former wages; and there is no doubt that the psychological effect of their all-round success was good, and tended somewhat even to decrease fatigue, of the nervous kind.

A remarkable case of decrease of fatigue owing to a change in the arrangement of rest periods is given by Mrs. Clark and Miss Wyatt in their study of women workers.[1] The girls employed on rather monotonous work in a bleachery were allowed two periods of ¾-hour rest in the day besides their dinner-time of three-quarters of an hour. Under Mr. H. L. Gantt's management they were given spells of 1 hour 20 minutes' work, 20 minutes' rest, throughout the working-day, with an arrangement of "spare hands" which obviated any break in the work of the machines. The girls' output was increased about 60 per cent. and they were able to earn about 50 per cent. more wages.

The authors observe that in another part of the factory the girls were allowed to choose their rest-period, and chose two long ones, during which they usually did fancy-work. The result was not as satisfactory.

We have already said that Mr. Gilbreth advises works managers to make the question of fatigue their own immediate personal concern, and work it out for the special conditions of their own works. If carried out with tact and real consideration the enquiry should certainly make for much better understanding between management and workers. It may be suggested that the adjustment of an industrial operation with the aim of eliminating un-

[1] "Making Both Ends Meet," by S. A. Clark and E. Wyatt. Quoted in Mr. H. L. Gantt's paper, "The Task and the Day's Work," read at a Dartmouth College Conference on Scientific Management in 1911.

necessary fatigue might possibly lead to a diminution of output, whereas an employer is supposed to be aiming continually at increase of output. He may be assured that nothing could be of better service to him in the long run than an object-lesson of this kind, showing that he is quite prepared for less output in an operation for the sake of the smaller amount of fatigue generally caused to the operator, and that he knows it will not " pay," in any sense, to have an over-fatigued worker.

CHAPTER XI

STANDARDIZATION OF METHODS

(Continued)

C. The Schedule Time or Standard Task

THE final product of all these careful studies is the fixing of a proper time for an operation, when it is performed by a standard method under standard conditions. In some works this time is spoken of as schedule time simply; but the expression "standard task" has been more common. Dr. Taylor used the word "task," though he deprecated the unfortunate connection with "slave-driving" given by adopting the word, which suggests some objectionable pressure on the worker.[1] Mr. Gantt has made the word entirely his own by calling his method of remuneration the "Task and Bonus System."

Dr. Taylor suggested, and the point is urged more strongly by Mrs. Gilbreth in her "Psychology of Management," that the general mental effect of having a definite amount of work to do in a certain time is helpfully stimulating; and that people often prefer working towards a definite goal. The *Psychological Review* for 1906 contains an interesting

1 "Principles of Scientific Management," p. 120.

contribution on this suggestion by a psychologist, Mr. W. R. Wright, who does not appear to have been at all aware of Taylor's industrial methods at the date of his experiments (1904-5). His general conclusions were—

1. The subject accomplished more work when working under the mental stimulus of having a set task to be performed than he did when working without a definite aim.

2. A known impossibility to accomplish the required condition tends to decrease the subject's total results.

3. The fatigue accompanying work is not so great when the subject is working under the direct stimulus of a definite aim, notwithstanding the fact that he has at the same time produced an increase in his amount of work.

These conclusions seem certainly favourable to the idea of a standard task, not too difficult. The work done was muscular. A good many experiments were tried, but the number of individuals who were the subjects of experiment was small. Two women were included, and about half a dozen men. There was some considerable amount of variation in the percentage changes for different people.

Mrs. Gilbreth also deprecates the word "task," and would like it to be changed to "stint." This has been used in certain industries in England, but

sounds strange to most of us.[1] Mr. Emerson has said in an interview that he "hates the word 'task.'"

There is not much difference in meaning between standard task and schedule time, except that the former specifies the work to be done in a fixed time, and the latter specifies the time to be taken for a definite operation. The latter is certainly free from any prejudice or misunderstanding. The idea is inherent already in a large amount of engineering, if not other industrial, work. Many operations, like the driving of a locomotive for passenger-traffic, *must* be performed in their allotted time; and in scientific management the process of routing, and the endeavour to formulate a strict time-table for each shop, necessitates as much as possible of the whole industry being "scheduled" as to time.

Nevertheless, we must treat chiefly of the "standard task," as the expression has been adopted so completely by the Americans. This standard has to be set up with extreme care and forethought, because the whole system of records and rewards is based upon it as an unalterable foundation. All that can cause it to change is a serious change in the method, or the conditions of work. Otherwise, it is

[1] See Schloss, "Methods of Industrial Remuneration," chap. i. Schloss refers (pp. 48-49) to the existence of a task-wage in certain English industries, in which a definite amount of work was insisted on to obtain the day-wage, and says it was regarded with "extreme dislike"—another unlucky circumstance for the use of the word.

the constant in negotiations and calculations.[1] Mr. Gantt says that the setting of each of his tasks meant at least a year's preliminary work at time- and motion-study, general or special, and in some cases two years.

We have seen that the operation has been examined, element by element, to find the best way of performing each, and to improve every surrounding condition; that the time of a good worker to perform each element has then been ascertained, and a total time obtained by addition. Allowances are then made for rest and for delays that cannot be avoided. Finally a percentage is added to the best possible time to transform it into the usual time which a worker should take, after the approved method has been acquired.

It is the fixing of this percentage increase in time which is not an easy matter. The principle that there should be an increase is laid down quite clearly by all scientific managers, from Taylor onwards.

[1] In Mr. Sanford Thompson's articles on time-study, to which reference has already been made (p. 85), he advises the approaching of the schedule time gradually, with the object of making it an unalterable quantity when finally fixed. Thus (p. 386): "In beginning tasks on a certain line of work it is frequently advisable to give a longer time than will be adopted permanently; provided, however, it is clearly stated to the operatives that this is simply temporary, so as to enable them to become accustomed to the new methods, and provided it is also clearly stated that after a certain fixed period the rates will be changed to new definitely-stated figures. These permanent figures must be given out before tasks are begun. *Never change this regular rate unless radical changes in methods or machinery are made by the management, and then only with the consent of the operatives.*"

A worker must *not* be worn out by continuing to accomplish, or attempt, the standard task. It must be fixed so that he keeps in good health physically and mentally, and thrives generally as he goes on. There must not be any chance of his being " too old at forty." The managers contend that any other way of using an employé is not good business, not real efficiency. It is certainly obvious that when a management has given time, thought and energy to training its workers in its own methods, it will be extremely loth to lose their services ; in fact, it will pay better neither to exhaust them nor to quarrel with them.

Although overworking the operator has been so strongly deprecated, there has been great misunderstanding on this subject. One may suggest that this has partly been brought about by the very frequent use of the expression, a " first-class man," as being put on the job, giving the impression that the task set is not within the power of many of those who are asked to attempt it. Dr. Taylor constantly uses this expression. His " first-class man " was not found ready-made ; he was to be a man with some natural aptitude for the particular work, who was then specially trained to do it in the ascertained best manner. The inducement offered for him to place himself under an instructor who claimed to know more about his work than he did was of course a substantial increase of wages, and with this attraction there was usually no lack of supply of the right kind of man. Taylor's early

experience was with workmen for whom a high standard of physique was absolutely necessary, and therefore he exercised more vigorous selection to secure his first-class man than would be needed in ordinary operations. He was therefore led to make pronouncements which have often been quoted against him; *e.g.*, that when an establishment is very well organized, "*in many cases* [italics ours] the task shuold be made so difficult that it can only be accomplished by a first-class man," [1] and that finally, in the Bethlehem Works, the task was "so severe that not more than one out of five labourers . . . could keep up." [2] Such cases are certainly the exception much more than the rule. In Mr. Gantt's training of factory girls he has been able to make the large majority of each set into "first-class workers," chiefly by the exercise of patience and tact.[3]

Mrs. Gilbreth in her "Psychology of Management" does her best to get a clear definition of a task, and of a first-class worker, but seems to cause some fresh confusion by speaking of a "standard man," who does not perform the standard task, but actually makes the best time—makes the record, as we should say. Her definitions dovetail into each other thus:—

"The standard man . . . is the fastest worker working under the direction of the man best informed in the particular trade as to the motions of

[1] "Shop Management," p. 64.

[2] *Ibid.*, p. 54.

[3] See "Work, Wages, and Profits," especially the charts

the best present practice, and being timed by a time-study expert."

" A first-class man . . . is the man best fitted by nature and by training to do the task permanently, or until promoted."

The " given man " is stated to be anyone set to do the work, who has not necessarily the qualifications of a first-class man.

" The task is that percentage of a standard man's achievement that the given man to whom the task is to be assigned can do continuously and thrive, that he can do easily enough to win his bonus without injuring himself, temporarily or permanently, in any way."

These statements bring us back to our first enquiry—what is this percentage to be? It evidently depends on whether Mrs. Gilbreth's " given man " is a " first-class man " or not, and is therefore variable. It is here that the " human element " appears among the scientific determinations. One important criticism of scientific management is that the scientific method will not apply to human work, and we can see that such a criticism bears on this instance. The shortest time for an operation on the best method can be determined with scientific precision. This minimum is not to be prescribed to the average worker. But if the average time taken by a set of workers when they are first put to the job is adopted, it will be too great, as after some practice their speed always increases. Mr. Gantt gives a good example in his latest book. An operation took

on an average 2·17 minutes. After the method had been modified the worker took 1·6 minutes. In a short time she took only ·5 minute. He says[1] "Inasmuch as any large reduction in the time of an operation is usually made by a change of method, it is necessary to get the operator out of his old habits and train him in new ones."

The scientific managers make it quite clear that they have no scientific law for adjusting the standard task or schedule time between the minimum and the learner's average; they make a rule, but are governed by circumstances in making it. Mr. Gantt is obviously fully aware of the difficulty, and the nature of the criticism, and has stated very well the conditions which primarily govern the choice of the percentage. The time allowed must be liberal—a good worker may often take less, and profit by his celerity—so that failure is not easily caused by any small contingency, for failures will occupy the time of the foremen and investigators in finding out how the worker can be helped to make good. On the other hand, he finds that he gets better work all round if the task is not too easy and requires undivided attention. In his work with girl operators, quoted above, the minimum time (about ·5 minute) was increased by 30 per cent. The result in six months was that most of the girls had exceeded their task by 30 to 40 per cent. in their output, and their wages by 50 or 60 per cent., which was considered very satisfactory on both sides.

[1] "Industrial Leadership," p. 76.

Mr. Knoeppel in two articles on time-study[1] states also that there can be no absolute rule as to a fair standard; but that halving the difference between best time and average time has given very good results.

Mr. Emerson's standard is 50 per cent. of his fastest worker's achievement.[2]

At the Watertown Government Arsenal an allowance as large as 66⅔ per cent. on best time was given. In the experiment quoted on p. 94, the best time being determined as 24 minutes, 40 minutes was made standard; and most workers soon accomplished the work in less—one in 20 minutes, as related. It is noted that initially the workers, before they had tried, were extremely sceptical that the work could be done in 40 minutes.

Mr. D. V. Merrick[3] attacked the problem by the direct use of statistical methods, in which perhaps few will care to follow him. He computes the average time taken by each *element* in the operation, also the shortest time for each. Dividing the first by the second, he obtains the percentage *deviation* (the percentage that the minimum is below the average time). This number is obtained for every element in the operation, and the average is then

[1] *Southern Machinery*, vol. xxxi.

[2] Interview with Mr. R. G. Hoxie; see the latter's book, "Scientific Management and Organized Labour," p. 156.

[3] Paper on Time Study read at the Efficiency Society Convention at Lake Placid Club, September, 1915. This is a very useful paper, and gives, among other valuable data, Mr. Barth's formula for the estimation of percentage for fatigue allowance, to which reference was made on p. 97.

obtained and called the *standard deviation.* This percentage of the average time is taken as standard time.

It should be remarked that the observer, before computing average or shortest time, rejects any recorded times that seem to him anomalous, whether too high or too low. Also that each set of computations is made on the work of a single man; but a number of men may be separately studied and the results compared. The method seems to have given good results.

It will be noticed that some of the expedients tried use both average and shortest time as a basis; others only the shortest.

It will very probably occur to the reader after reflection that the percentage allowance on best time must really be influenced by the economic situation with regard to labour. The first result of the time-study experiments, if their effect is according to anticipation, is to increase the productiveness of the workers. This may lead directly to increase of output, or it may lead to diminishing the number of workmen employed on these particular operations. Thus the girl inspectors of bicycle balls (see p. 101) were considerably reduced in number. Taylor's shovellers at the Bethlehem Works were reduced from between 400 and 600 to about 140.[1] It is not to be assumed that the girls or men taken off these jobs were dismissed; most of them probably had other work found for them in the same industry. But if

[1] "Principles of Scientific Management," p. 71.

these particular operations could be so arranged as to give the original output from much fewer workers, then the task can be made fairly severe, and only the more capable people kept. There will be a process of selection, such as Taylor was often able to carry out. But this is where there are plenty of labourers to be had. If the supply of labour is short, and again if a considerable increase of output is desired, the standard task must approximate more nearly to the average, for more workers must be able to reach it. Taylor discusses the matter from this point of view very fully and frankly on p. 175 in "Shop Management," admitting that "the precise point, between the average and the first class, which is selected for the task, should depend largely upon the labour-market in which the works is situated." At the same time, he says that at Bethlehem he was always able, by the increase of wages offered, to get plenty of first-class men, although "labour was as scarce and difficult to get as it ever has been in the history of this country."

The subject will be under consideration again in chap. xvi. on Education.

It is rather evident that the changing conditions of labour in the United States have had some considerable influence in producing the tendency in more recent scientific management to much less screwing up of the standard than was done in Taylor's early work. Taylor was often able to realize the very natural ambition to exhibit a picked team of superlatively good workmen.

So also the more modern managers are usually extremely unwilling to dismiss any worker who has failed in reaching the standard prescribed for any job, unless he is obviously and generally unsatisfactory. The capacity of the worker has been studied, and the particular reason for his not coming up to standard has been noted. Unless labour should be extraordinarily plentiful, *good* management will always try to select some different work for an employee, whose good and bad points have been tested, unless the latter greatly preponderate. Scientific management rests on *specialized functions* as one of its essentials, and therefore expects to have to test, select, and train its workpeople ; it is on the look-out for special aptitudes and special weaknesses, to come out in the time of trial.

In conclusion we may say that it seems well established that the difference between first-class work by proper methods, and average work where the operator evolves his own method, is far greater than employers or workmen have ever imagined. According to Taylor, three times the quantity of work (always undiminished in quality, if not improved) is no overstatement. It has been said that he would always guarantee twice as much. Certainly many results obtained by students of motion like Mr. Gilbreth and his disciples have been startling and gratifying, and have quite justified the outlay of money on time-study as a lucrative investment.

Occasionally, of course, the method that has been spontaneously evolved by an expert worker may

leave little room for suggestion or improvement, though even then some trouble will have to be taken by the management to see that his method is demonstrated to, and adopted by, others. But it is not at all common for a single worker to have struck out the best way unaided. The reason, no doubt, is because the idea of studying industrial motions with the object fo preventing waste of energy is comparatively so recent.

CHAPTER XII

STANDARDIZATION OF METHODS

(Continued)

D. The Instruction Card

THE worker who is to operate by standard methods, and to aim at accomplishing a standard task or achieving an operation in standard time, is provided with an Instruction Card.

Specimens of the forms used in different works may be found in books or magazine articles describing and illustrating their working.[1] They follow much the same general lines. The more elaborate ones are usually chosen for reproduction. The extent to which cards like these are actually used varies somewhat with the kind of job for which directions are issued. On a job which is simple and means a good deal of repetition work, an operative may soon dispense with his card, because he knows it by heart ; on the other hand, a very unusual job may not have had its details standardized to the

[1] For instance, Ferracute Machine Co., in " Applied Methods of Scientific Management " by Parkhurst ; " The Making and Use of Instruction Cards," by F. B. Gilbreth, *Industrial Engineering*, vol. xi., p. 381 ; " Instruction Card for a Turret Lathe," by H. W. Reed, *American Machinist*, vol. xxxv., p. 688, vol. xxxvi., p. 915. Mr. H. L. Gantt has several in " Work, Wages, and Profits," pp. 264-267, and another in his article, " Practical Application of Scientific Management," *Engineering Magazine*, vol. xli., p. 6, and another in *System*, vol. xx., p. 402 ; this last is reprinted in the popular book, " How Scientific Management is Applied," p. 27.

right amount. But between these two extremes, the document is not only useful, it is necessary to the full application of time-study methods. It is the written communication of what the standard task is, what reward is given for executing it, and how exactly it is to be undertaken.

In its proper form all details which are variable are omitted—details such as the date, the name of the worker, the particular machine, and the time actually taken for a single attempt at doing the task; the card has a stereotyped form, and is made strong enough in mounting to stand a good deal of wear and tear, and to be ready for constant use. When not in use it is preserved and filed.

Some cards, however, have blank spaces for filling in the details appropriate to a single use of them, spaces which have to be filled up by a foreman as a record of an individual operation after its completion. These forms are used only once. Most establishments find it better to have a separate card for details that are entered each time the job is performed, and call this the operation- or the time-card. If reference is made to the instruction cards mentioned in note, p. 117, the reader will see that most of them are really operation cards, because blanks are left for the details, varying each time the card is used. The procedure is evidently rather different in different works. The example here reproduced is the instruction card from Mr. Merrick's paper on Time Study (see p. 112), and refers to the stitching, by machine, of a cushion for an automobile seat.

FROM	INSTRUCTION CARD	MATERIAL Leather	MACH. 4XE	OPERATION DTAM	DESIGN SC6C4

FRONT CUSHION TOP
NAME OF STOCK OR PIECE

Stitch Pleats
OPERATION

MACHINE TIME: 9.00 Min
HAND TIME PER PIECE: 3.60 Min

DETAIL INSTRUCTIONS

		ALLOWED TIME	CUMULATIVE TIME
1	Change card at window	2.00	
2	Return to work	.60	
3	Get stock from rack	1.00	
4	Prepare bobbins & re-thread needles (0.0017 per inch of stitching XSC4")		.16
5	Land top on machine & start at "A"		.15
6	Stitch from A to B		.07
7	Move top over & start at "C"		.12
8	Stitch from C to D		.23
9	Move top over & start at "E"		.18
10	Stitch from E to F		.23
11	Move top over & start at "G"		.11
12	Stitch from G to H		.14
13	Partly turn top & start at E		.18
14	Stitch from E to G		.07
15	Move top over & start at "C"		.13
16	Stitch from C to I		.22
17	Move top over & start at A		.16
18	Stitch from A to H		.22
19	Move top over & start at B		.17
20	Stitch from B to F		.14
21	Remove & land top on pile		.12
22	Remove stock to rack (Finished Rack)	.1:00	
23	Get card signed	2.00	
24	Take to window	.80	
		7.00	
	Allowance on Fatigue --	2.00	
	Preparation --	9.00	
			2.70
	Allowance for Fatigue-		.81
	Time per piece ----		3.51

WHEN WORK CANNOT BE DONE AS SHOWN, REPORT MUST AT ONCE BE MADE TO FOREMAN SIGNED THIS CARD.

DATE 1/20/15

SIGNED BY D.V. MERRICK

The times given for each element are not, of course, the minima recorded, but those to which some percentage has been added to bring them within the reach of the average worker, as indicated in the last chapter (p. 107). Another allowance is added, in this instance, to the total time, definitely for fatigue. In other types of card the allowance is different according to whether it is "handling" time or "machine" time. The former is always much larger. Most of the exponents of instruction cards state that this general allowance is for fatigue, and for inevitable delays. Sometimes fatigue allowance is left out, because it may prove a simpler arrangement to give a rest allowance apart from the task, and, also, the delays may have been eliminated from the ordinary routine. This is the case with Mr. Gantt's employment of girls in the bleacheries (see p. 102), and in his form of instruction card generally. The Ferracute card does not contain any reference to fatigue, and as far as can be ascertained from the book describing the Ferracute management, fatigue allowances are not definitely made there.[1]

A complete instruction card for an engineering shop gives, when necessary, a sketch for the placing of the tools and fixtures, and a tool list; matters very important to the operator, but not affording material for discussion here. The same may be said

[1] By far the longest portion of this very useful descriptive work is taken up with standardization of equipment, and only a short portion devoted to time-study and to remuneration.

of the feeds and speeds to be used, and of the particulars about the bonus to be earned.

It has often been asked, Why bother the workman with these elemental times at all? Why not give him merely the total time in which the task has to be done? The answer seems to be, first, that he may know exactly how the total time has been obtained —not by conjecture or guess—and, secondly, that, if he fails, he can more easily identify the particular element in which he does not make good, and get the foreman, whose duty it is so to do, to investigate the cause and remove it. Just as in a good cost-accounting system a cost that seems excessive can be tracked to the particular item which causes the excess, so in a good job-timing system any loss of time can be similarly tracked. The operator can challenge any entry in the column for elemental times, and ask to have his time on the particular element observed or to have further instruction on the motions Of course, if the worker finds he is making good time and producing satisfactory work on the correct methods, he will not take further interest in the elemental times; then they need not be issued to him every time the job is repeated, but they must be kept ready for reference, or for fresh workers.

The efficiency engineer rejoices in the instruction card because it signifies to him the elimination of "rule-of-thumb" methods, either of doing a job or of calculating the time it ought to take. He contends, of course, that you cannot announce to a worker how long he should be over a long operation,

unless you both *time* its elements and say *how* each is to be performed.

This contention is met by critics with the objection that initiative, *i.e.*, choice and judgment, are taken from the worker ; and the objection is a sound one. The use of the card tends to produce a new kind of worker. It can be urged that his intelligence and initiative are directed into other channels. It is certain that a good deal of specialized intelligence will be necessary to comprehend fully and follow an instruction card. Mr. Gilbreth speaks of the worker learning the scientific way of looking at an operation. The mind of the worker is supposed to be occupied during his work partly by the interest of performing the operation in the right time, and seeing that all the circumstances are as they ought to be for that end ; and partly by his being on the look-out for possible improvements. It is constantly said by scientific managers that suggestions are welcome, and there are often schemes of rewards for suggestions ; but the rule is that suggestions from a worker are not considered before he has performed the task in the standard way.

No doubt workers will be very prompt to complain of any hindrance they meet with in getting on with their work, and with this and the other stimuli mentioned it would seem that they would need the qualities of " mental alertness and physical responsiveness " which one critic says it is difficult to preserve under this system.[1] There seems much to

[1] J. C. Frey, *Journal of Political Economy*, June, 1913.

prevent work under an instruction card from being monotonous. It may also be said that, quite apart from the bonus incentive, which we have still to discuss, the workers are encouraged to do well by the chance of promotion, as the instructors or demonstrators are chosen from the best workers. Mr. Gantt said in his evidence before the U.S. Commission :

" We get from our men . . . when we begin to instruct them, and they have the inspiration of the higher grade man who is helping them and not driving them, the material for more responsible positions."

There are obvious dangers, however, threatening the workman who is trained merely to more specialized work. It is said that he can be passed from one job to another when they are all standardized in the same way ; but it would seem that he would, as a rule, pass through a period of lower efficiency and therefore lower pay when thus changed. The length of the period varies through a large range (see last chapter), according to the novelty and difficulty of the new task.

Who makes out the instruction card ? For any form like the one reproduced on p. 119 several people must be responsible, each for certain entries. Most of it comes from the recorded data of the time-study men. Taylor's instruction card clerk or foreman was responsible mainly for distributing them, and filing them when not in use.

Occasionally gang instruction cards are used, and

given to the " boss " or foreman of the group. This departure from the principle of treating men individually may be necessary from the nature of the work; but is sometimes essential in the United States from having foreign workmen who cannot interpret a card in English. It is sometimes possible on Gilbreth's methods to give them diagrams and illustrations of method instead of written directions.

CHAPTER XIII

REMUNERATION UNDER SCIENTIFIC MANAGEMENT

In their campaign to ensure efficiency, scientific managers find it essential to adopt some scheme of remuneration which will reconcile the workers to certain of the changes made, and will stimulate them to do their best. In the latter aim their problem is very much the same as that of other managers. It would be impossible to give here an adequate account of the schemes that have been launched during the last few decades with the object of giving the workman pecuniary incentive to get as much work done as he can. But brief reference must be made to some of them, to compare them with the methods of which we have to give account.

When Dr. Taylor read his paper on "A Piece-Rate System" to the American Society of Mechanical Engineers in 1895,[1] his chief object was to introduce his hearers to the idea of time-study. Incidentally he sketched a "differential" piece-rate which he used to recompense his workmen in his new plans. He expressed surprise afterwards that thirteen speakers commented on the latter, whereas

[1] See *Trans. of Amer. Soc. of Mechanical Engineers*, vol. xvi. and C. B. Thompson's Collection.

only two discussed the former subject. One might suggest that his title was somewhat responsible for this. But the salient fact is that the engineers and works managers present were immediately ready to devote their attention to a new piece-rate system; the problem how to make any piece-rate effective was constantly present to them.

It should be observed at once that while Dr. Taylor believed that his whole system would succeed in making workmen do their best, he did not consider the differential piece-rate essential to its foundation. It has not indeed been generally adopted in its original form by those who otherwise follow him closely; they prefer, in the main, Mr. Gantt's "Task and Bonus" system, the first modification which was suggested. According to an editorial in *Industrial Engineering* in 1911,[1] the Link Belt Works, however, now use this differential rate with success among their workmen.

What Dr. Taylor aimed at primarily was to create a management that should have the expert knowledge necessary to pronounce how long a given job ought to take. That knowledge was to be gained by his new methods of time-study. He saw that on many jobs one of the primary methods of remuneration might still have to be used, but he meant to use any of them with a difference.

What are the primary methods? They are usually referred to as "time-wage," and "piece-rate." In the former a worker is paid for his time,

[1] Vol. viii., p. 377. See also C. B. Thompson's Collection.

by the week, day or hour ; the amount he does in the time is assumed to depend on his conscientiousness, and on the exhortation or driving of his foreman. In piece-rate he is paid so much for each operation, or piece of product turned out, and is left to make the total as large as he can in a day's work. The two methods seem entirely different to an outsider, and the second seems certainly preferable if rapid work is desired. But the matter is by no means so simple. Schloss, in his valuable work on " Methods of Industrial Remuneration " (chiefly devoted to conditions in England) shows very plainly that there is not actually the clear-cut division between the two that appears, by definition, to exist. Under a time-wage it is usually made clear, with more or less exactitude, what is expected in a day's work. Under a piece-rate, the rate itself has to be fixed as a preliminary settlement, the chief consideration being that a man's weekly wage should reach a certain standard if he works hard, and should not get much beyond it. This weekly wage may be about 25 per cent. greater than the time-wage it supersedes, and is then called by the workers " time and a quarter." [1]

It is the observation of this tacit custom, that a man's weekly earnings should not reach more than a certain amount, which is the besetting evil of piece-rates. If the employers have fixed the rate so that a man earns quite easily an unprecedentedly large

[1] In munition work during the war the piece-rate has risen frequently higher than this, without " cutting."

wage, they feel that the rate was fixed too high—as is extremely likely, when it is estimated by guesswork, and with rather insufficient knowledge. They then proceed to "cut" it, *i.e.*, lower it. In consequence the worker has to work harder, in order to obtain an average week's wages, than he did before; and the chance of high wages has disappeared. If, on the other hand, the piece-rate has been fixed too low, the employer will not be in a hurry to alter it unless some force, expressing the workman's discontent, can be brought to bear on him.

Therefore the phenomenon appears which is so incomprehensible to people quite outside industrial matters, that workers on a piece-rate do *not* try to work as fast as possible. They fear the cutting of the rate as soon as their wages become high. This cutting is, in fact, the simplest and the most disheartening kind of unfair "speeding-up," making the worker do continually more work for the same wages.

There is often a second reason for men not putting forth their best powers. A new piece-rate may be based on the records of one of the quickest workers. If he exerts himself to the utmost he knows that his weaker brethren will be expected to achieve as much, and may well find their earnings insufficient if they cannot equal his output, while he does not benefit himself at all. Therefore he does not do his best, particularly if he thinks his work is being studied, as an example or "pace-setter"; and the outside public complains of the incomprehensible idleness and slackness of working-men.

It is only fair to add that there must be cases where the rate has really been set too high, and where the employer may suffer serious loss if he cannot lower it; and that at times the power of the Trades Union may prevent him from lowering it. At any rate the dissatisfaction of most employers with the piece-rate system generally is obvious.

There is yet another fertile source of friction caused by the system. The worker will be at an actual loss in money if there are any hitches in the arrangements which compel him to remain idle because he cannot get on with his job. If not actually stopped, he may be hindered in countless ways; by tools in bad order, by something unusual about the material, by countless small mishaps. In cases of this kind it is the bad management that prevents him making good earnings, and he is not likely to bear this patiently.[1] Indeed, it is so palpable that the output must depend at least as much on the conditions of work as on the worker that one can hardly be surprised at Mr. Harrington Emerson informing the American Society of Mechanical Engineers in 1904 that one did not "buy output" from a worker, and therefore his wages should not be reckoned by output.[2]

[1] This view of piece-rates is well discussed in the Evidence given in favour of Scientific Management, given to the Interstate Commerce Commission, U.S.A., 1910.

[2] From "A Rational Basis for Wages," *Trans. of Amer. Soc. of Mechanical Engineers*, vol. xxv., p. 868. This is a useful contribution to the general philosophy of the subject, though it includes views which are the direct outcome of Mr. Emerson's special experience and personal idiosyncrasies. These views were not generally acceptable to his hearers at the time.

Mr. Emerson proceeded to investigate the separate counts for which a workman is paid. Obviously it was for something beyond his mere time. At any rate everyone was agreed that it was unsatisfactory to pay him for time merely. Dr. Taylor ten years before in his own paper had spoken very strongly against the slackness of workers, as he knew them when on a time-wage. The American slang for this slackness when deliberate is "soldiering."[1] Reading this in war-time, one recalls with an effort the obvious derivation of this word to describe attitude to work. Mr. Emerson remarked in the paper above quoted that soldiers, sailors, and more notably firemen, have to be paid regular time-wages for doing nothing for long periods of time, and performing unusually strenuous exertion at other times.

It is generally said now that "soldiering" in America is by no means as serious as Taylor represented it. When Mr. Hoxie's committee, representing the U.S.A. Commission on Industrial Relations in 1914, presented in writing Dr. Taylor's "claims for Scientific Management" to Mr. Gantt and Mr. Harrington Emerson for confirmation, both of them picked out the statement, "It tends to prevent soldiering" for exception, with the remark, "True, but unimportant."[2] Schloss's impartial investigations in England go to show that systematic slacking under a time-wage is not as a rule very feasible.

[1] "A Piece-Rate System," § 22. C. B. Thompson's Collection, p. 344. "Shop Management," p. 30.

[2] R. F. Hoxie, "Scientific Management and Labour," Appendix II., par. A 10, and pp. 151 and 166.

However, it is everywhere admitted that the time-wage brings no incentive to increase the amount of work.

The usual form taken by an attempt to compromise between time-wage and piece-rate, each alone having proved unsatisfactory, is to assure some sort of minimum time-wage to a worker, and then to draw up a system of rewarding him for extra exertion, measured naturally in terms of greater output, or of shorter time taken. As the extra amount done must be the basis of this system, the arrangement will be someth ng resembling a piece-rate.

Schloss calls these "time-wage and piece-rate" systems, or, generally, "progressive wages." The more modern name for them is "premium-bonus systems."

Taylor gave in his original paper[1] a critical account of an American system of the kind first used by Mr. Towne in 1886, and elaborated by Mr. Halsey, who read a paper to the American Society of Mechanical Engineers on it in 1891. Schloss describes the Towne-Halsey method, and an English one, used by Messrs. Willans and Robinson at Rugby, which is on rather different lines. The methods of calculation of the bonus are complicated, so we shall not describe them in detail. The essential in each scheme is to fix some standard amount of work or standard time first, and then fix the reward for saving time or doing more work, whichever it is.

It is somewhat interesting to study the adminis-

[1] Also in "Shop Management," p. 38, *et seq.*

trative developments which were the direct outcome of the installation of the scheme in the English firm. Schloss notes specifically the necessity for careful inspection, for fixing what is called "the reference rate" permanently, "except where method is changed," and for communicating it to the workmen at the beginning. Also the advisability of calculating the time for work individually, not on a gang basis, and of paying the bonus weekly, not delaying it. The objection that book-keeping and cost-keeping would be complicated was met by the firm exactly as Taylor met it, by pointing out that labour costs in any case ought to be ascertained carefully and in detail.

But in studying premium-bonus systems we are interested chiefly in the principle on which the bonus is given. The standard work or time mentioned above "was determined," Halsey says, but determined in the old-fashioned general manner, not by any study of the elements of the work. The peculiar fact about the calculation of the reward is that the workman is not given the whole profit due to his extra exertion; he is asked to share that profit with his employer. Sometimes he is told that he will get half of it; sometimes that he will get one-third. Very occasionally on certain jobs it might be admitted that he was entitled to the whole, but much more commonly the management contends that he is entitled to very little, as the increased output is due to better arrangements, and causes him no extra exertion.

Mr. H. M. Norris,[1] who has followed the Towne-Halsey plan, states that Halsey recommends a generous allowance for the initial job-rating or time-setting, and then a small premium rate—at first, at least, for it is easier to raise it than to lower it. Mr. Norris prefers the reverse arrangement. Halsey states in his own paper that he thought one-third the most suitable proportion generally, but would vary it according to the extra amount of exertion entailed. In his works in the United States it was one-third to one-half; in those in Canada one-quarter to one-third. (This difference seems due to different labour conditions, and not to bear any reference to exertion.) He mentions a Glasgow firm which made the proportion one-half (Messrs. G. & J. Weir). Another firm (D. Rowan's) calculated their bonus quite differently, so that it rose very rapidly at first, but the rate of increase diminished rapidly if the extra output was very large.

Both Mr. Halsey and Mr. Norris admit incidentally in their papers what will be clear to everyone after a little thought: that the management stand to gain considerably if the overhead expenses remain the same during the men's extra exertions, as there will be a smaller charge per unit of output when the output is increased. They contend, however, that certain expenses will increase: expenses for inspection, motive power, general wear and tear, and for some of the materials used; and evidently feel

[1] "The Premium Plan for Wages." *Engineering Magazine*, vol. xv (1901), p. 631.

that it is fairer to the employer that the workman should not receive the whole profit made by extra work, that being one of their objections to piece-work. Halsey explains explicitly that he will give just enough reward to make it worth the workman's while to exert himself as required; that he will choose the workman who will do it for the smallest reward. He is therefore not concerned with amount of output or with any idea of equity in distribution.[1] He has also stated that, broadly speaking, the increase in earnings by the workers comes to rather less than half the savings to the employer.

Schloss does not discuss the abstract justice of the situation at all, but observes (p. 113) that a worker is likely to be better off under a bonus system which promises him a definite reward and keeps the promise exactly, than under a piece-rate system, in which, although his reward is nominally proportional to his output, his earnings are liable to be cut down frequently.

After reviewing these opinions, Emerson's contention that you do not buy output from your worker will seem quite sound. He would add to the minimum wage he wished to establish something for skill and experience, and something more for "co-operation"—being willing to push on the work and do his best. But his measurement by "efficiency," which will be discussed shortly, will in most

[1] In this context see (later) a criticism by E. D. Jones on the Taylor system, which brings in also the further question of lowering the price to the consumer.

industrial concerns have to be measurement by output ; although it is necessary in many of the railway operations with which he has been personally concerned to find some other means of computing efficiency.

The English workman has been, especially of late years, very strong in his disapproval of the theory upon which premium-bonus systems are founded, and also of them in practice, on the ground that the employer takes a considerable portion of the extra profit created solely by the workman. This opinion is voiced by Mr. G. D. Cole[1] thus: "It is the business of the Unions to resist with all their might all attempts to introduce the premium-bonus system and the like into their works." A workman in the engineering industry, writing to the *New Statesman*, Oct. 14, 1916, speaks of the system as "a palpable fraud," and a "despicable cheating system." In the same letter he puts the workman's general case against piece-work very well: "In ten piece-work establishments in which I have worked I have found the maximum to vary from time-and-one-eighth to time-and-one-half, and any attempt to earn more was followed by a reduction in price. Therefore where organization existed among the men, the speed of the slowest man became the speed of the shop."

We must now discuss the methods used in Scientific Management.

We have said that Taylor and his followers use

[1] "The World of Labour," p. 323.

systems allied to the premium-bonus systems, but claim to use the bonus principle in a perfectly different way. First, the basis is settled, the standard task, by knowledge and not by guess. Standard task or schedule time, whichever it may be, is a matter of observation and computation. The determination is made by analysis into elements, and the details of these elements are given to the workman for his examination, so that he can point out exactly what he may think difficult or impossible. We have seen that this process is one of the first principles of scientific management, though we have always to remember that it needs much patience and perseverance to realize it ; that these standards and schedules are not created in a day, or a week, or a month.

Next, the workers are not left to their own devices for increasing their skill or speed, as in the usual bonus systems. The management undertakes entirely the investigation into the best ways of working ; it then asks the workman to receive instruction in these ways, whenever they are different from his former practice, and to adopt them instead of his own. It also undertakes that the conditions are all that they should be ; that a worker is not hindered or stopped by imperfect tools, or the non-appearance of some of his equipment. All difficulties, as far as possible, are to be cleared out of his way. He will then receive a bonus for the extra work which he accomplishes.

It will be obvious that when a management of this

kind claims a share of the extra profit from extra output by the worker, it is a claim that can be substantiated, even if the proportion in which the profit is shared has still to be discussed. All leaders of the efficiency movement lay the greatest stress on its being, primarily, the business of the management to get work done well and done quickly, and not to leave either quality or quantity to the individual exertions of each worker, according to his lights.

We must now describe in detail the three best known methods of remuneration, as used by three of the leaders.[1]

Dr. Taylor's differential piece-rate is known to the Link Belt workers as " the two piece-rate " system. A certain number of pieces per hour or per day is fixed as the standard. For the whole number of pieces, if above the standard, the worker is paid at a certain rate ; if his number is below the standard he is paid for all at a different, lower, rate. A simple example is given by Dr. Taylor of men who were paid 35c. per " piece " when they made 10 or more than 10 in a day ; and only 25c. per piece when they made less than 10. The simplicity of this method seems its only attraction, as there appears a great injustice if one compares the treat-

[1] A very complete and clear account of them is given in R. F. Hoxie's " Scientific Management and Labour," pp. 65-75.

Schloss refers to Taylor's piece-rate system in a perfunctory and misleading way on p. 91 (edition 1898), mentioning only the *cut* in rate, for not completing the specified amount. But " Shop Management " had not been published, and very little was known about Taylor's work.

ment of a man making just 10 with a man making $9\frac{1}{2}$. The change in rate is absolutely abrupt, without gradation. Also, there is no minimum wage, as in other efficiency methods. If a man's output is much below 10, his earnings will be very small. The average piece-work wage, before changes in the method were made, was $2·50 a day, so that a man making only 9 pieces a day would fall below the previous *average* wage, though not necessarily below his own previous wage. The previous piece-work rate was, however, 50c. per piece, and a man got average wages by completing 5 pieces. After Taylor had made improvements in method, and calculated the due time on the improved method, he concluded that 10 pieces could be made in a day, but he did not propose to pay 50c. each for them ; he said that as soon as the workers were used to the change they would find they could make $3·50 a day without extra exertion. On p. 82 of " Shop Management " it is stated that competing firms in the neighbourhood were offering piece-work wages by which the men made $2·00 to $2·50 a day. The above statements will serve as a rather crude example of the way in which the method works.

Besides the abrupt jump in scale, the condition that makes this method difficult to introduce is that the penalization of the slow worker would be very discouraging to those attempting the new method. A man who achieved only 7 pieces would make only $1·75 a day. This might, of course, be tempered in practice while the method was still new. Gantt's

system was, however, invented to overcome this objection permanently. Indeed, it seems obvious that one will hardly persuade a set of workmen to make a good trial at the new method under the new conditions, if they are not guaranteed their former wages during the trial.

The lower piece-rate can be postponed until a good deal of training has been imparted, and might be deferred almost indefinitely. But meanwhile there must be a minimum time-wage ; and a change which cancels that minimum will be a drastic change, likely to be unpopular. It must be remembered, again, that Taylor never pressed this method of payment.[1] His view presumably was :—introduce it if you think you can, but don't wreck your other work by insisting on it, if it would lose or endanger the hearty co-operation of your workers. He gave, however, one sound plea for its use :—that a slow worker might injure the work of others who were kept waiting for jobs which followed consecutively on his ; and therefore it was to the benefit of the workers generally that there should be some penalty for falling behind. Of course such a state of things would be only temporary. The adjustment aimed at, if any worker continued to fail to come up to the standard of the others, would be to transfer him to other work. The continued existence of workers at the lower piece-rate

[1] See, besides " Shop Management," the note on p. 576 of an article by him in the *American Magazine* for March, 1911 : " Under scientific management the particular pay system is . . . one of the subordinate elements."

would be a sign of want of success in the management.

Mr. Gantt's Task and Bonus system secures a day-rate of wages to all who do not complete the standard task; and gives a sudden rise, the bonus, as soon as they do. The bonus increases in proportion as the amount of work surpasses the standard. It is calculated in a rather complicated way as percentage on time saved, but works out practically like a straight piece-rate, though one which there is no intention of cutting.

We have still the sudden rise, which may seem very unfair to a man who is just not able to complete the standard task; but, as we saw in the last chapter, much depends on how difficult the standard is made. Also it seems to be quite customary in many works to begin paying a small bonus when the standard amount is nearly accomplished, beginning when 90 per cent. or even 80 per cent. of it has been achieved.

Mr. Emerson's system is based on an efficiency computation[1] instead of on a standard task, and can be readily used when the computation has to be on some other basis than output. His 100 per cent. efficiency corresponds to the standard task; and he fixes this generally as about half the result of his best man's exertions; *i.e.*, his "percentage allowance," as discussed in pp. 107-112, is about 50.

The bonus paid in addition to the time-wage begins at two-thirds efficiency—67 per cent. It

[1] See p. 13, *ante*.

is at first very small, but increases rapidly. At 90 per cent. efficiency the bonus is 10 per cent. of the ordinary wage ; after that it increases 1 per cent. for every unit per cent. increase of efficiency, so that the standard, 100 per cent. efficiency, has a 20 per cent. bonus, and the increase above 100 is paid by the same increase in rate. There is no abrupt change. The actual percentage of bonus is subject to a little variation, but the figures stated are the most usual.

The variables in these two forms of bargains are : the average minimum day-wage, which forms the basis, and the amount of the bonus. Before discussing these more fully, we may repeat the remark made by Hoxie, that both plans mean a distinct lowering of piece-rate—of the actual sum paid per piece. He works out a hypothetical case on the Emerson system and shows that the piece-rate itself falls gradually as the output gets larger, although the actual sum received in wages grows also larger. In the Taylor and the Gantt systems the actual piece-rates are constant, but Taylor began with an openly acknowledged "cut" in rates, because the production of the article was made much easier ; and Gantt makes what is, in effect, a cut in rates, if he fixes his standard task as any accomplishment higher than the workers achieved under old conditions at their day wage.

The fact that the effect of the bonus is to lower the price paid to the workers per unit or piece is a very damaging one in their eyes, even when they know that they are receiving a greater sum for

their day's work. The effect is inevitable; it is part of the programme of efficiency to lower labour cost per unit. To this end an increase of overhead expenses is incurred in the improvement of conditions, and in the establishment of planning and of time-study departments. It is true that the actual overhead expenses per unit of output may be finally lowered, not increased, whereby the employer may get some separate profit; but he does expect to see his outlay on scientific management reflected in his diminished labour cost per unit. He contends that he is not in the same position as the emp'oyer who stimulates the workman to produce the whole extra output by his own skill, speed and exertion. He makes it quite clear that it is the undertaking of the management that the workman should be enabled to produce this extra output without undue exertion, and that he should be trained and instructed till he has the necessary skill. Then he proposes to raise his wages, for compliance with directions and general co-operation, by giving him a proportion of the profits which ensue.[1]

The bonus arranged by Taylor and Gantt in their systems seems to vary a good deal according to what they expected of their workmen under the new conditions; and it is not possible to quote even typical figures as has been done for the Emerson system. In the evidence quoted by Mr. Brandeis,

[1] See also Hoxie's note, p. 74, to his own discussion on this lowering of piece-rates, admitting that it is justifiable when increased output is due to better organization or equipment.

when he set out to show the applicability of scientific management to the improvement of American railway organization,[1] the following figures are given for the actual increase of wages in works operating the Gantt or Taylor system.

WAGES INCREASE.

Brighton Mills	45 to 75 per cent.	"above day-rate."
Tabor Co.	25 to 30 per cent.	"above average."
Link Belt Co.	25 to 35 per cent.	"over generally prevailing wage."

But we do not learn what was the percentage decrease in labour cost. In Mr. Parkhurst's book already quoted,[2] describing the Ferracute Machine Works, the matter of proportioning the bonus to the man's "influence" on the saving in labour cost is quite fully and lucidly tackled, and he shows that there is great variation according to circumstances.

As a rule 25 to 35 per cent. increase on day wages was given when the standard was reached in a machine operation; 35 to 50 per cent. increase on manual operations, particularly on such operations as assembling machines, which operation depends greatly on skilful and quick handling by the worker.

Parkhurst speaks of an average increase of 25 per cent. in overhead expenses, but that labour cost and "total manufacturing cost" have been diminished to about half.

[1] Investigation, before the Interstate Commerce Commission, U.S.A., of Proposed Advances in Freight Rates, 1910. Brief by L. D. Brandeis. Docket No. 3400.

[2] See pp. 84 and 117.

In " Concrete Costs " Mr. Sanford Thompson and Dr. Taylor state that carpenters engaged on concrete work got 35 per cent. increase on day wage. (They worked on the Gantt Task and Bonus system.) Mr. Thompson, in an article in the *Journal of Political Economy*,[1] says that in a certain industry girls on hand-labour earned about 40 per cent. more than their day wage, while reducing labour cost 50 per cent. ; men on machine work got the same percentage increase in wages, and reduced the cost 35 per cent.

Another consideration which will come into the adjustments made for the new conditions is whether the selling price of the article is to be lowered or not. Mr. Brandeis' brief gives instances where this has been done ; at the Tabor Manufacturing Co. and the Link Belt Co. the selling prices have been lowered 10 or 15 per cent. in the last few years p. 58).

It seems clear that, as under the premium-bonus systems, there must be a good deal of variation in practice as to the division of the extra profit between employer, employé and customer, and that no general principle will be of any avail. Some writers on efficiency have tried to evolve a principle, nevertheless. Such rough-and-ready methods as one-third to workman, one-third to employer, one-third to customer have been suggested.[2] Mrs. Gilbreth in " Psychology of Management " suggests (p. 297)

[1] Vol. xxi.

[2] See F. E. Cardullo, " Industria Organization under Scientific Management," *Machinery*, vol. xix., p. 20.

that approximately one-third is to go to workman, one-third to employer, one-third to "maintaining the system and carrying out further investigations." She does not consider the lowering of selling price; but she does make clear, what other writers do not, that the defraying of the extra expense entailed by efficient management is an entirely different claim on profits from the employer's, which is merely the desire for higher dividends. Emerson sees this quite clearly, and spoke in his interview with Mr. Hoxie[1] of the reward being apportioned to *four* classes: "worker, saver, society and leader." These seem to correspond to worker, scientific manager, consumer—and, presumably, employer. He does not suggest an equal division, but is confident that a *just* division can be made.[2]

Some attempt to determine what is the portion due to the worker seems certainly necessary if intelligent workmen are to be satisfied, and fully willing to co-operate. The attitude frankly taken by Mr. Halsey, that he would give only the least increase of wage that he thought would be accepted, will never be taken by a scientific manager, for he has to work on the principle of permanent high wages as one of the essentials in his programme; he

[1] "Scientific Management and Labour," p. 163.

[2] Prof. E. D. Jones, in a general criticism on Taylorian methods in the *American Economic Review* (June, 1913), suggests that if the bonus to labour is that which induces it to co-operate, the reward to capital should be similarly what secures the maintenance of the new conditions, and that the remainder of the profit should pass to the consumer in lowered prices. See also J. A. Hobson, "Science of Wealth."

does not wish to beat down the workman to the lowest possible figure. But Dr. Taylor's attitude about paying workmen was very little more satisfactory, from the point of view of justice. No reference is made to the increase of output, but he speaks ("Shop Management," pp. 25-29) of giving an increase of 30 per cent. to 100 per cent. on the ordinary day wage, according to the kind of job, saying that he arrived at the *right* percentage by "a method of trial and error." He certainly believed in original observation and experiment in psychological as other matters, but it is difficult to see how a manager will keep his workers in good temper while he is trying experiments on the amount of bonus suitable, and making frequent alterations. Then his theory, that "it does not do for a man to get rich too fast," though doubtless supported by many facts, is one which might be observed silently, but could not be proclaimed publicly.[1] Indeed, a workman might be as much offended by the management expressing concern on these grounds as by the premium-bonus assumption that it would be a pity to pay him one penny more than the least sum that will induce him to make the extra exertion expected.

The discussion on Remuneration has been necessarily rather protracted, not, as has been said already more than once, because it is of the first importance in the new management to adopt one system rather than another, but because it is the

[1] In the *American Magazine* for June, 1911, he says that about 60 per cent. is enough to "improve" men.

point of primary importance to the worker, and therefore the one which affects chiefly his attitude towards the changes made in management.

It should have become clear gradually during the discussion that there are two main questions which can be the subject of adjustment and bargaining: the average day wage which is the basis from which calculations are made, and the percentage increase which the bonus system arranges to give over this basis wage. It is on these questions that the scientific manager has to encounter Trade Unions, where labour is organized. The subject will be further considered in chap. xv.

In the last chapter we showed somewhat fully that the actual remuneration will always be affected by the exact fixing of the output for the standard task, and that the fixing cannot be done with scientific accuracy in so far as it has to strike a mean between the best, and the average untrained, man.

Besides the bonus paid to the individual, it is quite customary under the new methods to pay a small bonus to the man in charge of the work of a group—the gang boss, or the speed-boss, among Taylor's functional foremen—for each man in his group who completes his task. He is paid this as a teacher, not as a driver. He is also paid an extra bonus if all the workers whom he directs obtain their bonus. At the Brighton Mills [1] the gang-boss in charge of twelve men receives six cents a day for every man who gets a bonus, but it is increased to

[1] Mr. Brandeis' Brief, p. 57. Record of Evidence.

ten cents per man if all the twelve get a bonus. The object of the first bonus is to make him teach effectively; of the second, to cause him to give more attention to those who fall behind.

The idea of a teacher having a bonus on results is, of course, familiar to us, but, while it has sometimes a dubious value in education, it will certainly have one in industry, because of the previous history of such bonuses. In American industry generally the result of giving bonuses or similar encouragement to the old-fashioned type of driving foreman has certainly produced the worst forms of speeding-up, with no assistance to the men. The workmen and their functional foreman must be on entirely different terms of relationship for the desired effect to be obtained.

It has not been possible to include here a comparative account of profit-sharing or co-partnership as a method of incentive to workmen. Profit-sharing has been very ably criticized from the general point of view by Schloss, in his work already quoted, and from the scientific management point of view by Dr. Taylor, in " A Piece-Rate System," and in " Shop Management," p. 37.

Employers in England are sure to have it brought to their notice as an alternative to the American methods. If they compare the arguments of the advocates of each, they will be interested to see that each claims to create the best possible co-operation between employer and employé, and to demonstrate the thesis that the two really have the same

interests. Scientific management holds that the stimulus is best applied to the individual rather than to the working-staff as a whole, and that the reward should be immediate, not delayed. It has also freed itself from the objection that it is the men who earn the whole of the extra profit they are asked to "share."

Profit-sharing is often liked by employers, especially where the men are encouraged to invest in the firm rather than draw out profits, because it attaches their men in a permanent way to the establishment; and it is distrusted by workmen for the same reason.[1] Efficiency managers like to keep their trained men; but the leaders, from Taylor onwards, have always left them free to go to better work if they find it; nothing is done to attach them to a firm beyond trying to make their position in it satisfactory.

[1] Readers who wish to pursue the subject will find advocacy of the methods in the tract, "Co-partnership in Industry," by C. Carpenter, 6d. net. (Co-partnership Publishers), and criticism of them by a Socialist in Fabian Tract, No. 170, by E. R. Pease, 1d. These will also direct them to other literature.

CHAPTER XIV

SCIENTIFIC MANAGEMENT AND WELFARE WORK

THE movement among employers towards ameliorating the conditions under which employés work has gradually taken form and driving force during the epoch in which Taylor's ideas have also been taking root. It is not, therefore, surprising to find that his own writings, especially those best known, contain very little trace of welfare development, or Industrial Betterment, as it is more usually called in America. Still, experiments in making general workshop conditions much more comfortable date much further back than Taylor's essays, both in America and in England, though the general movement in imitation of these experiments (which have on the whole proved very successful), is comparatively new. In England the promulgation and furthering of welfare work has, of course, received an extraordinary impetus since the war. There are two main reasons for this. First, the conditions under which women work are matters on which public sentiment is always more active than when men are concerned; and many employers, feeling the sentiment themselves, and anxious to demonstrate to the public that they feel it, have proceeded

at once to improve the conditions when they had to engage a large new contingent of female workers. The second reason is that the health of munition workers has been discovered to be a matter of national importance.[1]

In the United States these particular reasons have naturally not come so much to the fore. There are firms who believe that their own prosperity is increased in a marked degree by having the best workshop conditions; there are firms who are already prosperous, and have a genuine philanthropic desire to let their workers benefit by their prosperity, independent of the hope of getting a further increase in dividends. Again, some firms want to attract workpeople of a superior class. And, lastly, many firms have fully grasped the importance of attracting custom by being able to display and advertise fully the conveniences and amenities of their industrial establishments. America has certainly travelled far since 1904, when Mr. Emerson, in his paper on "A Rational Basis for Wages," incurred very sarcastic comment by saying that he would pay his minimum wage to a worker, "sick or well." One speaker in the discussion observed: "What a delightful arrangement, to transfer all the responsibilities of keeping

[1] See Mr. Lloyd George's preface to Miss Proud's book on Welfare Work: "If a maximum output was to be reached—still more if it was to be maintained for a protracted period—it was all-important that the health and well-being of the worker should be carefully guarded." And also that Welfare Supervision is "beneficial to the employer, particularly in works employing women."

our workpeople in good health on to the shoulders of the already somewhat overburdened employers!" [1]

With regard to the attitude of scientific management in this matter, there should be no doubt in the mind of anyone who has studied it thus far that the best possible general conditions in the establishment must be part of the programme. It would appear to be one of the guarantees which is given to the worker, in promising him all possible improvement of equipment to facilitate work.

Nevertheless, the code setting forth the claims of scientific management to benefit labour as Mr. Hoxie obtained them from Dr. Taylor [2] speaks only very generally on the question of material conditions. We have—

A. 6 *h*. By instituting and enforcing rational rest periods and modes of recreation during the working hours.

6 *i*. By surrounding the workers with the safest and most sanitary shop environments.

B. 4 *f*. By careful study of fatigue. . . .

But, for the most part, benefits by means of change in the mutual relations of employer, foreman and workman are dwelt upon, whereas in most welfare or betterment work material improvements in conditions certainly come first. It seems possible

[1] See *Trans. of Amer. Soc. of Mechanical Engineers*, vol. xxv.
[2] Hoxie, Appendix II.

that a reason for this is that the kind of work amongst which Taylor did the earlier part of his organizing was out of doors; and that therefore the questions of light, heating, ventilation, cleanliness or neatness did not count for quite as much as they do in a closed-in factory where workers remain almost stationary. The same might be said of Gilbreth's bricklayers. Taylor's own interesting studies in fatigue were based entirely on the exertions of the worker. At the close of "Shop Management" (pp. 201-2) he gives as his general opinion on "welfare work" that it is "of secondary importance. "They" (*i.e.* "aids and improvements") "should come in all establishments, but they should come after the great problem of work and wages has been permanently settled to the satisfaction of both parties."

Mr. Gilbreth has taken an entirely different view, and evidently considers the "aids and improvements" part of his programme. He has led the way, in his fatigue-study, to laying great emphasis on the importance of all the external conditions in industrial establishments, as factors for or against fatigue. It may, in fact, be said that the new management has definitely linked itself to welfare work by making the study of fatigue one of its functions. Less prominence, however, is given to this function by some exponents of the method, who say little about fatigue.

Mr. Gilbreth's view of welfare work is worth quoting *in extenso*:

"The term 'betterment work' is used, by those who are interested in measured management, instead of 'welfare work,' to emphasize a distinction in thought. Some welfare work implies that it is the gift of the manager to the workers. Betterment work is the same type of work, done with the distinct understanding that what is done is for the good and profit of the organization. It is the due of every member of the organization to have the best resting condition possible.

"Many employers have resolved that, so far as their plants are concerned, needless fatigue must be eliminated. They have resolved that the day is coming when every worker shall go home from work happy in what he has done, with the least amount of unnecessary fatigue, and prepared to go back in perfect condition on the morrow." [1]

In comparison with this, two sentences may be quoted from a recent article in England by the Rt. Hon. G. N. Barnes, M.P.[2]

"The lesson is being learnt here, as well as in America, that increased comfort and improved relations mean greater efficiency and more output.

"A feeling of revulsion arises within me as I look back upon my own twenty years of workshop experience—the ill-conditioned workshop, the absence of the ordinary conveniences of civilized life, and the sense of humiliation engendered thereby."

[1] F. B. Gilbreth, "Fatigue Study," pp. 47 and 158.

[2] *Daily Chronicle*, Dec. 28, 1916.

It is worthy of remark that in Miss Proud's " Welfare Work " she enumerates certain duties of the welfare supervisor which would be already undertaken by other members of the staff in a management working on efficiency methods. For instance (p. 145), the supervisor is to enquire into the reason if a worker's output is below normal, the fact being reported to him, or her, as a matter of routine. In a works under scientific management the foreman-instructor of the worker would be taking action or making enquiries. Again (p. 173), the supervisor is to suggest new arrangements to diminish strain, such as altering the height of a table or bench. This would be primarily the work of Gilbreth's " fatigue eliminator," who is on the time-study staff. Still, a staff under the new management would probably not despise the assistance of the supervisor in these matters, and also in " explaining the wage system to the workers and hearing their criticism " (p. 145). And use could be made of his or her opinion in engaging or considering workers, not as to their technical skill, but as to their character and their state of health.

Scientific managers, as others, will find that betterment work divides itself naturally into improvements in the condition of the worker during working hours, and improvements in his condition when away from the establishment. Under the former heading will come not only arrangements in the shops themselves, but such direct installations as the provision of a room in which to

take food, the provision of food itself, of a rest-room, of proper lavatories and cloak-rooms. We need not enumerate them all. The other type of betterment is the one of which workmen are more suspicious, as it tends to interfere with their liberty. It often strikes them also as an intention to grant them houses, libraries, club-rooms, and so on, instead of better wages.

Now if a " fatigue eliminator "—it is not a very prepossessing title—is going to be quite thorough, he has been told by Miss Goldmark in no uncertain way that he is concerned with home conditions, most of all housing. The scientific manager values each worker, and wants to keep him at his best. How can this be done if he arrives each morning jaded and worn from sleeping in an insanitary room, and continually combating cold, damp and draughts, or dirt, bad drains and effluvia? Yet it is often treading on very difficult ground to attempt to solve the housing problem for him. The manager may have to be content with his provision of high wages as the best solution he can make to the problem, and trust to his men being able to make their homes comfortable by the help of their well-filled pockets. Apropos of the high wages, the author of " Welfare Work " makes an observation which in general drift agrees rather remarkably with Taylor's estimate of its place in a programme—that nothing of the kind ought to be attempted in a works where the wages are not at least as high as any in the neighbourhood (p. 136). She adds that this condition is

generally satisfied. Under scientific management *a fortiori* it ought to be.

But when works suddenly spring up in a new neighbourhood, the housing problem may press for solution by the employers, because there is no one else to solve it. Instances in England, in munition work, have been frequent lately ; and the war has produced a similar situation in America, where mushroom towns have sprung up round hastily developed industries concerned with satisfying the new needs of Europe. Unfortunately in these cases there is no time for deliberation, and the provision may be far from efficient, so that it is to be hoped it need only be temporary.

But where the permanent opinion of the worker on the environment created for him has to be considered, it will be found advisable by managers to devolve a certain amount of the control and administration on the workers themselves. This would certainly prevent such egregious mistakes as providing libraries and lectures for men who were being worked seven days a week for twelve hours a day, as was done at Pittsburgh ;[1] and such minor ones as laying out all the plots of ground round the dwelling-houses as if they were parts of a public park, leaving no room for private gardening. The desirability of creating some sort of workmen's committee extends to the administration of canteens, rest-rooms, cloak-rooms, etc., for the institutions will certainly not be efficient if they do

[1] See Fitch, "The Steel-Workers of Pittsburgh."

not directly meet the needs and wishes of the people using them.[1] The question of control by the workers, however, belongs properly to the next chapter.

Educational schemes, which are often made a special feature of welfare work, have their separate place in schemes of scientific management (see chap. xvi.).

A section of workers in the United Kingdom hold the view that the State will be able to enforce all necessary improvement in conditions by legislation and thorough inspection. Workmen in the United States have far less hope from legislation, and trust more to the power of their Unions. It may be pointed out to the English workers that the State can enforce only a minimum upon all employers, and that conditions far beyond the power of legislation in the immediate future might be accepted from employers willing to create them, with suitable safeguards, and a real mutual understanding and co-operation.

[1] In this context the chapter on Industrial Amelioration in Miss Jane Addams' book, "Democracy and Social Ethics," should be read. Although written in 1902, this contribution to the subject of welfare work is extremely valuable.

CHAPTER XV

SCIENTIFIC MANAGEMENT AND TRADES UNIONS

One of the most definite and most often repeated aims of the new management is to obtain the complete good-will and co-operation of the workers. English readers will infer that their programme should include the winning over of the Trade Unions to a belief in the new schemes, unless these schemes are to be started only in industries where Unions are weak or non-existent. Such a limitation would rule out the most important industries, and the majority of capable and thoughtful workers. Readers will be fully aware, however, that the situation created by the war has brought into our important industries a large amount of unorganized labour; semi-skilled and unskilled men's labour, and female labour, which has had little or no opportunity to organize. It may have occurred to readers already that the repetition jobs which form a large part of munition work would lend themselves very readily to time-study and the rest of the programme of scientific management. This fact is of great importance if we are trying to look beyond the war; because there is no doubt that employers who have invested largely in the automatic and semi-

automatic machines that utilize semi-skilled labour will try to use these machines, when peace comes, for the production of different articles; and will then try to retain the same kind of labour, as far as they can resist the claims of the skilled men returning to industrial work. All employers will find that they are more likely to have disputes and friction with the Craft Unions, which contain only skilled men, than with the Industrial Unions, which contain men of all degrees of skill, and which are better able, and more inclined, to admit women workers.

These aspects of our own affairs stand out pre-eminently as soon as we open the subject. But before pursuing the discussion of how efficiency methods, if adopted here, will be greeted by the English Trades Unions, of one kind and another, it will be better to review briefly the relations between scientific management and organized labour in America. Mr. R. F. Hoxie, who undertook such a review, gives a very thorough, and on the whole a very just account of the present state of things; though it is naturally criticized by American journalists writing in the capitalist interest as being too favourable to the views of labour. But it gives hardly enough prominence to the fact that, while the new principles have been developing in many directions under Taylor's initial stimulus and inspiration, the attitude taken by his disciples to Unionism has been gradually altering; it may, indeed, be said that alteration has been forced on them.

Dr. Taylor believed that if his ideas of management were fully adopted Labour Unions would be "unnecessary." He considered that the Union methods of regulating wages and conditions were "vastly inferior" to his own. In this context he refers to his own method as "the plan of stimulating each workman's ambition by paying him according to his individual work." This phrase occurs in his essay of 1895; but paragraph 13 in this essay is more definite: "The necessity for the Labour Union, however, disappears when . . . the employers take pains to study the character and performance of each of their employés and pay them accordingly." [1]

This is a curious echo of the opinion of a British employer seventy years before, except that Taylor does not mention an "agreement": "That which has struck most effectually at the root of all combination among workmen is to pay every man according to his merit, and allow him to make his own agreement with his employer." [2]

It seems clear, then, that Dr. Taylor believed in individual rather than collective bargaining. He was able to demonstrate in his many years' practice that his workmen "never went on strike," and this fact alone he regards as satisfactory proof that they

[1] See quotation from "A Piece-Rate System," in "Shop Management," on p. 186. The tone of the passage is quite conciliatory to Unions, but gives no indication that they would find any place under his management.

[2] See "Industrial Democracy," S. & B. Webb, note on p. 319. Alexander Galloway's evidence to Committee on Artizans and Machinery, 1824.

were conteted. Doubtless, as a rule, his intercourse with, and influence over, his men were of an excellent, friendly and humanizing nature; but there is equally no doubt that his method of treating them tended to weaken their power and opportunity of combination. We see in that passage in "Shop Management" (p. 68), where he makes his well-deserved boast that he had no strikes, that there was a tendency for his men to leave their Unions—a fact of which he seems to have been equally proud. We select the following from his last pronouncement on his system, given by Hoxie in his Appendix II.:

A. 5 *f*. [Scientific management benefits the worker]
By treating each worker as an independent personality.

B. 6 *b*. By substituting the rule of law [meaning scientific law] for the arbitrary decision of foremen, employers, and Unions.

B. 20. Scientific management makes collective bargaining and trades unionism unnecessary as means of protection to the worker.

B. 21. Scientific management, however, welcomes the co-operation of unionism.[1]

B. 22. Scientific management tends to prevent strikes and industrial warfare.

[1] No indication is given of how or where it is to co-operate It would surely have been advisable to suggest that the Union should give definite help in investigating what the scientific laws were.

Dr. Taylor's attitude to Trades Unionism itself seems to have remained much the same to the end of his life. On the more general question of the duties and responsibilities of the employer there is reason to think that his views modified as years went on. In "Shop Management," p. 143, we find the following blunt statement: "All employés should bear in mind that each shop exists, first, last, and all the time, for the purpose of paying dividends to its owners." In April, 1914, he gave testimony thus before the Industrial Relations Commission: "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 . . . 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 life to that sort of thing for the sake of making more money for a whole lot of manufacturers." [1]

Perhaps the two views are not quite inconsistent, but the emphasis is entirely changed.

Mr. H. L. Gantt's general view of Labour Unions is much like that of his leader; he thinks that they will prove unnecessary under scientific management. To him they represent "force" in antithesis to "knowledge." He writes in "Work, Wages, and Profits" as if a Union in one's works was something to be avoided, something for which, however, the ways of the old-fashioned employer were a good deal

[1] See H. B. Drury, "Scientific Management," p. 204

responsible. Whereas there is "a better means" of accomplishing the workers' ends. "If we wish to prevent him [joining a Union], we must make it to his interest not to do so" (p. 59). His writings show great sympathy for the worker as long as he is considered as an individual. But when he says, "if you make conditions work towards high efficiency, and compensate liberally, no man will spend his spare time trying to find out how to raise the wages of the other fellow" (p. 72), we realise that he has not grasped the true attitude of a Trade Union member towards his fellow-members.

In his latest book ("Industrial Leadership") he speaks again of Unions with general sympathy, and quotes with approval (p. 40) an opinion that the labour leaders in the Lawrence strike had more intelligence and more knowledge about labour problems than the employers. On p. 5 he says of the Unions, "which have been and are now so effective in increasing the class-rate, and which have done much to ameliorate the conditions of the workmen." But he does not suggest that the class-rate should be, or could be, used as the basis for his bonus system.

Mr. Harrington Emerson, in his paper written in 1904, speaks of his minimum wage being settled by the State "as a wage below which no one should accept employment." He elaborated the idea somewhat fully, in a way which must have been novel to his hearers.[1] The second count on which workers

[1] *Loc cit.* p. 129. See particularly pp. 874 and 877 of the *Transactions.*

were to be paid he defined as " skill and experience " ; and this would be done according to " supply and demand modified to some extent by the Unions." The third count, for " intelligent co-operation," was a matter to be left wholly to employer and employé.

In an article of more recent date in the *Iron Age* [1] he says explicitly : " I do not care how strongly a shop is organized," explaining in the context that no Union will object to standard efficiency or time being constituted if the matter is properly put before them. Mr. Hoxie [2] quotes from Mr. Emerson's recorded testimony to the Commission on Industrial Relations that he " knows of nothing that would make it [the system he advocates] antagonistic to collective bargaining." Mr. Hoxie finds, however, that Mr. Emerson's attitude in their interviews was not consistent with this statement, and Mr. Emerson certainly seems to have been evasive. The upshot of his comments, given there, on Taylor's views, is to endorse this one of Taylor's :—that where matters of management are reduced to objective scientific fact, any bargaining is out of place. He adds, though, that under any management an employer may be unjust, and in that case Trades Unionism would not be unnecessary.

Mr. F. E. Cardullo, of the New Hampshire School of Agriculture, has written a good deal lately, with

[1] *Iron Age*, vol. lxxxii. 1908.

[2] " Scientific Management and Labour," p. 163.

much enthusiasm, on scientific management, and an article of his in *Machinery*, vol. xix., has been reprinted in the C. B. Thompson Collection. In this we find :

" It is undeniable that Unions are necessary for the welfare of workmen, and that without organized effort it would be difficult for them to maintain satisfactory wages and conditions of employment in the face of the tendency of capital to combine into trusts and associations. If scientific management is incompatible with Labour Unions, workmen cannot afford to accept it."

It is not true that individual bargaining is essential to the methods.

" We can still have agreements with regard to minimum wage, hours of labour, conditions of employment, and many other things which affect the welfare of the worker. The Unions, however, must stop short of making any requirements with regard to methods of work, or quantity of output, or maximum wages paid, or premiums given, because such things are not proper subjects of discussion between the Unions and the employer."

The range of subjects " proper for discussion " in this way has tended on the whole to increase rather than decrease, where Unions are strong ; and one would expect Mr. Cardullo to include at least premiums among them, when he indicates, after the passage first quoted, that if there were no Unions the benefits due to increased efficiency might be entirely appropriated by capital ! He shows some

understanding, too, of Unions' policy, in observing that they will be opposed to "forms of welfare activity which tend to limit their power . . . during times of industrial strife;" while he is generally enthusiastic about welfare work.[1]

Meanwhile, outside critics of the efficiency movement have continually insisted that collective bargaining must be countenanced under the new methods. The final report of the Commission on Industrial Relations, 1915,[2] says that the methods should be used with scrupulous care that the worker has (among other requisites) full opportunity for collective bargaining if he should so desire. The valuable article by the economist, Mr. F. T. Carlton, on "Scientific Management and the Wage-Earner," sums up the situation by saying:[3] "The collective bargain can be utilized to fix day wages, and amount or rate of premium or bonus." These are exactly the two points to which we drew attention at the end of the chapter on Remuneration, as those on which the workmen collectively must be consulted. Possibly one reason why the leaders do not see this

[1] The efficiency movement is, however, likely to suffer some damage from the attitude taken to Unions by the writers of popular articles in its favour. For instance, the *American Magazine* of April, 1913, contains an article by F. B. Copley, in which the following passage occurs: "Scientific Management knows no way of fixing returns for labour other than that which has obtained all along where the natural workings of things have not been interfered with by Trades Unions."

[2] This can be read in the *American Machinist*, vol. xxxvi., p. 473.

[3] *Journal of Political Economy*, vol. xx., p. 834. Reprinted in C. B. Thompson's collection. See p. 731 of the latter.

clearly is that they have not committed themselves to a single unalterable system of remuneration. But it hardly seems feasible to evolve one in which collective bargaining would not be the most suitable method for the settlement of fundamentals.

The list of Trades Union objections formulated by Mr. Hoxie[1] states that scientific management—

B. 22. Is incompatible with and destructive of collective bargaining.
23. Destroys all the protective rules and standards established by Unionists.
24. Discriminates against Union men.
25. Is incompatible with and destructive of Trades Unionism.

These, like many of these formulated objections, are certainly not justified by the avowed programme, procedure, and aims of genuine scientific management. In fact, they seem to have been compiled by people imperfectly acquainted with these as published. But Mr. Hoxie in his book makes it very clear that there is a large amount of pseudo-scientific management already developed in America, and that many crimes against the worker are committed in its name. In fact, the cases are only too numerous in which just a few of the ideas have been put into practice, and have been used greatly to the disadvantage of the workers. All the cautions given by the men of real experience as to going slowly,

[1] See Appendix V. to his book.

overhauling the management itself first so as to increase its efficiency to the highest degree, standardizing conditions, making time-study a real, conscientious and scientific undertaking, approaching workmen tactfully and proving beyond doubt that their health, welfare and financial prosperity are made the direct concern of the management—all these have in numerous instances gone by the board, and the name of scientific management has been used to mask the worst sins of the old kind—reckless speeding-up and exhaustion of the workers, impossibly hard tasks set on insufficient knowledge and experiment, rates ruthlessly cut if mistakes turn out at all to the employer's loss, and so on. Moreover there are self-styled experts who call themselves efficiency engineers ready to take over the management of works and to commit all this havoc with fervent vague promises of making the "concern pay." One of the leaders has aptly christened them "stunt-peddlers"; but the matter is too serious for epigram.

Any arrangement which has resulted in increased output has often been assumed by the workmen, or by the outsider, to be a form of scientific management. Hoxie says very frequently that the new methods as planned by the leaders would not produce results of this disastrous nature, and he admits that there are works existing which amply prove this. Certainly organizations where fatigue-*study* is taken up seriously, quite apart from making fatigue allowances merely, cannot allow injurious

speeding-up to continue if it should manifest itself; and the programme of efficiency cannot countenance the rapid exhaustion of the worker.

We will not expatiate further on this controversy, important though it is, because there is already plenty of matter published on the subject, and Mr. Hoxie's book puts the two cases with fairness and generosity to both sides; and also because it is necessary to consider possibilities for scientific management in the United Kingdom rather than its successes and failures in the United States. But it must be pointed out that the study of papers and articles giving the views on increase of output of American employers who have not the aims and ideals of the Taylorian methods would impress every reader with an appalled sense of the brutal speeding-up that has gone on in America during the last twenty years, during the development of costly rapid machinery. Fitch's book entitled the "Steel-Workers of Pittsburg" has already been mentioned. He describes graphically the terribly long hours, the ceaseless driving by foremen, the premature ageing of workers, the absolute prohibition of Trades Unions. An article in the *Engineering Magazine*, August, 1895, entitled "Production to the Power Limit," explains how, since it is more economical to wear out each machine tool as fast as possible, the men must be speeded up on a piece-rate with high wages. If a man does not speed up "he is followed, without harshness (?), until he does do so, or he goes." The piece prices are subject to small but

steady reductions. It is not surprising that any system with higher wages given for increased output should cause distrust among American workers. The Unions have been steadily gaining strength; and, so far, the changes caused in the United States by the war have greatly strengthened the power of labour generally. The flood of European immigrants has entirely stopped; in fact, foreign workers have been steadily leaving the States, so that the tide has turned the other way. There is no unemployment; wages are rising, and the demand for a shorter day is being pressed.[1]

When we survey the situation in England we find that the most modern economists are often to be found urging upon employers the full recognition of Trades Unions. Times have entirely changed since "political economy" thought it had demonstrated that Trades Unions were futile, or detrimental to the real interests of their members; but the idea still lingers among employers who do not study current economics and sociology. The late Prof. W. Smart in his last book says that the employer "has no divine right to his honourable position unless he governs divinely. And if I am not mistaken, the first thing that will test his worthiness for the high office is the attitude he takes to Trades Unions."[2] He continues in a note: "I am afraid Trades Unionism is a thing which the unregenerate

[1] See an article in the *Engineering Magazine* for April, 1916, by F. C. Howe, the Commissioner of Immigration, U.S.A.

[2] "Second Thoughts of an Economist," p. 154, and note.

employer cannot understand, and I should earnestly recommend him to a preliminary course of reading in labour and socialistic journals. There he will, of course, find only one side, but it will be a side which he has never realized, and, by his difficulty in understanding it, he may suspect that the worker has as much difficulty in understanding him."

These "Thoughts," however, may seem rather advanced in their attitude. But Prof. Ashley has definitely stated that in the wages bargain the isolated workman is usually at a disadvantage in comparison with the employer.[1]

A writer on economics treating of the situation since the war has pointed out that the recognition of a Trades Union as a body with which various aspects of industrial work can be discussed tends to eliminate all forms of tacit conspiracy among workers which result in restriction of output.[2] And this is practically the same point as the one made by Mr. J. R. Commons in his recent article, reprinted in the Thompson Collection, where he says: "Organized labour is the organized expression of what labour itself would express if organized."[3]

It may be said, too, that all writers on the present

[1] "Adjustment of Wages," p. 17. The same admission may be found in other economic writers, as he points out.

[2] Paper by Mr. H. Clay, of Leeds University, in the *Industrial Outlook*, edited by Sanderson Furniss. (Papers read at Ruskin College, 1916.)

[3] *Journal of Political Economy*, 1913. English people will probably prefer the first and less abstract expression of the point.

industrial outlook are laying stress on the necessity of better understanding and co-operation between employer and employed, and therefore urge that the Unions should be given the very best opportunities to express the workers' point of view, that they should be fairly and frankly met in consultation.

Do modern economists make any suggestions which tend in the same direction as the aims of scientific management ?

The quotations from Smart given at the end of the second chapter show how much he felt it the duty of the employer to organize industry so that workmen have opportunity to do good work. He says again on p. 157 : " What I am trying to suggest in this disquisition on Trades Unionism is that the function of the employer has become ever so much more complex and responsible than it was, and really requires for its conduct very special qualities, including, I may say, an extraordinary amount of patience with and understanding of those employed."

Prof. Chapman, in vol. iii. of " Work and Wages," says : " The physical and mental vigour of the workers is . . . a national concern, even if regard is paid solely to the output " (p. 4). And the following passage hints at the work which can be done by education, to which reference is made in our next chapter.

" The end of production is to secure what is demanded at the least sacrifice. . . . So far as possible, the methods of production should be such that their mere performance yields satisfaction, or

involves a minimum of dissatisfaction.[1] . . . There is implied in this fundamental principle that the work of individuals should be governed by their tastes, which desideratum seems to necessitate freedom in the choice of work, agencies for discovering and training tastes, and facilities for bringing individuals to the work that suits them. Given the realization of this desideratum, can it be doubted that the quantity and quality of the ponderable output would be improved? "

An English employer desiring to instal the new efficiency methods as his contribution towards these ideals, is almost certain to have to deal very soon and very intricately with the English Trades Unions. It is true that the effect of the war has been to introduce into many industries unskilled, semi-skilled and female labour, which are much less organized. There seems reason to think that the whole training, in standard motions and in working to tasks, is more easily imparted to women than to men. If this should be so, an employer wishing to adopt the new methods may be more tempted than others to retain female labour. But he will be bound as much as others to the pledge to reinstate skilled men. And scientific management must vindicate its claim to benefit the skilled worker.

[1] See also Harrington Emerson, " Efficiency as a Basis for Operation and Wages " (*Engineering Magazine*, vol. xxxvi., p. 178). " It must be made pleasanter and more agreeable for the worker to attain standard output than to fall below it." Some people would interpret this as meaning merely that it would be *un*pleasant and *dis*agreeable if he fell below it.

There are two main ways in which it can do so. It can make use of his skill and full co-operation in investigating and completing a standard method, (during which process it must give him some extra pay) ; and it can put him in a superior position as instructor or demonstrator of the new methods. All Taylor's functional foremen should certainly be skilled workers. So far the efficiency manager seems able to conciliate the craftsman, but he has still to meet certain general objections.

Will there still be room in his works for men of all-round training, or will all the workmen become highly specialized ? Will it prove to a workman's advantage to transfer his craft or special skill to the management, who will make it the basis of a method to be imparted to the workers in general ? We have seen already that employers themselves are not always convinced that the scientific ideal, pooling all expert knowledge for common use and benefit, is to be preferred to the keeping of trade secrets. The same hesitation is natural to the workman.

Will not work on incessantly running machines, where everything is provided without a hitch at the exact time needed, prove infinitely more monotonous and tiring than the old form of work ?

It is quite possible for a manager to administer the new methods so that these questions are answered in a satisfactory way. Mr. Hoxie, able critic as he is, has practically admitted the possibility, in more than one context. But everything depends on the administration. The " system " will do nothing if

the personnel working it is not of the right kind. The authors' own belief in the possibility of a satisfactory answer to these questions is based on some knowledge of one of the English establishments in which the new methods have been taken up. Their impression is the same as that of many visitors to the establishment ; all are struck by the cheerful, unhurried interest taken by the employés in their work. A visitor who had particularly watched one set of girls for a little time asked the forewoman: "Is there a rule against their talking?" "Oh no," was the reply, "they can talk if they like; but they're keen about their work, you see, and they can talk enough in the intervals." The setting of a task, the highly specialized routine, have each their good side and their bad side.

The results of Mr. W. R. Wright's study of the psychology of working towards a task have already been noted (p. 104).

The late Prof. Muensterberg, in his book "The Americans," put in a plea for specialization. "So it is that the specialized workman is he who constantly contributes to perfect technique, proposes modifications, and in general exercises all the intelligence he has to bring him on in his profession" (p. 243).

These academic suggestions will serve to indicate the lines on which really thoughtful and efficient management can proceed.

The problem to be solved is that the worker should not suffer, physically or mentally, from the palpable monotony of his work. Physically, the solution is

being supplied by careful fatigue study; mentally it rests on the possibility of producing permanent sources of interest. No bonus system can have an infallible power to produce such interest. Schemes involving competition among workers are usually unfair and in other ways objectionable. The discussion of motions and their times can make details very interesting; this has been especially experienced by Mr. Gilbreth's followers, who can show the workers the fascinating results of their ingenious mechanisms. But security as to present position, and a lively hope for advancement and promotion, may prove the greatest help of all. The workers' co-operation in improvements of method has to be ensured, and a generous treatment of suggestions, with a well-thought-out scheme for obtaining them, should give satisfactory results.

But we have not yet come to the end of our Unionist worker's valid objections. The most important of all, the one that goes the deepest, is whether scientific management will actually weaken the solidarity of his Union, even if it should recognize and deal with the Union as a representative organization. With all his shrewd knowledge of men, Taylor did not comprehend the strength of loyalty to each other which workmen may develop. Individualist sentiments have so long been the most popular ones in America and have given the catchwords to so many propaganda, that it is difficult for middle-class people there to see that a section of the community, which resents "paternalism" in

government as strongly as they do, may yet be inspired by the idea of brotherhood. Miss Jane Addams[1] has expressed the growth of the new moral impulse admirably: "Outside the pen of philanthropists, the proletariat had learned to say in many languages that 'the injury of one is the concern of all.'" . . . "Their watchwords were brotherhood, sacrifice, the subordination of individual and trade interests to the good of the working-classes." . . . "The workers have developed social virtues beyond the conception of an employer who appreciates only individualist virtues."

We have already indicated that this aspect of the situation as between employer and employed is vital in the consideration of welfare work.

But we must now turn to study the action of the same new moral impulse in the economic situation that is created by the new methods. A standard task or schedule time is evolved for one particular operation, and a few workmen only are put on this work. Their wages are very greatly increased, and thus they stand out from their fellows. One of the complaints made at the Government Arsenal at Watertown when these standard tasks were introduced was that not enough men were given bonus work. This might at first seem inconsistent with objecting to bonus work in general, but it is essentially sound. If the new arrangement is an improvement, all should have their chance with it; if

[1] "Democracy and Social Ethics," chapter on Industrial Amelioration.

it is the reverse, some people are being unjustly penalized. Then the effect of time-study may be to improve certain processes greatly, and the bonus system may produce a great difference in the operator's wages. Other processes may be altered hardly at all, and there is little chance of financial benefit.

Mr. Sanford Thompson (in "Concrete Costs"), and Mr. Emerson, see that this difficulty can be met properly only by adjusting the percentage of bonus so that the reward to the workman for his collaborating is not dependent on the increase of output. Here we have a very strong reason for allowing the workers to discuss the percentage of bonus, in order that their sense of social justice for all the workers of their class shall be satisfied.

It is in speaking of class, and of a class-rate, that another of the Unionists' objections will become apparent. The new management must entail some re-classification of labour, even if the process is gradual. The members of an Industrial Union probably would not object to this as much as those of a Craft Union would. But the latter have in the past found classification on their own method difficult enough, and they know only too well that in these days the whole classification of labour is in a state of flux to which scientific management can add but a little more instability. Here, as everywhere else, mutual discussion is the only way of promoting understanding and agreement.

With regard to remuneration, British workmen

have chosen to abide by piece-work in certain industries, by time-wages in others, according to the differing conditions in each. In 1904 about two-thirds of the men in Unions were on time-wages.[1] Before the war, with a much greater proportion of workers in Unions, the general trend was towards time-wages, as on the whole subject to fewer abuses. Efficiency managers have said that the time system of payment is a better foundation for the modifications they wish to introduce than piece-rates. A minor difficulty in their programme in that case, however, presents itself at once. Men paid by time have no particular reason to be pleased at every hindrance being cleared out of their way in order that they may turn out more work.

As we have seen in chap. xiii., the ordinary systems giving some bonus for extra output are extremely unpopular.

It was also suggested at the end of that chapter that collective bargaining ought to be used to fix the minimum day-wage paid under any scientific management plan of task and bonus. The American employers are apt to constitute this minimum as "the average wages paid in the neighbourhood." The British Unions will expect their standard rate to be taken as the basis, even though there may be some variation in this according to the neighbourhood. The existence of this standard rate has been essentially misunderstood by British middle-class people, and concluded to be that mythical uniform

[1] S. and B. Webb, "Industrial Democracy," p. 286.

wage paid to all workers, good and bad alike; whereas it is only the minimum; a good worker is practically never forbidden to take more where he can get it.[1] Nevertheless, Mr. and Mrs. Webb point out that, at any rate with a time-wage, the adoption of a standard rate does tend towards equalization of wages.

There is no doubt that the desire for something more like equalization is growing, as a sentiment and as a principle, among workers. It is a direct development of their new ideal of society and social obligation that a man should not be worse paid than another in his class because of minor differences in natural strength, alertness or dexterity, although they do believe in better pay for any capacity in achievement which is the result of longer training.

Readers will see that this sentiment will constitute a theoretical barrier of objection to paying a worker absolutely by efficiency; and this will make yet another reason for what has been already urged—that the arrangement and gradation of the bonus should be matters on which the workmen are consulted, if they are to show loyalty to and enthusiasm for the new methods. It has been said frequently by the leaders, with very strong conviction, that rates must not be cut. If the management makes a mistake in setting a task, and certain workers earn very large wages, the management must abide by its mistake and bear the loss until at any rate some reasonable adjustment in the whole task can be suggested. But what would the Unions say to such

[1] "Industrial Democracy," pp. 281-3.

an event? By a mere chance a few of their members would be earning far higher wages than any of the rest, with no real title to them. The management's endeavour to abide by their word about rates would hardly meet with general approval. In the same way a bonus system that brought the wages of a semi-skilled, little-trained worker higher than that of a skilled man with a record behind him would not be popular.

Although we are treating of relations between employers and Unions, it should be noted that there can be collective bargaining with workers, about a standard rate for minimum or about bonus, where there is no actual Trades Union; and it will be found that bargaining of the kind is generally conducive to smooth working of the new methods. The Union certainly provides a ready means for negotiations and shortens the process of "getting the workers' co-operation."

What many workers dread is instability in position and fluctuating wage, both of which conditions prevent their having any reasonably secure life or tranquil leisure. And after the war more than ever some permanence in conditions and outlook will be part of their ideal, rather than any excitement as to what their weekly wage will add up to each time it is paid. It may very possibly turn out that scientific management will have to modify its schemes of remuneration—never prescribed in any quite definite form, we must remember—quite anew to meet this new desire for stability.

In most recent writings about the British industrial situation after the war the final reform which is urged upon employers with some emphasis is that they should give the workmen "more voice in" or "more control over" the processes in production with which they are concerned. It has been pointed out with much earnestness that the gospel preached everywhere in war-time that each workman is "a member of a co-operative body working harmoniously to a common end" is also a gospel for industry in peace-time.[1] It must never be forgotten that the Trades Unions of Great Britain have foregone their securities, and trusted them to the good faith of the Government and the nation as completely as any capitalist has trusted his financial securities. As much as he does, they deserve to get those securities back with interest, even if in a modified form.

One event which has happened, though not with far-reaching present consequences, is the representation of workers on Munition Committees in various parts of the country which are actually directing industry.[2] This is a step in the right direction. Scientific management will have a better chance of doing valuable work in the industrial reconstruction here if it can create and utilize workmen's committees as one of its means of getting willing co-operation.

[1] See, in the *Industrial Outlook* (C. S. Furniss), Mr. G. W. Daniell's lecture at Ruskin College.

[2] See the *Industrial Outlook*, p. 123; "Labour in War-Time," by G. D. Cole, pp. 196 and 223-5.

Mention is made occasionally by the American managers of their foremen's committees, once a month or once a fortnight.[1] It may be suggested that Taylor's functional foremen would co-ordinate their work and help each other greatly if they had opportunity for discussion and consultation. A workmen's committee is also greatly to be desired for the administration of many developments in welfare work.

A British manager known to the authors lately constituted his first workmen's committee to deal entirely with arrangements for fining workers for irregular attendance at work. This problem, so crucial in all munition work at present, is being solved satisfactorily in his works by the men's own rules and system.

The whole of the old thorny question of "restriction of output," with its endless misunderstandings, will come up for rediscussion after the war under entirely new circumstances. Thorough discussion, with the ability to see all points of view, above all the national one, will be the one chance of an effective plan of action.

Somewhat connected with this question is that of the length of the working day. It is curious that American efficiency engineers on the whole plainly think this a matter for collective bargaining, whereas scientific experiment and research contribute more every year towards its solution, and a

[1] See C. W. Carpenter, "Profit-Making Management," and an article by V. Hoxie in *System*, vol. xix.

good deal of investigation is going on. It is one of the most pressing problems in fatigue-study; it is vitally important in considering output of munitions. Everybody is becoming persuaded that science will be able to make some pronouncement on the subject shortly.

Meanwhile the majority of people still assume that work done bears the usual simple proportion relation to hours worked, *i.e.*, that one does in a factory in twelve hours half as much again as in eight hours; and if one puts in two hours' overtime after that, another quarter of the eight hours' output will be added. And nearly a century ago Robert Owen had proved that the rule of simple proportion did not hold with regard to output and hours!

The American efficiency leaders have taken their stand on the assertion that facts established by scientific investigation cannot form the subject of bargaining. It is a reasonable hope that the *optimum* number of hours for each kind of labour, for regular permanent work, will before long be in this position. This optimum may not be eight hours; it may be a little more or less.[1]

Of course, if workpeople are being paid any sort of bonus for extra work, on a system which is some sort of piece-rate, they may themselves desire to work longer hours than the optimum, to gain more

[1] Sir William Lever, in a recent article in the *Daily Chronicle* (Christmas, 1916), was disposed on general social grounds to suggest six hours.

pay ; just as with the same motive they may neglect to take the proper rest prescribed by the agent responsible for fatigue-study. It will be a matter of persuasion to make them adopt the best way ; and scientific managers must remind themselves that in all ranks of life there are many people whose minds do not readily give allegiance to what " science tells us." The best way to cultivate this mental habit is to give everyone some opportunity for careful observations and conclusions.

CHAPTER XVI

SCIENTIFIC MANAGEMENT AND EDUCATION

We can offer only a slender contribution on this very important subject, because the whole question of technical education for the young worker is in an extremely unstable condition. The establishment of any scheme of compulsory continuation of education for boys and girls who have begun industrial work will alter the aspect of affairs entirely; and in England some action of the kind is sure to be taken shortly. Every employer ought to be facing these questions:—Shall I select young people who have undergone some previous training in trade or technical schools? If so, what sort of preparation for my work shall I prescribe or recommend in these schools? What form of training shall I give my young workers in my establishment; either (*a*) starting from the groundwork they have received at a technical school, or (*b*) starting from the beginning? And further, he has to ask himself: How are all my workers to be selected? How are they to be classified after selection?

The introduction of any system by which an employer has to set his young workers free for a certain number of hours in the day-time each

week, for further education, will certainly cause any forms of apprenticeship which may still exist in certain trades to have less and less importance. For some of these hours, at least, will be devoted to technical education, although the proportion of these hours to the whole will need careful discussion. Employers will certainly have considerable influence in deciding the curricula to be adopted.

Meanwhile the direction of some educational curriculum for young workers has already been adopted in various places as part of welfare work. Employers who are undertaking work with this aim are able to meet the educational authorities very fairly, and to ally themselves with their ideals of education to a very large extent. Inasmuch as most welfare work concerns itself, to some extent at least, with the worker's life as a human being, who must have human interests as well as technical knowledge and dexterity, welfare activities for the young are likely to include instruction in literature and other humane subjects, rather than devoting all the hours given to continuation of education to trade-training entirely, or even predominantly. The education given will then be free from the reproach incurred by most employers who show an eagerness for getting workers technically trained at State expense, which is usually interpreted as merely an eagerness for larger " dividends."

Now scientific managers, whether instituting welfare work or not, approach the whole educational problem at a different angle from that of ordinary

employers. They have to train their own workers; that is a very definite part of their programme; and they must have their own scheme of instruction, including capable teachers, in all the technical part of the work. The procedure for establishing and imparting standard methods has already been dwelt upon very fully. The first process is the transference of skill from experienced workers—not direct to a junior or apprentice, but to the management. The skill of all experienced workers available is studied, criticized and improved by people who have become experts at that study. The skilled worker is not to hold back the secret of any manipulation or trick of his own; he is to throw it into the common stock, and the result will be at the disposal of the management that has co-ordinated the whole. Then the management will organize the training of new workers, using the skilled man again if he shows himself a good demonstrator or teacher. And they expect him to have the spirit of the genuine teacher, to be eager that all his pupils should equal or surpass him in capability. His reward for all this is: (1) that he is paid extra while his work is being studied; (2) that he *may* receive something for specially useful or original contribution; and (3) he will receive extra wages, and probably a bonus, for teaching.

The very novelty of this programme is likely to cause the skilled workman, with his old traditions and habits, much distrust; but it will also stir up his old deep-seated objection to an unlimited number

of apprentices in his trade, or to the introduction of "illegal" men, *i.e.*, men not properly trained.[1] Nevertheless, he has to remember that the rapid changes in industrial technique due to new machinery press hard on him, tending to make his skill out of date. He is by no means in the position of the old-fashioned worker who could guard and preserve his technique over many decades. He will in many cases be well-advised to sell it, by transferring it to the management at the moment when it is most valuable. Scientific management must differentiate itself from other management by offering him good terms.

Turning to the second part of the programme, the training of the worker, the student interested in its educational aspect will find that, until lately, efficiency engineers mostly take on workers to train rather irrespective of their age and previous experience.

We find, however, that younger people are sometimes classed apart as needing a longer period of training, and a different method of remuneration or incentive. Before we discuss further the treatment of learners, we must note that the exact effect of the training on all workers depends essentially on how the standard task is fixed.

If it is high, the result will be a small band of workers highly competent in their specialized line. A skill, of a much narrower kind, it is true, than that of the skilled craftsman, has been created, and the

[1] See "Industrial Democracy": The Entrance to a Trade.

workers who possess it will form a body with distinctive status and a natural pride in their efficiency. We hear from Mr. Gantt [1] of societies of these skilled people who showed great exclusiveness. Dr. Taylor himself took the greatest pride in his "body of picked labourers," [2] though perhaps we hardly follow him in calling it "virtually a labour union of first-class men." [3] Still, they doubtless did command the "admiration and respect of all classes." This state of things forms the defence for the severity of his task, for which he has been so bitterly blamed—that "one in five" which his opponents never allowed him to forget.

The reverse of this plan, setting the standard task very low, brings a different danger which threatens the skilled worker very much in the same way that under-skilled, under-trained workers have always threatened him. If the task is made too easy any "man in the street" becomes a competitor for his job. Hoxie says there are shop departments where he has been told that he could become a bonus worker in two weeks,[4] though this statement has been received with incredulity in various quarters.

However, it was made clear in chap. xi. that the training may be quite slight in certain conditions, and the amount of selection or specialization equally slight, in vivid contrast to Taylor's much-anathematized methods. But when rather elaborate

[1] "Work, Wages, and Profits," p. 166.
[2] "Principles of Scientific Management," p. 72.
[3] "Shop Management," pp. 56-7.
[4] *Loc. cit.*, p. 129.

motion-study has been taken up, differences between workers in their powers of observation and manipulation will come out very strongly, and there will be consequent selection of certain workers and elimination of others. And the qualifications for which workers are chosen will often be extremely specialized. One has only to read the very interesting chapters in Muensterberg's "Psychology and Industrial Efficiency" to realize how much specialized.

The aim of psychologists in education, according to these recent theories, is to classify children at school according to the occupation for which they are best adapted. It is agreed that the attainment of this aim will entail years of study to elaborate the proper methods and experiments. The old classifications and generalizations, as to "memory," or "powers of observation," are much too vague; each individual has his strong memory for one set of details, his weak memory for another set. His very attitude towards monotony in occupation has to be ascertained and diagnosed carefully.[1]

It is this new type of psychological investigation which makes the American movement called "vocational guidance" really new in its scope and aim. Otherwise much of the work done under this high-sounding title would be very much like the work of the English Juvenile Advisory Committees. The "guidance" has, it is true, been put into more systematic and orderly form, and the information

[1] See Muensterberg's chapter on this subject in the book mentioned.

for the help of young people obtained more thoroughly than we can do here without some more administrative machinery installed. But the originality of the vocational idea would seem to stand or fall by the way in which it can ascertain beforehand in which activities a child has a chance of doing good and effective work, in which activities it is likely to fail. To find this out is psychology of a very carefully specialized and very valuable type.

The amount and place of training for a vocation, when once that vocation has been indicated, is quite another matter ; also the training may not be entirely devoted to strengthening the strong points ; it might aim at strengthening the weak ones.

Scientific management, like all other forms of management, may choose, according to circumstances and aims, for how much preliminary training of its workers it will ask ; but if it has committed itself to any psychological study of work it must welcome heartily the development of detailed vocational guidance, as this will assist it greatly, and shorten its processes of selection and classification. This has been seen clearly, and adopted as part of his programme by Mr. Gilbreth only among the leaders ; the others seem to consider the whole conception of the educational experts concerned too new and vague to be of much use to them, and are inclined to adhere to their own " training."

A management which means to be efficient in all senses must see to the training of new generations of skilled workers ; it must train up its own teachers,

and look far ahead to produce for itself the kind of people it needs. It has evidently been desired, in the administration of all the chief scientific managers, to arrange for each foreman or skilled man to train up his immediate successor, who meanwhile serves under him ; and this seems often to have excellent results. But a far wider and more completely thought-out scheme than this is necessary. Differentiation must be made, too, in most cases, for young people who come in at different ages, according to their previous education, and according to their aims in a future career. The usual classification in England, as in America, is the boy or girl from an elementary school, the youth from a secondary school, and the college-student. Under present conditions this classification is likely to continue. The college student is specially valuable for time-study observations if he is given the right sort and amount of preliminary experience as well ; and he should also be under training to become an efficiency engineer or efficiency manager. A very good article on the subject of his training was written by Dr. Taylor in 1912, in the *Sibley Journal of Engineering*, entitled " Why Manufacturers dislike the College Graduate." One of the chief reforms advocated in the paper was the alternation of time in some works with time in academic training, each for a period of about a year at a time. This is already the custom in the curriculum for a degree in engineering in England. In America, during the last two or three years, courses of lectures

in scientific management itself have been delivered in certain universities, such as Harvard, in the engineering or commercial schools ; and some new text-books on business organizations treat of efficiency methods. The subject seems hardly yet in the stage at which an elementary text-book is of much value, however ; it is certainly by no means in stereotyped condition, so as to lend itself to formal lessons.

There seems every reason why scientific managers should undertake the greater part of technical training of their workers, building on the preliminary work done at school or college ; but it will be mainly or entirely technical training, not education. They have to avoid on the one hand the excessive paternalism of the employer who desires that *all* the supplementary education, technical and humane, when a youth has once entered his works, should be under his jurisdiction and take place in the works,[1] and the exploiting selfishness of the employer who lets the State do all the training that the youth gets, and expects to start with all workers possessed of some amount of capacity and experience.

While the foregoing pages have been written the industrial world has lost the man who was perhaps in reality the best friend that the movement of

[1] See D. Proud, "Welfare Work," chapter on Education. This may seem a much less crime than the other extreme is ; but one must remember how stimulating to the mind and imagination is a thorough change in environment and atmosphere. The worker must get right away from the works for some part of his *thinking* hours. Miss Addams' chapter on Industrial Amelioration is worth reading again in this connection.

scientific management has had—Mr. R. F. Hoxie. In his last article on the subject [1] he has devoted much space to the question of education, and words in any case well worth quoting have now a double significance as the last from his pen. Those who have conceived him as the implacable foe of the efficiency methods will see here how he envisaged it, in its possibilities, as something that ought to be a great national or international asset ; but the safeguards that would be necessary he desired to see supplied by a perfectly independent national education.

He closes the discussion thus :

" To attempt to limit specialization and restore the old apprenticeship system in the shop would mean to prevent to a large degree the productive effectiveness and the productive improvements which we cannot afford to forego. Moreover, to require that scientific managers themselves maintain training-schools for all their workers, effective in a social sense, would severely penalize and handicap if it did not eliminate, the system.

" Nor do we wish the training of the worker to be centred in the hands and under the control solely of the employer. It seems that what we really need, as a supplement to scientific management—so that we may avail ourselves of its beneficial possibilities and eliminate or minimize its possible evil effects—is an adequate system of industrial education, socially launched and socially controlled—an integral part of our public school system."

[1] *Journal of Political Economy*, Nov., 1916

CHAPTER XVII

THE INSTALLATION OF EFFICIENCY METHODS

It has been said that since the war the "business man"—if by that expression is meant he who commands and directs some large organization of industry—has at last been respectfully treated by the governing class in Great Britain; that his counsel has been valued and followed in national crises, and that he has had proper opportunity to prove, not only his devotion to his country, but his capacity to serve her. And it is naturally assumed by the public, if not by the business men themselves, that now they have been called upon, and have responded so vigorously and satisfactorily, they will remain props of the state in peace-time. It is, indeed, to be hoped that this will be true, for no set of men in the Empire will have a more onerous and important task in rebuilding than the men who have to reconstruct industry.

It will be better to speak of these as managers rather than as employers. For whether the head of an industry takes a primary personal interest in dividends, or whether he himself is employed at a salary to produce dividends, the nature of his

management is the essential matter, the pivot on which all turns. He must put before him, as his first aims, efficiency, leading to increase of quality and quantity of output, and amicable relations with his workers. These form his national duties. If he find some fortunate combination of low labour cost and high wages, he may also produce good dividends. But it will hardly be a national duty to do this; in fact, the nation may continue to disapprove of large dividends. He may remember that, as the economy of high wages has been fairly well established, so has the soundness of a policy of small profits and a large production.

In laying out his course of action to attain these two great aims, any manager will find it worth while to consider very seriously whether the Taylorian methods will help him. This book is not written to persuade him to try them. The authors have hoped it will indicate as clearly as possible what are the actual methods, distinct from pseudo-methods, and what seems the best path towards the really high aims involved; further, to indicate how to avoid the pernicious imitations which pass under the name of "scientific management." These may cause national trouble, if not national disaster, if allowed to grow up on any extensive scale.

The alteration of any existing organization to the new methods is a process which experience has proved to be no easy one to carry out. The expression that rises naturally to one's memory is the inscription on that "pale lure" that Bassanio

finally put his choice on—" Who chooseth me must give and hazard all he hath." The operation is invariably a lengthy one, even when conditions are most favourable. Taylor spoke of its taking from three to five years to complete. There are two main reasons for its being slow. In the first place so much work of standardization is required before there can be any detailed planning or costing. And as the general principles of the standards, the classification, and so on, once set up must remain—for it would be most inconvenient to alter them—a very large amount of careful investigation and forethought is necessary for their formulation. In the second place, the human elements concerned must receive constant and concentrated attention. Swift, drastic changes in any organization are apt to produce a restless feeling among the members, which is itself a cause of inefficient and incoherent working. In many cases it will take an individual six months to be thoroughly familiar with his new conditions and responsibilities. But, further, rapid change may produce actual hostility towards and mistrust of the administrative heads, which will be a hopeless barrier against any realization of co-operation between manager and subordinate. Then many of the characteristics of efficiency methods are already regarded with prejudice and suspicion by workers. Experience under management of the old school has taught them that the appearance of a man with a stop-watch has usually presaged a cut in piece-rates. And as we have already said, there

have been scandalous examples of the worst sort of speeding-up of workmen by methods superficially resembling time- and motion-study, with no fatigue-study, no allowances, as well as no real *elemental* time-study. These facts are greatly to be regretted, as the use of the studies, in the proper hands, should prove as much a help to the workman in making his work convenient and more pleasant as they are to the commercial success of the undertaking.

Detailed planning of work must be introduced with much care and tact, otherwise it is apt to be resented and strongly resisted by the foremen. They are naturally ready to resent any curtailing of their scope and authority, and are given to regard an " order-of-work " clerk as an interloper. Their dislike of him may show itself in constant complaints about his instructions, and those of the planning department generally ; and also in a silent obstruction of his work.

The actual starting-point and the lines of development must be decided by the conditions in each case. No hard-and-fast programme can be laid out. But one preliminary is essential, and must be taken in hand at the outset. The statistics of all kinds, which indicate the present condition of affairs before the change is begun, must be carefully ascertained and compiled. Otherwise there is nothing to start from, and nothing to compare progress with. This compilation will take time and money, as many data will be required which in most cases are not ready to hand ; and reorganization may have to

wait until this thorough overhauling has been accomplished.

Full and complete standardization of tools, material and general equipment usually forms the first step when all is ready. Before this is complete, the segregation of similar machines and appliances can be made, and this rearrangement will form a good opportunity to initiate the system of functional foremen, with more specialized duties.

Another innovation which can often be brought in at an early stage is the establishment of a form of instruction card, not yet, of course, based as it will be eventually on time- and motion-study, but one giving instruction in the details of work, particularly the speed of the machines, which is drawn up by a skilled and experienced operator placed in the office. He can have men with the functions of the "speed-bosses" working under him in the shops. A card of this kind will at any rate supersede the old-fashioned method of the foreman guessing at proper times and speeds; it may be made a natural development out of any rate-fixing organization that already exists. When its meaning is carefully explained to the workers it should become popular with them; especially if they are only semi-skilled. Written instructions can be made very acceptable, and these will pave the way for the permanent instruction card that will follow later on.

Specification of process and of material cannot be carried out effectively until materials and equipment have undergone a considerable amount of

standardization. When specification is begun, the "progress department," which has probably existed in some form, can be reorganized to form the germ of the planning department proper, and when this nears completion in its development the costing department can be adapted to carry out the more detailed costing which is so important a part of the programme. It is true that this will entail more clerical labour, in making the records of the actual time used in the shops. Therefore the time-keeping section should have been strengthened, and have been given some new training and coaching, before any revised plan for the costing routine is tried.

Each section of the new organization must pass through various stages of evolution; and no good result can come from any attempt to hurry or anticipate these stages, or from taking any step which is not definitely directed and worked out. The whole actual programme in its entirety should be laid down before the first move is made, and each step should be made when the time is ripe, not before. Moreover, the steps should have a logical sequence and coherence, and each should to the utmost extent possible demonstrate to every member of the organization a slow but steady advance in efficiency. They should feel assured, too, that their own positions are improved by each change that directly affects them. In this way, if no false step is made, everybody will begin to rely on the management, and to believe that it means to dis-

charge the function it has taken on itself of making people's work easy and pleasant. Everyone will begin to live in that atmosphere of confidence and willing co-operation which it is the desire of the genuine efficiency engineer to create. If this atmosphere is once created and becomes natural, it will not be easily destroyed, as it will become the traditional tone of the place, the only effective safeguard for its permanent stability in any non-material sense ; but in the initial stages the mental and moral atmosphere is the most unstable factor.

The amount of patience, forethought and tact required from the individuals who set out to establish these changes cannot be too much emphasized. They may find they are able to avail themselves of expert help from outside, if they can secure advice from people with genuine experience ; but we might say with much greater force that they must avail themselves of help from inside. This not only because each person accepts a change in routine ten times more willingly if he has been consulted about it, but because everybody's special knowledge and experience is to be utilized.

It would obviously be futile to embark on any details in these mere suggestions of how to instal efficiency methods ; one industry differs in many ways from another. A good deal of detailed description of schemes actually in working is to be found in American books :—Concerning the operations in railways in Emerson's books. For engineering shops there is Parkhurst's " Applied Methods of

Scientific Management," also various articles in the C. B. Thompson Collection. There are special articles on the operations in naval shipyards in this Collection, and also in the publications of the American Society of Naval Engineers. "Concrete Costs" has already been mentioned as a very complete guide to its own subject. Office organization is treated in an article by J. G. Frederick and H. S. McCormack in *System*, vol. xxi. Mrs. Frederick, fired with the excellent idea of introducing some efficiency into domestic affairs, particularly in work where motions can be studied and simplified, has given in her "New Housekeeping" very valuable suggestions as to how a modern kitchen can be planned. This will at any rate show, to those who do not take much interest in "pots and pans," that the range of activities to which scientific method and motion-studies can be applied is extremely large.

At present managers in England are not likely to be troubled by the existence of individuals advertising themselves as experts ready to come in and advise about installation of "scientific" methods; but it is possible that they may arise. They seem to have been the most active enemies that the real methods in America have had, and to have done them endless harm. In the *Iron Age* for January, 1913, Mr. R. T. Kent discusses this prevailing curse and its cure. He observes justly that if an outsider to a business is to be entrusted with any important part of its reorganization, the manufacturers must

be assured that he is a thorough, competent, and experienced engineer; his record is everything, his promises nothing; in fact, a candidate who promises very glibly is entirely to be distrusted. The affair is not one of juggling with figures about time saved here and expense saved there. Mr. Kent hopes a good deal from the institution of two new societies of engineers, both formed in 1912. One, called the *Efficiency Society*, is rather wide in its scope, but includes among its aims making a list of those of its members who are engineers who can undertake management. The other, the *Society to Promote the Science of Management*, is more definitely committed to Taylorian methods, and consists of members who have already operated, or are now being trained to operate, by those methods. A third and younger society, the *Taylor Co-operators*, dates from the time of his death, and is pledged to carry on the general propaganda of the methods on the lines he had laid down for his own activities as consultant in his last years.

It would seem only right to conclude this discussion of installation by some statements as to the results to be obtained by efficiency methods. But people with some experience will be quite aware that results given merely as printed figures are not very convincing. The English establishments which are trying the methods are, very wisely, not making any premature statements of results; and the quickly changing, essentially temporary, conditions in which we all live at present make comparison

with past results almost valueless. Mr. H. B. Drury devotes a chapter of his treatise to an account of the chief American works in which the methods have been, or are now being, tried; but points out, among other just observations, that the magnitude of the changes recorded as results must depend very much on the previous state of the works in question.

Again, we cannot set up one single criterion by which to judge and compare, nor will all the results which we want to see be measurable in figures. Figures might give directly the "high wages with low labour cost" which were Taylor's aim, but these will bear the possible imputations of driving and otherwise exploiting workers

There is much to be said for the manager who is willing to stake his reputation on his small labour "turnover," indicating that his workers are neither exhausted nor dissatisfied, and that good workers are valued by the firm. This statistic would refute hostile criticism more effectually than the mere statement that there had been no strikes, which might merely mean no organization among the workers. But to weigh the value of the figures for labour turnover properly, we should need to know the labour conditions in the neighbourhood.

Again, time is needed to show the full effect of a system which is to occupy a long time in installation; time to estimate the changes in finance, in organization, and in the mental and physical condition of all the employés. And, after results have been pub-

lished, for any success to be continuous there must still be the right sort of men in charge to carry on the concern in the right way. No manager would consent to have his record marked up periodically by statistics alone as if it were a mere matter of arithmetical computation.

It would probably be a great service to the British industrial world generally if some municipal or other public industrial undertaking were allowed to instal efficiency methods according to the best possible lights, and to work quietly, without much publicity or outside criticism, for three or four years; after which it might invite and carry out a thorough investigation from within and without, and issue a report of results which would be without any bias. Success could be acknowledged and traced to its proper source; failure could be acknowledged just as freely, without any reason for concealment, and even a failure would be an experiment of great public utility, and, as such, worth some expenditure of public money.

The following figures have been taken from the works of Taylor and Gantt, from H. B. Drury's book, and from Mr. Brandeis's brief in favour of Scientific Management at the Interstate Commission. They have been recalculated in a good many instances so that they may all be presented in the same form.

Bethlehem Works. F. W. Taylor. ("Shop Management," p. 34.)	Per cent.
Cost of handling 1 ton raw material decreased by	54
Average earnings per man increased by	61

	Per cent.
Average no. of tons handled per man per day increased	256
No. of labourers required for same amount of work decreased by	72

MIDVALE WORKS. F. W. TAYLOR.
("Shop Management," p. 82.)

Cost per piece decreased by	41
Average earnings per man increased by	40

GIRLS INSPECTING BICYCLE BALLS. S. B. THOMPSON.
("Shop Management," p. 89.)

No. of girls employed decreased by	81
Average earnings per girl increased by	93
Accuracy of work estimated greater by	33

(The girls worked 8½ hours a day with a half-holiday, instead of 10½ hours without.)

BLEACHERY. H. GANTT.
("Work, Wages, and Profits.")

Increase in output	200
Decrease in labour cost	40
Increase in wages	40
Average of four establishments—	
Output increase	100-200
Cost decrease	40
Wages increase	20-50

See also his Charts, p. 207 *seq.*

BRICKLAYING UNDER F. B. GILBRETH'S IMPROVEMENTS.

Increase in no. of bricks laid—	
By Taylor's statement, S. M.	192
By Gilbreth's statement (Brandeis)	170

BUILDING CONSTRUCTION. F. B. GILBRETH.
(Brandeis, Docket, p. 57.)

Decrease in labour cost	50

	Per cent.
YALE AND TOWNE MANUFACTURING CO. H. R. TOWNE. (Brandeis, Docket, p. 57.)	
Average of 14 branches—	
Decrease in labour cost	32
Decrease in overhead charges	31
TABOR MANUFACTURING WORKS. H. K. HATHAWAY. (Drury, pp. 130-137. Brandeis, Docket.)	
Increase in output	200
Increase in *value* of output	150
Decrease in selling price	10-15
Average increase in wages	25-30
LINK BELT WORKS. J. M. DODGE. (Drury, p. 134.)	
Increase in output	100
Increase in wages	25-30
Decrease in labour cost	50
Decrease in total cost	20
Decrease in selling price	10-15
FERRACUTE WORKS. F. A. PARKHURST. (Drury, p. 144.)	
Time for certain jobs decreased by	62
Average increase in wages	51
Decrease in total cost	53
WATERTOWN ARSENAL. GEN. CROZIER. (C. B. Thompson's Collection, and Drury, p. 138.)	
Increase in output	150
If all men had been on bonus work—	
Average increase in wages	28·6

The saving to the State in decreased estimates and the using up of old stock are not stated in percentages.

There was a good deal of trouble with labour, partly owing to the very unequal distribution of the bonus, which was applied only to certain of the men, and with very varying results.

	Per cent.
RAILROADS. H. EMERSON. (Brandeis, *loc. cit.*)	
Results in this field are not easily compared with the foregoing.	
Average efficiency of workers increased from -	60-100
Average increase on output - - - -	67
Average increase on wages - - -	20

The following special items are worth notice:—

At the Link Belt Works (see Drury, p. 161), the decrease in the amount of stores carried per unit of output was 33 per cent. This was partly caused, however, by the increase in output.

Mr. Emerson says in "Efficiency" (p. 79), that in the Santa Fé railroad works the average life of belting has increased six-fold and the cost of maintenance decreased to one-seventh by proper attention.

An American enthusiast[1] for efficiency methods has lately discovered the kernel of the whole matter in Bacon's Twenty-fifth Essay—on Dispatch! This little sermon on business certainly contains singularly *apropos* remarks, upon which the business man may well meditate; so that the present writers gladly adopt it as final comment, recognizing their good fortune in being able to make an end with a passage so well worth reading for its own sake.

"Affected dispatch is one of the most dangerous

[1] H. D. Minich. "Francis Bacon, Efficiency Engineer," *Engineering Magazine*, vol. xlvii., p. 733.

things to business that can be. . . . Therefore measure not dispatch by the times of setting, but by the advancement of the business. On the other hand true dispatch is a rich thing. For time is the measure of business as money is of wares, and business is bought at a dear hand where there is small dispatch. . . . Above all things, order and distribution and singling out of parts is the life of dispatch, so as the distribution be not too subtile. For . . . he that does not divide will never enter well into business, and he that divideth too much will never come out of it clearly. To choose time is to save time, and an unseasonable motion is but beating the air. . . . There be three parts to business: the preparation, the debate or examination, and the perfection. Whereof, if you look for dispatch, let the middle one only be the work of many, and the first and last the work of few. . . . The proceeding upon somewhat conceived in writing doth for the most part facilitate dispatch."

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