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Scientific Management

Frederick W. Taylor

The writer has found that there are three questions uppermost in the minds of men when they become interested in scientific management.

First. Wherein do the principles of scientific management differ essentially from those of ordinary management?

Second. Why are better results attained under scientific management than under the other types?

Third. Is not the most important problem that of getting the right man at the head of the company? And if you have the right man cannot the choice of the type of management be safely left to him?

One of the principal objects of the following pages will be to give a satisfactory answer to these questions. . . .

Before starting to illustrate the principles of scientific management, or "task management" as it is briefly called, it seems desirable to outline what the writer believes will be recognized as the best type of management which is in common use. This is done so that the great difference between the best of the ordinary management and scientific management may be fully appreciated.

In an industrial establishment which employs say from 500 to 1000 workmen, there will be found in many cases at least twenty to thirty different trades. The workmen in each of these trades have had their knowledge handed down to them by word of mouth, through the many years in which their trade has been developed from the primitive condition, in which our far-distant ancestors each one practised the rudiments of many different trades, to the present state of great and growing subdivision of labor, in which each man specializes upon some comparative small class of work.

The ingenuity of each generation has developed quicker and better methods for doing every element of the work in every trade. Thus the methods which are now in use may in a broad sense be said to be an

evolution representing the survival of the fittest and best of the ideas which have been developed since the starting of each trade. However, while this is true in a broad sense, only those who are intimately acquainted with each of these trades are fully aware of the fact that in hardly any element of any trade is there uniformity in the methods which are used. Instead of having only one way which is generally accepted as a standard, there are in daily use, say, fifty or a hundred different ways of doing each element of the work. And a little thought will make it clear that this must inevitably be the case, since our methods have been handed down from man to man by word of mouth, or have, in most cases, been almost unconsciously learned through personal observation. Practically in no instances have they been codified or systematically analyzed or described. The ingenuity and experience of each generation—of each decade, even, have without doubt handed over better methods to the next. This mass of rule-of-thumb or traditional knowledge may be said to be the principal asset or possession of every tradesman. Now, in the best of the ordinary types of management, the managers recognize frankly the fact that the 500 or 1000 workmen, included in the twenty to thirty trades, who are under them, possess this mass of traditional knowledge, a large part of which is not in the possession of the management. The management, of course, includes foremen and superintendents, who themselves have been in most cases first-class workers at their trades. And yet these foremen and superintendents know, better than anyone else, that their own knowledge and personal skill falls far short of the combined knowledge and dexterity of all the workmen under them. The most experienced managers therefore frankly place before their workmen the problem of doing the work in the best and most economical way. They recognize the task before them as that of inducing each workman to use his best endeavors, his hardest work, all his traditional knowledge, his skill, his ingenuity, and his goodwill—in a word, his "initiative," so as to yield the largest possible return to his employer. The problem before the management, then, may be briefly said to be that of obtaining the best *initiative* of every workman. And the writer uses the word "initiative" in its broadest sense, to cover all of the good qualities sought for from the men.

On the other hand, no intelligent manager would hope to obtain in any full measure the initiative of his workmen unless he felt that he was giving them something more than they usually receive from their employers. Only those among the readers of this paper who have been managers or who have worked themselves at a trade realize how far the average workman falls short of giving his employer his full initiative. It is well within the mark to state that in nineteen out of twenty industrial establishments the workmen believe it to be directly against their interests to give their employers their best initiative, and that instead of working hard to do the largest possible amount of work and the best quality of work for their employers, they deliberately work as slowly as they dare while they

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at the same time try to make those over them believe that they are working fast.¹

The writer repeats, therefore, that in order to have any hope of obtaining the initiative of his workmen the manager must give some *special incentive* to his men beyond that which is given to the average of the trade. This incentive can be given in several different ways, as, for example, the hope of rapid promotion or advancement; higher wages, either in the form of generous piecework prices or of a premium or bonus of some kind for good and rapid work; shorter hours of labor; better surroundings and working conditions than are ordinarily given, etc., and, above all, this special incentive should be accompanied by the personal consideration for, and friendly contact with, his workmen which comes only from a genuine and kindly interest in the welfare of those under him. It is only by giving a special inducement or "incentive" of this kind that the employer can hope even approximately to get the "initiative" of his workmen. Under the ordinary type of management the necessity for offering the workman a special inducement has come to be so generally recognized that a large proportion of those most interested in the subject look upon the adoption of some one of the modern schemes for paying men (such as piece work, the premium plan, or the bonus plan, for instance) as practically the whole system of management. Under scientific management, however, the particular pay system which is adopted is merely one of the subordinate elements.

Broadly speaking, then, the best type of management in ordinary use may be defined as management in which the workmen give their best *initiative* and in return receive some *special incentive* from their employers. This type of management will be referred to as the management of "*initiative and incentive*" in contradistinction to scientific management, or task management, with which it is to be compared.

The writer hopes that the management of "*initiative and incentive*" will be recognized as representing the best type in ordinary use, and in fact he believes that it will be hard to persuade the average manager that anything better exists in the whole field than this type. The task which the writer has before him, then, is the difficult one of trying to prove in a thoroughly convincing way that there is another type of management which is not only better but overwhelmingly better than the management of "*initiative and incentive*."

The universal prejudice in favor of the management of "*initiative and incentive*" is so strong that no mere theoretical advantages which can be pointed out will be likely to convince the average manager that any other system is better. It will be upon a series of practical illustrations of the actual working of the two systems that the writer will depend in his efforts to prove that scientific management is so greatly superior to other types. Certain elementary principles, a certain philosophy, will however be recognized as the essence of that which is being illustrated in all of the

practical examples which will be given. And the broad principles in which the scientific system differs from the ordinary or "rule-of-thumb" system are so simple in their nature that it seems desirable to describe them before starting with the illustrations.

Under the old type of management success depends almost entirely upon getting the "initiative" of the workmen, and it is indeed a rare case in which this initiative is really attained. Under scientific management the "initiative" or the workmen (that is, their hard work, their good-will, and their ingenuity) is obtained with absolute uniformity and to a greater extent than is possible under the old system; and in addition to this improvement on the part of the men, the managers assume new burdens, new duties, and responsibilities never dreamed of in the past. The managers assume, for instance, the burden of gathering together all of the traditional knowledge which in the past has been possessed by the workmen and then of classifying, tabulating, and reducing this knowledge to rules, laws, and formulæ which are immensely helpful to the workmen in doing their daily work. In addition to developing a *science* in this way, the management take on three other types of duties which involve new and heavy burdens for themselves.

These new duties are grouped under four heads:

- First.* They develop a science for each element of a man's work, which replaces the old rule-of-thumb method.
- Second.* They scientifically select and then train, teach, and develop the workman, whereas in the past he chose his own work and trained himself as best he could.
- Third.* They heartily cooperate with the men so as to insure all of the work being done in accordance with the principles of the science which has been developed.
- Fourth.* There is an almost equal division of the work and the responsibility between the management and the workmen. The management take over all work for which they are better fitted than the workmen, while in the past almost all of the work and the greater part of the responsibility were thrown upon the men.

It is this combination of the initiative of the workmen, coupled with the new types of work done by the management, that makes scientific management so much more efficient than the old plan.

Three of these elements exist in many cases, under the management of "*initiative and incentive*," in a small and rudimentary way, but they are, under this management, of minor importance, whereas under scientific management they form the very essence of the whole system.

The fourth of these elements, "an almost equal division of the responsibility between the management and the workmen," requires further explanation. The philosophy of the management of "*initiative and incen-*

tive" makes it necessary for each workman to bear almost the entire responsibility for the general plan as well as for each detail of his work, and in many cases for his implements as well. In addition to this he must do all of the actual physical labor. The development of a science, on the other hand, involves the establishment of many rules, laws, and formulæ which replace the judgment of the individual workmen and which can be effectively used only after having been systematically recorded, indexed, etc. The practical use of scientific data also calls for a room in which to keep the books, records,² etc., and a desk for the planner to work at. Thus all of the planning which under the old system was done by the workman, as a result of his personal experience, must of necessity under the new system be done by the management in accordance with the laws of the science; because even if the workman was well suited to the development and use of scientific data, it would be physically impossible for him to work at his machine and at a desk at the same time. It is also clear that in most cases one type of man is needed to plan ahead and an entirely different type to execute the work.

The man in the planning room, whose specialty under scientific management is planning ahead, invariably finds that the work can be done better and more economically by a subdivision of the labor; each act of each mechanic, for example, should be preceded by various preparatory acts done by other men. And all of this involves, as we have said, "an almost equal division of the responsibility and the work between the management and the workman."

To summarize: Under the management of "initiative and incentive" practically the whole problem is "up to the workman," while under scientific management fully one-half of the problem is "up to the management."

Perhaps the most prominent single element in modern scientific management is the task idea. The work of every workman is fully planned out by the management at least one day in advance, and each man receives in most cases complete written instructions, describing in detail the task which he is to accomplish, as well as the means to be used in doing the work. And the work planned in advance in this way constitutes a task which is to be solved, as explained above, not by the workman alone, but in almost all cases by the joint effort of the workman and the management. This task specifies not only what is to be done but how it is to be done and the exact time allowed for doing it. And whenever the workman succeeds in doing his task right, and within the time limit specified, he receives an addition of from 30 per cent to 100 percent to his ordinary wages. These tasks are carefully planned, so that both good and careful work are called for in their performance, but it should be distinctly understood that in no case is the workman called upon to work at a pace which would be injurious to his health. The task is always so regulated that the man who is well suited to his job will thrive while working at this

rate during a long term of years and grow happier and more prosperous, instead of being overworked. Scientific management consists very largely in preparing for and carrying out these tasks.

The writer is fully aware that to perhaps most of the readers of this paper the four elements which differentiate the new management from the old will at first appear to be merely high-sounding phrases; and he would again repeat that he has no idea of convincing the reader of their value merely through announcing their existence. His hope of carrying conviction rests upon demonstrating the tremendous force and effect of these four elements through a series of practical illustrations. It will be shown, first, that they can be applied absolutely to all classes of work, from the most elementary to the most intricate; and second, that when they are applied, the results must of necessity be overwhelmingly greater than those which it is possible to attain under the management of initiative and incentive.

The first illustration is that of handling pig iron, and this work is chosen because it is typical of perhaps the crudest and most elementary form of labor which is performed by man. This work is done by men with no other implements than their hands. The pig-iron handler stoops down, picks up a pig weighing about 92 pounds, walks for a few feet or yards and then drops it onto the ground or upon a pile. This work is so crude and elementary in its nature that the writer firmly believes that it would be possible to train an intelligent gorilla so as to become a more efficient pig-iron handler than any man can be. Yet it will be shown that the science of handling pig iron is so great and amounts to so much that it is impossible for the man who is best suited to this type of work to understand the principles of this science, or even to work in accordance with these principles without the aid of a man better educated than he is. And the further illustrations to be given will make it clear that in almost all of the mechanic arts, the science which underlies each workman's act is so great and amounts to so much that the workman who is best suited actually to do the work is incapable (either through lack of education or through insufficient mental capacity) of understanding this science. This is announced as a general principle the truth of which will become apparent as one illustration after another is given. After showing these four elements in the handling of pig iron, several illustrations will be given of their application to different kinds of work in the field of the mechanic arts, at intervals in a rising scale, beginning with the simplest and ending with the more intricate forms of labor.

One of the first pieces of work undertaken by us, when the writer started to introduce scientific management into the Bethlehem Steel Company, was to handle pig iron on task work. The opening of the Spanish War found some 80,000 tons of pig iron placed in small piles in an open field adjoining the works. Prices for pig iron had been so low that it could not be sold at a profit, and it therefore had been stored. With the

opening of the Spanish War the price of pig iron rose, and this large accumulation of iron was sold. This gave us a good opportunity to show the workmen, as well as the owners and managers of the works, on a fairly large scale the advantages of task work over the old-fashioned day work and piece work, in doing a very elementary class of work.

The Bethlehem Steel Company had five blast furnaces, the product of which had been handled by a pig-iron gang for many years. This gang, at this time, consisted of about seventy-five men. They were good, average pig-iron handlers, were under an excellent foreman who himself had been a pig-iron handler, and the work was done, on the whole, about as fast and as cheaply as it was anywhere else at the time.

A railroad switch was run out into the field, right along the edge of the piles of pig iron. An inclined plank was placed against the side of a car, and each man picked up from his pile a pig of iron weighing about 92 pounds, walked up the inclined plank and dropped it on the end of the car.

We found that this gang were loading on the average about $12\frac{1}{2}$ long tons per man per day. We were surprised to find, after studying the matter, that a first-class pig-iron handler ought to handle between 47 and 48 long tons per day, instead of $12\frac{1}{2}$ tons. This task seemed to us so very large that we were obliged to go over our work several times before we were absolutely sure that we were right. Once we were sure, however, that 47 tons was a proper day's work for a first-class pig-iron handler, the task which faced us as managers under the modern scientific plan was clearly before us. It was our duty to see that the 80,000 tons of pig iron was loaded onto the cars at the rate of 47 tons per man per day, in place of $12\frac{1}{2}$ tons, at which rate the work was then being done. And it was further our duty to see that this work was done without bringing on a strike among the men, without any quarrel with the men, and to see that the men were happier and better contented when loading at the new rate of 47 tons than they were when loading at the old rate of $12\frac{1}{2}$ tons.

Our first step was the scientific selection of the workman. In dealing with workmen under this type of management, it is an inflexible rule to talk to and deal with only one man at a time, since each workman has his own special abilities and limitations, and since we are not dealing with men in masses, but are trying to develop each individual man to his highest state of efficiency and prosperity. Our first step was to find the proper workman to begin with. We therefore carefully watched and studied these seventy-five men for three or four days, at the end of which time we had picked out four men who appeared to be physically able to handle pig iron at the rate of 47 tons per day. A careful study was then made of each of these men. We looked up their history as far back as practicable and thorough inquiries were made as to the character, habits, and the ambition of each of them. Finally we selected one from among

the four as the most likely man to start with. He was a little Pennsylvania Dutchman who had been observed to trot back home for a mile or so after his work in the evening about as fresh as he was when he came trotting down to work in the morning. We found that upon wages of \$1.15 a day he had succeeded in buying a small plot of ground, and that he was engaged in putting up the walls of a little house for himself in the morning before starting to work and at night after leaving. He also had the reputation of being exceedingly "close," that is, of placing a very high value on a dollar. As one man whom we talked to about him said, "A penny looks about the size of a cart-wheel to him." This man we will call Schmidt.

The task before us, then, narrowed itself down to getting Schmidt to handle 47 tons of pig iron per day and making him glad to do it. This was done as follows. Schmidt was called out from among the gang of pig-iron handlers and talked to somewhat in this way:

"Schmidt, are you a high-priced man?"

"Vell, I don't know vat you mean."

"Oh yes, you do. What I want to know is whether you are a high-priced man or not."

"Vell, I don't know vat you mean."

"Oh, come now, you answer my questions. What I want to find out is whether you are a high-priced man or one of these cheap fellows here. What I want to find out is whether you want to earn \$1.85 a day or whether you are satisfied with \$1.15, just the same as all those cheap fellows are getting."

"Did I vant \$1.85 a day? Vas dot a high-priced man? Vell, yes, I was a high-priced man."

"Oh, you're aggravating me. Of course you want \$1.85 a day—everyone wants it! You know perfectly well that that has very little to do with your being a high-priced man. For goodness' sake answer my questions, and don't waste any more of my time. Now come over here. You see that pile of pig iron?"

"Yes."

"You see that car?"

"Yes."

"Well, if you are a high-priced man, you will load the pig iron on that car tomorrow for \$1.85. Now do wake up and answer my question. Tell me whether you are a high-priced man or not."

"Vell—did I got \$1.85 for loading dot pig iron on dot car tomorrow?"

"Yes, of course you do, and you get \$1.85 for loading a pile like that every day right through the year. That is what a high-priced man does, and you know it just as well as I do."

"Vell, dot's all right. I could load dot pig iron on the car tomorrow for \$1.85, and I get it every day, don't I?"

"Certainly you do—certainly you do."

"Vell, den, I was a high-priced man."

"Now, hold on, hold on. You know just as well as I do that a high-priced man has to do exactly as he's told from morning till night. You have seen this man here before, haven't you?"

"No, I never saw him."

"Well, if you are a high-priced man, you will do exactly as this man tells you tomorrow, from morning till night. When he tells you to pick up a pig and walk, you pick it up and you walk, and when he tells you to sit down and rest, you sit down. You do that right straight through the day. And what's more, no back talk. Now a high-priced man does just what he's told to do, and no back talk. Do you understand that? When this man tells you to walk, you walk; when he tells you to sit down, you sit down, and you don't talk back at him. Now you come on to work here tomorrow morning and I'll know before night whether you are really a high-priced man or not."

This seems to be rather rough talk. And indeed it would be if applied to an educated mechanic, or even an intelligent laborer. With a man of the mentally sluggish type of Schmidt it is appropriate and not unkind, since it is effective in fixing his attention on the high wages which he wants and away from what, if it were called to his attention, he probably would consider impossibly hard work.

What would Schmidt's answer be if he were talked to in a manner which is usual under the management of "initiative and incentive"? say, as follows:

"Now, Schmidt, you are a first-class pig-iron handler and know your business well. You have been handling at the rate of $12\frac{1}{2}$ tons per day. I have given considerable study to handling pig iron, and feel sure that you could do a much larger day's work than you have been doing. Now don't you think that if you really tried you could handle 47 tons of pig iron per day, instead of $12\frac{1}{2}$ tons?"

What do you think Schmidt's answer would be to this?

Schmidt started to work, and all day long, and at regular intervals, was told by the man who stood over him with a watch, "Now pick up a pig and walk. Now sit down and rest. Now walk—now rest," etc. He worked when he was told to work, and rested when he was told to rest, and at half-past five in the afternoon had his $47\frac{1}{2}$ tons loaded on the car. And he practically never failed to work at this pace and do the task that was set him during the three years that the writer was at Bethlehem. And throughout this time he averaged a little more than \$1.85 per day, whereas before he had never received over \$1.15 per day, which was the ruling rate of wages at the time in Bethlehem. That is, he received 60 per cent higher wages than were paid to other men who were not working on task work. One man after another was picked out and trained to handle pig iron at the rate of $47\frac{1}{2}$ tons per day until all of the pig iron was handled

at this rate, and the men were receiving 60 percent more wages than other workmen around them.

The writer has given above a brief description of three of the four elements which constitute the essence of scientific management: first, the careful selection of the workman, and, second and third, the method of first inducing and then training and helping the workman to work according to the scientific method. Nothing has as yet been said about the science of handling pig iron. The writer trusts, however, that before leaving this illustration the reader will be thoroughly convinced that there is a science of handling pig iron, and further that this science amounts to so much that the man who is suited to handle pig iron cannot possibly understand it, nor even work in accordance with the laws of this science, without the help of those who are over him.

The law is confined to that class of work in which the limit of a man's capacity is reached because he is tired out. It is the law of heavy laboring, corresponding to the work of the cart horse, rather than that of the trotter. Practically all such work consists of a heavy pull or a push on the man's arms, that is, the man's strength is exerted by either lifting or pushing something which he grasps in his hands. And the law is that for each given pull or push on the man's arms it is possible for the workman to be under load for only a definite percentage of the day. For example, when pig iron is being handled (each pig weighing 92 pounds), a first-class workman can only be under load 43 percent of the day. He must be entirely free from load during 57 percent of the day. And as the load becomes lighter, the percentage of the day under which the man can remain under load increases. So that, if the workman is handling a half pig weighing 46 pounds, he can then be under load 58 per cent of the day, and only has to rest during 42 per cent. As the weight grows lighter the man can remain under load during a larger and larger percentage of the day, until finally a load is reached which he can carry in his hands all day long without being tired out. When that point has been arrived at this law ceases to be useful as a guide to a laborer's endurance, and some other law must be found which indicates the man's capacity for work.

When a laborer is carrying a piece of pig iron weighing 92 pounds in his hands, it tires him about as much to stand still under the load as it does to walk with it, since his arm muscles are under the same severe tension whether he is moving or not. A man, however, who stands still under a load is exerting no horse-power whatever, and this accounts for the fact that no constant relation could be traced in various kinds of heavy laboring work between the foot-pounds of energy exerted and the tiring effect of the work on the man. It will also be clear that in all work of this kind it is necessary for the arms of the workman to be completely free from load (that is, for the workman to rest) at frequent intervals. Throughout the time that the man is under a heavy load the tissues of his

arm muscles are in process of degeneration, and frequent periods of rest are required in order that the blood may have a chance to restore these tissues to their normal condition.

To return now to our pig-iron handlers at the Bethlehem Steel Company. If Schmidt had been allowed to attack the pile of 47 tons of pig iron without the guidance or direction of a man who understood the art, or science, of handling pig iron, in his desire to earn his high wages he would probably have tired himself out by eleven or twelve o'clock in the day. He would have kept so steadily at work that his muscles would not have had the proper periods of rest absolutely needed for recuperation, and he would have been completely exhausted early in the day. By having a man, however, who understood this law, stand over him and direct his work, day after day, until he acquired the habit of resting at proper intervals, he was able to work at an even gait all day long without unduly tiring himself.

Now one of the very first requirements for a man who is fit to handle pig iron as a regular occupation is that he shall be so stupid and so phlegmatic that he more nearly resembles in his mental make-up the ox than any other type. The man who is mentally alert and intelligent is for this very reason entirely unsuited to what would, for him, be the grinding monotony of work of this character. Therefore the workman who is best suited to handling pig iron is unable to understand the real science of doing this class of work. He is so stupid that the word "percentage" has no meaning to him, and he must consequently be trained by a man more intelligent than himself into the habit of working in accordance with the laws of this science before he can be successful.

The writer trusts that it is now clear that even in the case of the most elementary form of labor that is known, there is a science, and that when the man best suited to this class of work has been carefully selected, when the science of doing the work has been developed, and when the carefully selected man has been trained to work in accordance with this science, the results obtained must of necessity be overwhelmingly greater than those which are possible under the plan of "initiative and incentive."

Notes

1. The writer has tried to make the reason for this unfortunate state of things clear in a paper entitled "Shop Management," read before the American Society of Mechanical Engineers.

2. For example, the records containing the data used under scientific management in an ordinary machine shop fill thousands of pages.

5 The Real Meaning of Taylorism

Harry Braverman

First Principle

"The managers assume . . . the burden of gathering together all of the traditional knowledge which in the past has been possessed by the workmen and then of classifying, tabulating, and reducing this knowledge to rules, laws, and formulae. . . ." We have seen the illustrations of this in the cases of the lathe machinist and the pig-iron handler. The great disparity between these activities, and the different orders of knowledge that may be collected about them, illustrate that for Taylor—as for managers today—no task is either so simple or so complex that it may not be studied with the object of collecting in the hands of management at least as much information as is known by the worker who performs it regularly, and very likely more. This brings to an end the situation in which "Employers derive their knowledge of how much of a given class of work can be done in a day from either their own experience, which has frequently grown hazy with age, from casual and unsystematic observation of their men, or at best from records which are kept, showing the quickest time in which each job has been done." It enables management to discover and enforce those speedier methods and shortcuts which workers themselves, in the practice of their trades or tasks, learn or improvise, and use at their own discretion only. Such an experimental approach also brings into being new methods such as can be devised only through the means of systematic study.

This first principle we may call the *dissociation of the labor process from the skills of the workers*. The labor process is to be rendered independent of craft, tradition, and the workers' knowledge. Henceforth it is to depend not at all upon the abilities of workers, but entirely upon the practices of management.