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The Principles of Scientific Management

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By far the most important fact which faces the industries of our country, the industries, in fact, of the civilized world, is that not only the average worker, but nineteen out of twenty workmen throughout the civilized world firmly believe that it is for their best interests to go slow instead of to go fast. They firmly believe that it is for their interest to give as little work in return for the money that they get as is practical. The reasons for this belief are twofold, and I do not believe that the workingmen are to blame for holding these fallacious views.

If you will take any set of workmen in your own town and suggest to those men that it would be a good thing for them in their trade if they were to double their output in the coming year, each man turn out twice as much work and become twice as efficient, they would say, "I don't know anything about other people's trades; what you are saying about increasing efficiency being a good thing may be good for other trades, but I know that the only result if you come to our trade would be that half of us would be out of a job before the year was out." That to the average workingman is an axiom; it is not a matter subject to debate at all. And even among the average business men of this country that opinion is almost universal. They firmly believe that that would be the result of a great increase in efficiency, and yet directly the opposite is true.

THE EFFECT OF LABOR-SAVING DEVICES

Whenever any labor-saving device of any kind has been introduced into any trade—go back into the history of any trade and see it—even though that labor-saving device may turn out ten, twenty, thirty times that output that was originally turned out by men in that trade, the result has universally been to make work for more men in that trade, not work for less men.

Let me give you one illustration. Let us take one of the staple businesses, the cotton industry. About 1840 the power loom succeeded the old hand loom in the cotton industry. It was invented many years before, somewhere about 1780 or 1790, but it came in very slowly. About 1840 the weavers of Manchester, England, saw that the power loom was coming, and they knew it would turn out three times the yardage of cloth in a day that the hand loom turned out. And what did they do, these five thousand weavers of Manchester, England, who saw starvation staring them in the face? They broke into the establishments into which those machines were being introduced, they smashed them, they did everything possible to stop the introduction of the power loom. And the same result followed that follows every attempt to interfere with the introduction of any labor-saving device, if it is really a

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labor-saving device. Instead of stopping the introduction of the power loom, their opposition apparently accelerated it, just as opposition to scientific management all over the country, bitter labor opposition today, is accelerating the introduction of it instead of retarding it. History repeats itself in that respect. The power loom came right straight along.

And let us see the result in Manchester. Just what follows in every industry when any labor-saving device is introduced. Less than a century has gone by since 1840. The population of England in that time has now more than doubled. Each man in the cotton industry in Manchester, England, now turns out, at a restricted estimate ten yards of cloth for every yard of cloth that was turned out in 1840. In 1840 there were 5,000 weavers in Manchester. Now there are 265,000. Has that thrown men out of work? Has the introduction of labor-saving machinery, which has multiplied the output per man by tenfold, thrown men out of work?

What is the real meaning of this? All that you have to do is to bring wealth into this world and the world uses it. That is the real meaning. The meaning is that where in 1840 cotton goods were a luxury to be worn only by rich people when they were hardly ever seen on the street, now every man, woman, and child all over the world wears cotton goods as a daily necessity.

Nineteen-twentieths of the real wealth of this world is used by the poor people, and not the rich, so that the workingman who sets out as a steady principle to restrict output is merely robbing his own kind. That group of manufacturers which adopts as a permanent principle restriction of output, in order to hold up prices, is robbing the world. The one great thing that marks the improvement of this world is measured by the enormous increase in output of the individuals in this world. There is fully twenty times the output per man now that there was three hundred years ago. That marks the increase in the real wealth of the world; that marks the increase of the happiness of the world, that gives us the opportunity for shorter hours, for better education, for amusement, for art, for music, for everything that is worthwhile in this world—goes right straight back to this increase in the output of the individual. The workingmen of today live better than the king did three hundred years ago. From what does the progress the world has made come? Simply from the increase in the output of the individual all over the world.

THE DEVELOPMENT OF SOLDIERING

The second reason why the workmen of this country and of Europe deliberately restrict output is a very simple one. They, for this reason, are even less to blame than they are for the other. If, for example, you are manufacturing a pen, let us assume for simplicity that a pen can be made by a single man. Let us say that the workman is turning out ten pens per day, and that he is receiving $2.50 a day for his wages. He has a progressive foreman who is up to date, and that foreman goes to the workman and suggests, "Here, John, you are getting $2.50 a day, and you are turning out ten pens. I would suggest that I pay you 25 cents for making that pen." The man takes the job, and through the help of his foreman, through his own ingenuity, through his increased work, through his interest in his business, through the help of his friends, at the end of the year he finds himself turning out twenty pens instead of ten. He is happy, he is making $5, instead of $2.50 a day. His foreman is happy because, with the same room, with the same men he had before, he has doubled the output of his department, and

the manufacturer himself is sometimes happy, but not often. Then someone on the board of directors asks to see the payroll, and he finds that we are paying $5 a day where other similar mechanics are only getting $2.50, and in no uncertain terms he announces that we must stop ruining the labor market. We cannot pay $5 a day when the standard rate of wages is $2.50; how can we hope to compete with surrounding towns? What is the result? Mr. Foreman is sent for, and he is told that he has got to stop ruining the labor market of Cleveland. And the foreman goes back to his workman in sadness, in depression, and tells his workman, "I am sorry, John, but I have got to cut the price down for that pen; I cannot let you earn $5 a day; the board of directors has got on to it, and it is ruining the labor market; you ought to be willing to have the price reduced. You cannot earn more than $3 or $2.75 a day, and I will have to cut your wages so that you will only get $3 a day." John, of necessity accepts the cut, but he sees to it that he never makes enough pens to get another cut.

CHARACTERISTICS OF THE UNION WORKMAN

There seem to be two divergent opinions about the workmen of this country. One is that a lot of the trade unions' workmen, particularly in this country, have become brutal, have become dominating, careless of any interests but their own, and are a pretty poor lot. And the other opinion which those same trade unionists hold of themselves is that they are pretty close to little gods. Whichever view you may hold of the workingmen of this country, and my personal view of them is that they are a pretty fine lot of fellows, they are just about the same as you and I. But whether you hold the bad opinion or the good opinion, it makes no difference. Whatever the workingmen of this country are or whatever they are not, they are not fools. And all that is necessary is for a workingman to have but one object lesson, like that I have told you, and he soldiers for the rest of his life.

There are a few exceptional employers who treat their workmen differently, but I am talking about the rule of the country. Soldiering is the absolute rule with all workmen who know their business. I am not saying it is for their interest to soldier. You cannot blame them for it. You cannot expect them to be large enough minded men to look at the proper view of the matter. Nor is the man who cuts the wages necessarily to blame. It is simply a misfortune in industry.

THE DEVELOPMENT OF SCIENTIFIC MANAGEMENT

There has been, until comparatively recently, no scheme promulgated by which the evils of rate cutting could be properly avoided, so soldiering has been the rule.

Now the first step that was taken toward the development of those methods, of those principles, which rightly or wrongly have come to be known under the name of scientific management—the first step that was taken in an earnest endeavor to remedy the evils of soldiering; an earnest endeavor to make it unnecessary for workmen to be hypocritical in this way, to deceive themselves, to deceive their employers, to live day in and day out a life of deceit, forced upon them conditions—the very first step that was taken toward the development was to overcome that evil. I want to emphasize that, because I wish to emphasize the one great fact relating to scientific management, the greatest factor: namely, that scientific management is no new set of theories that has been tried

on by any one at every step. Scientific management at every step has been an evolution, not a theory. In all cases the practice has preceded the theory, not succeeded it. In every case one measure after another has been tried out, until the proper remedy has been found. That series of proper eliminations, that evolution, is what is called scientific management. Every element of it has had to fight its way against the elements that preceded it, and prove itself better or it would not be there tomorrow.

All the men that I know of who are in any way connected with scientific management are ready to abandon any scheme, and theory in favor of anything else that could be found that is better. There is nothing in scientific management that is fixed. There is no one man, or group of men, who have invented scientific management.

What I want to emphasize is that all of the elements of scientific management are an evolution, not an invention. Scientific management is in use in an immense range and variety of industries. Almost every type of industry in this country has scientific management working successfully. I think I can safely say that on the average in those establishments in which scientific management has been introduced, the average workman is turning out double the output he was before. I think that is a conservative statement.

THE WORKMEN THE CHIEF BENEFICIARIES

Three or four years ago I could have said there were about fifty thousand men working under scientific management, but now I know there are many more. Company after company is coming under it, many of which I know nothing about. Almost universally they are working successfully. This increasing of the output per individual in the trade, results, of course, in cheapening the product; it results, therefore, in larger profit usually to the owners of the business; it results also, in many cases, in a lowering of the selling price, although that has not come to the extent it will later. In the end the public gets the good. Without any question, the large good which so far has come from scientific management has come to the worker. To the workmen has come, practically right off as soon as scientific management is introduced, an increase in wages amounting from 33 to 100 percent, and yet that is not the greatest good that comes to the workmen from scientific management. The great good comes from the fact that, under scientific management, they look upon their employers as the best friends they have in the world; the suspicious watchfulness which characterizes the old type management, the semi-antagonism, or the complete antagonism between workmen and employers is entirely superseded, and in its place comes genuine friendship between both sides. That is the greatest good that has come under scientific management. As a proof of this in the many businesses in which scientific management has been introduced, I know of not one single strike of workmen working under it after it had been introduced, and only two or three while it was in process of introduction. In this connection I must speak of the fakers, those who have said they can introduce scientific management into a business in six months or a year. That is pure nonsense. There have been many strikes stirred up by that type of man. Not one strike has ever come, and I do not believe ever will come, under scientific management.

WHAT SCIENTIFIC MANAGEMENT IS

What is scientific management? It is no efficiency device, nor is it any group of

efficiency devices. Scientific management is no new scheme for paying men, it is no bonus system, no piecework system, no premium system of payment; it is no new method of figuring costs. It is no one of the various elements by which it is commonly known, by which people refer to it. It is not time study nor man study. It is not the printing of a ton or two of blanks and unloading them on a company and saying, "There is your system, go ahead and use it." Scientific management does not exist and cannot exist until there has been a complete mental revolution on the part of the workmen working under it, as to their duties toward themselves and toward their employers, and a complete mental revolution in the outlook for the employers, toward their duties, toward themselves, and toward their workmen. And until this great mental change takes place, scientific management does not exist. Do you think you can make a great mental revolution in a large group of workmen in a year, or do you think you can make it in a large group of foremen and superintendents in a year? If you do, you are very much mistaken. All of us hold mighty close to our ideas and principles in life, and we change very slowly toward the new, and very properly too.

Let me give you an idea of what I mean by this change in mental outlook. If you are manufacturing a hammer or a mallet, into the cost of that mallet goes a certain amount of raw materials, a certain amount of wood and metal. If you will take the cost of the raw materials and then add to it that cost which is frequently called by various names—overhead expenses, general expense, indirect expense; that is, the proper share of taxes, insurance, light, heat, salaries of officers and advertising—and you have a sum of money. Subtract that sum from the selling price, and what is left over is called the surplus. It is over this surplus that all of the labor disputes in the past have occurred. The workman naturally wants all he can get. His wages come out of that surplus. The manufacturer wants all he can get in the shape of profits, and it is from the division of this surplus that all the labor disputes have come in the past—the equitable division.

The new outlook that comes under scientific management is this: The workmen, after many object lessons, come to see and the management come to see that this surplus can be made so great, providing both sides will stop their pulling apart, will stop their fighting and will push as hard as they can to get as cheap an output as possible, that there is no occasion to quarrel. Each side can get more than ever before. The acknowledgement of this fact represents a complete mental revolution. . . .

WHAT SCIENTIFIC MANAGEMENT WILL DO

I am going to try to prove to you that the old style of management has not a ghost of a chance in competition with the principles of scientific management. Why? In the first place, under scientific management, the initiative of the workmen, their hard work, their goodwill, their best endeavors are obtained with absolute regularity. There are cases all the time where men will soldier, but they become the exception, as a rule, and they give their true initiative under scientific management. That is the least of the two sources of gain. The greatest source of gain under scientific management comes from the new and almost unheard-of duties and burdens which are voluntarily assumed, not by the workmen, but by the men on the management side. These are the things which make scientific management a success. These new duties, these new burdens undertaken by the management have rightly or wrongly been divided into four

groups, and have been called the principles of scientific management.

The first of the great principles of scientific management, the first of the new burdens which are voluntarily undertaken by those on the management side is the deliberate gathering together of the great mass of traditional knowledge which, in the past, has been in the heads of the workmen, recording it, tabulating it, reducing it in most cases to rules, laws, and in many cases to mathematical formulae, which, with these new laws, are applied to the cooperation of the management to the work of the workmen. This results in an immense increase in the output, we may say, of the two. The gathering in of this great mass of traditional knowledge, which is done by the means of motion study, time study, can be truly called the science.

Let me make a prediction. I have before me the first book, so far as I know, that has been published on motion study and on time study. That is, the motion study and time study of the cement and concrete trades. It contains everything relating to concrete work. It is of about seven hundred pages and embodies the motions of men, the time and the best way of doing that sort of work. It is the first case in which a trade has been reduced to the same condition that engineering data of all kinds have been reduced, and it is this sort of data that is bound to sweep the world.

I have before me something which has been gathering for about fourteen years, the time or motion study of the machine shop. It will take probably four or five years more before the first book will be ready to publish on that subject. There is a collection of sixty or seventy thousand elements affecting machine-shop work. After a few years, say three, four or five years more, someone will be ready to publish the first book giving the laws of the movements of men in the machine shop—all the laws, not only a few of them. Let me predict, just as sure as the sun shines, that is going to come in every trade. Why? Because it pays, for no other reason. That results in doubling the output in any shop. Any device which results in an increased output is bound to come in spite of all opposition, whether we want it or not. It comes automatically.

THE SELECTION OF THE WORKMAN

The next of the four principles of scientific management is the scientific selection of the workman, and then his progressive development. It becomes the duty under scientific management of not one, but of a group of men on the management side, to deliberately study the workmen who are under them; study them in the most careful, thorough and painstaking way; and not just leave it to the poor, overworked foreman to go out and say, "Come on, what do you want? If you are cheap enough I will give you a trial."

That is the old way. The new way is to take a great deal of trouble in selecting the workmen. The selection proceeds year after year. And it becomes the duty of those engaged in scientific management to know something about the workmen under them. It becomes their duty to set out deliberately to train the workmen in their employ to be able to do a better and still better class of work than ever before, and to then pay them higher wages than ever before. This deliberate selection of the workmen is the second of the great duties that devolve on the management under scientific management.

BRINGING TOGETHER THE SCIENCE AND THE MAN

The third principle is the bringing together of this science of which I have

spoken and the trained workmen. I say bringing because they don't come together unless someone brings them. Select and train your workmen all you may, but unless there is someone who will make the men and the science come together, they will stay apart. The "make" involves a great many elements. They are not all disagreeable elements. The most important and largest way of "making" is to do something nice for the man whom you wish to make come together with the science. Offer him a plum, something that is worthwhile. There are many plums offered to those who come under scientific management—better treatment, more kindly treatment, more consideration for their wishes, and an opportunity for them to express their wants freely. That is one side of the "make." An equally important side is, whenever a man will not do what he ought, to either make him do it or stop it. If he will not do it, let him get out. I am not talking of any mollycoddle. Let me disabuse your minds of any opinion that scientific management is a mollycoddle scheme. . . .

THE PRINCIPLE OF THE DIVISION OF WORK

The fourth principle is the plainest of all. It involves a complete re-division of the work of the establishment. Under the old scheme of management, almost all of the work was done by the workmen. Under the new, the work of the establishment is divided into two large parts. All of that work which formerly was done by the workmen alone is divided into two large sections, and one of those sections is handed over to the management. They do a whole division of the work formerly done by the workmen. It is this real cooperation, this genuine division of the work between the two sides, more than any other element which accounts for the fact that there never will be strikes under scientific management. When the workman realizes that there is hardly a thing he does that does not have to be preceded by some act of preparation on the part of management, and when that workman realizes when the management falls down and does not do its part, that he is not only entitled to a kick, but that he can register that kick in the most forcible possible way, he cannot quarrel with the men over him. It is teamwork. There are more complaints made every day on the part of the workmen that the men on the management side fail to do their duties than are made by the management that the men fail. Every one of the complaints of the men have to be heeded, just as much as the complaints from the management that the workmen do not do their share. That is characteristic of scientific management. It represents a democracy, co-operation, a genuine division of work which never existed before in this world.

THE PROOF OF THE THEORY

I am through now with the theory. I will try to convince you of the value of these four principles by giving you some practical illustrations. I hope that you will look for these four elements in the illustrations. I shall begin by trying to show the power of these four elements when applied to the greatest kind of work I know of that is done by man. The reason I have heretofore chosen pig-iron for an illustration is that it is the lowest form of work that is known.

A pig of iron weighs about ninety-two pounds on an average. A man stoops down and, with no other implement than his hands, picks up a pig of iron, walks a few yards with it, and drops it on a pile. A large part of the community has the impression that scientific management is chiefly handling pig-iron. The reason I first chose pig-iron for an illustration is that, if you can prove to any one the strength, the effect, of those four principles when applied to such rudimentary work as handling pig-iron, the presumption is that it can be applied to something better. The only way to prove it is to start at the bottom and show those four principles all along the line. I am sorry I cannot, because of the lack of time, give you the illustration of handling pig-iron. Many of you doubt whether there is much of any science in it. I am going to try to prove later with a high class mechanic that the workman who is fit to work at any type of work is almost universally incapable of understanding the principles without the help of some one else. I will use shoveling because it is a shorter illustration, and I will try to show what I mean by the science of shoveling, and the power which comes to the man who knows the science of shoveling. It is a high art compared with pig-iron handling.

THE SCIENCE OF SHOVELING

When I went to the Bethlehem Steel Works, the first thing I saw was a gang of men unloading rice coal. They were a splendid set of fellows, and they shoveled fast. There was no loafing at all. They shoveled as hard as you could ask any man to work. I looked with the greatest of interest for a long time, and finally they moved off rapidly down into the yard to another part of the yard and went right at handling iron ore. One of the main facts connected with that shoveling was that the work those men were doing was that, in handling the rice coal, they had on their shovels a load of 3¾ pounds, and when the same men went to handling ore with the same shovel, they had over 38 pounds on their shovels. Is it asking too much of anyone to inquire whether 3¾ pounds is the right load for a shovel, or whether 38 pounds is the right load for a shovel? Surely if one is right the other must be wrong. I think that is a self-evident fact, and yet I am willing to bet that that is what workmen are doing right now in Cleveland.

That is the old way. Suppose we notice that fact. Most of us do not notice it because it is left to the foreman. At the Midvale works, we had to find out these facts. What is the old way of finding them out? The old way was to sit down and write one's friends and ask them the questions. They got answers from contractors about what they thought it ought to be, and then they averaged them up, or took the most reliable man, and said, "That is all right; now we have a shovel load of so much." The more common way is to say, "I want a good shovel foreman." They will send for the foreman of the shovelers and put the job up to him to find what is the proper load to put on a shovel. He will tell you right off the bat. I want to show you the difference under scientific management.

Under scientific management you ask no one. Every little trifle,—here is nothing too small,—becomes the subject of experiment. The experiments develop into a law; they save money; they increase the output of the individual and make the thing worthwhile. How is this done? What we did in shoveling experiments was to deliberately select two first class shovelers, the best we knew how to get. We brought them into the office and said, "Jim and Mike, you two fellows are both good shovelers. I have a proposition to make to you. I am going to pay you double wages if you fellows will go out and do what I want you to do. There will be a young chap go along with you with a pencil and a piece of paper, and

he will tell you to do a lot of fool things, and you will do them, and he will write down a lot of fool things, and you will think it is a joke, but it is nothing of the kind. Let me tell you one thing: if you fellows think that you can fool that chap you are very much mistaken, you cannot fool him at all. Don't get it through your heads you can fool him. If you take this double wages, you will be straight and do what you are told." They both promised and did exactly what they were told. What we told them was this: "We want you to start in and do whatever shoveling you are told to do and work at just the pace, all day long, that when it comes night you are going to be good and tired, but not tired out. I do not want you exhausted or anything like that, but properly tired. You know what a good day's work is. In other words, I do not want any loafing business or any overwork business. If you find yourself overworked and getting too tired, slow down." Those men did that and did it in the most splendid kind of way day in and day out. We proved their cooperation because they were in different parts of the yard, and they both got near enough the same results. Our results were duplicated.

I have found that there are a lot of schemes among my working friends, but no more among them than among us. They are good, straight fellows if you only treat them right, and put the matter up squarely to them. We started in at a pile of material, with a very large shovel. We kept innumerable accurate records of all kinds, some of them useless. Thirty or forty different items were carefully observed about the work of those two men. We counted the number of shovelfuls thrown in a day. We found with a weight of between thirty-eight and thirty-nine pounds on the shovel, the man made a pile of material of a certain height. We then cut off the shovel, and he shoveled again and with a thirty-four pound load his pile went up and he shoveled more in a day. We again cut off the shovel to thirty pounds, and the pile went up again. With twenty-six pounds on the shovel, the pile again went up, and at twenty-one and one-half pounds the men could do their best. At twenty pounds the pile went down, at eighteen it went down, at fourteen it went down, so that they were at the peak of twenty-one and one-half pounds. There is a scientific fact. A first class shoveler ought to take twenty-one and one-half pounds on his shovel in order to work to the best possible advantage. You are not giving that man a chance unless you give him a shovel which will hold twenty-one pounds.

The men in the yard were run by the old fashioned foreman. He simply walked about with them. We at once took their shovels away from them. We built a large labor tool room which held ten to fifteen different kinds of shoveling implements so that for each kind of material that was handled in that yard, all the way from rice coals, ashes, coke, all the way up to ore, we would have a shovel that would just hold twenty-one pounds, or average twenty-one. One time it would hold eighteen, the next twenty-four, but it will average twenty-one.

When you have six hundred men laboring in the yard, as we had there, it becomes a matter of quite considerable difficulty to get, each day, for each one of those six hundred men, engaged in a line one and one-half to two miles long and a half mile wide, just the right shovel for shoveling material. That requires organization to lay out and plan for those men in advance. We had to lay out the work each day. We had to have large maps on which the movements of the men were plotted out a day in advance. When each workman came in the morning, he took out two pieces of paper. One of the blanks gave them a statement of the implements which they had to use, and the part of the yard in which they had to work. That required organization planning in advance.

One of the first principles we adopted was that no man in that labor gang could work on the new way unless he earned sixty percent higher wages than under the old plan. It is only just to the workman that he shall know right off whether he is doing his work right or not. He must not be told a week or month after, that he fell down. He must know it the next morning. So the next slip that came out of the pigeon hole was either a white or yellow slip. We used the two colors because some of the men could not read. The yellow slip meant that he had not earned his sixty per cent higher wages. He knew that he could not stay in that gang and keep on getting yellow slips.

TEACHING THE MEN

I want to show you again the totally different outlook there is under scientific management by illustrating what happened when that man got his yellow slips. Under the old scheme, the foreman could say to him, "You are no good, get out of this; no time for you, you cannot earn sixty percent higher wages; get out of this! Go!" It was not done politely, but the foreman had no time to palaver. Under the new scheme what happened? A teacher of shoveling went down to see that man. A teacher of shoveling is a man who is handy with a shovel, who has made his mark in life with a shovel, and yet who is a kindly fellow and knows how to show the other fellow what he ought to do. When that teacher went there he said, "See here, Jim, you have a lot of those yellow slips, what is the matter with you? What is up? Have you been drunk? Are you tired? Are you sick? Anything wrong with you? Because if you are tired or sick we will give you a show somewhere else." "Well, no, I am all right." "Then if you are not sick, or there is nothing wrong with you, you have forgotten how to shovel. I showed you how to shovel. You have forgotten something, now go ahead and shovel and I will show you what is the matter with you." Shoveling is a pretty big science, it is not a little thing.

If you are going to use the shovel right you should always shovel off an iron bottom; if not an iron bottom, a wooden bottom; and if not a wooden bottom a hard dirt bottom. Time and again the conditions are such that you have to go right into the pile. When that is the case, with nine out of ten materials it takes more trouble and more time and more effort to get the shovel into the pile than to do all the rest of the shoveling. That is where the effort comes. Those of you again who have taught the art of shoveling will have taught your workmen to do this. There is only one way to do it right. Put your forearm down onto the upper part of your leg, and when you push into the pile, throw your weight against it. That relieves your arm of work. You then have an automatic push, we will say, about eighty pounds, the weight of your body thrown on to it. Time and again we would find men whom we had taught to shovel right were going at it in the same old way, and of course, they could not do a day's work. The teacher would simply stand over that fellow and say, "There is what is the matter with you, Jim, you have forgotten to shovel into the pile."

You are not interested in shoveling, you are not interested in whether one way or the other is right, but I do hope to interest you in the difference of the mental attitude of the men who are

teaching under the new system. Under the new system, if a man falls down, the presumption is that it is our fault at first, that we probably have not taught the man right, have not given him a fair show, have not spent time enough in showing him how to do his work.

Let me tell you another thing that is characteristic of scientific management. In my day, we were smart enough to know when the boss was coming, and when he came up we were apparently really working. Under scientific management, there is none of that pretense. I cannot say that in the old days we were delighted to see the boss coming around. We always expected some kind of roast if he came too close. Under the new, the teacher is welcomed; he is not an enemy, but a friend. He comes there to try to help the man get bigger wages, to show him how to do something. It is the great mental change, the change in the outlook that comes, rather than the details of it.

DOES SCIENTIFIC MANAGEMENT PAY?

It took the time of a number of men for about three years to study the art of shoveling in that yard at the Bethlehem Steel Works alone. They were carefully trained college men, and they were busy all the time. That costs money, the tool room costs money, the clerks we had to keep there all night figuring up how much the men did the day before cost money, the office in which the men laid out and planned the work cost money. The very fair and proper question, the only question to ask is "Does it pay?" because if scientific management does not pay in dollars and cents, it is the rankest kind of nonsense. There is nothing philanthropic about it. It has got to pay, because business which cannot be done on a profitable basis, ought not to be done on a philanthropic basis, for it will not last. At the end of three and one-half years we had a very good chance to know whether or not it paid.

Fortunately in the Bethlehem Steel Works they had records of how much it cost to handle the materials under the old system, where the single foreman led a group of men around the works. It costs them between seven and eight cents a ton to handle materials, on an average throughout the year. After paying for all this extra work I have told you about, it cost between three and four cents a ton to handle materials, and there was a profit of between seventy-five and eighty thousand dollars a year in that yard by handling those materials in the new way. What the men got out of it was this: Under the old system there were between four and six hundred men handling the material in that yard, and when we got through there were about one hundred and forty. Each one was earning a great deal more money. We made careful investigation and found they were almost all saving money, living better, happier; they are the most contented set of laborers to be seen anywhere. It is only by this kind of justification, justification of a profit for both sides, an advantage to both sides, that scientific management can exist.

I would like to give you one more illustration. I want to try to prove to you that even the highest class mechanic cannot possibly understand the philosophy of his work, cannot possibly understand the laws under which he has to operate. There is a man who has had a high school education, an ingenious fellow who courts variety in life, to whom it is pleasant to change from one kind of work to another. He is not a

cheap man, he is rather a high grade man among the machinists of this country. The case of which I am going to tell you is one in which my friend Barth went to introduce scientific management in the works of an owner, who, at between 65 and 70 years of age, had built up his business from nothing to almost five thousand men. They had a squabble, and after they got through, Mr. Barth made the proposition, "I will take any machine that you use in your shop, and I will show you that I can double the output of that machine." A very fair machine was selected. It was a lathe on which the workman had been working about twelve years. The product of that shop is a patented machine with a good many parts, 350 men working making those parts year in and year out. Each man had ten or a dozen parts a year.

The first thing that was done was in the presence of the foreman, the superintendent and the owner of the establishment. Mr. Barth laid down the way in which all of the parts were to be machined on that machine by the workman. Then Mr. Barth, with one of his small slide rules, proceeded to analyze the machine. With the aid of this analysis, which embodies the laws of cutting metals, Mr. Barth was able to take his turn at the machine; his gain was from two and one-half times to three times the amount of work turned out by the other man. This is what can be done by science as against the old rule of thumb knowledge. That is not exaggeration; the gain is as great as that in many cases.

Let me tell you something. The machines of this country, almost universally in the machine shops of our country, are speeded two or three hundred percent wrong. I made that assertion before the tool builders in Atlantic City. I said, "Gentlemen, in your own shops, many of your machines are two and three hundred percent wrong in speeds. Why? Because you have guessed at it." I am trying to show you what are the losses under the old opinions, the difference between knowledge on the one hand and guesswork on the other.

In 1882, at the end of a long fight with the machinists of the Midvale Steel Works, I went there as a laborer, and finally became a machinist after serving my apprenticeship outside. I finally got into the shop, and worked up to the place of a clerk who had something wrong with him. I then did a little bit more work than the others were doing, not too much. They came to me and said, "See here, Fred, you are not going to be a piecework hog." I said, "You fellows mean that you think I am not going to try to get any more work off these machines? I certainly am. Now I am on the other side, and I am going to be straight with you, and I will tell you so in advance." They said, "All right then, we will give you fair notice you will be outside the fence inside of six weeks." Let me tell you gentlemen, if any of you have been through a fight like that, trying to get workmen to do what they do not want to do, you will know the meanness of it, and you will never want to go into another one. I never would have gone into it if I had known what was ahead of me. After the meanest kind of a bitter fight, at the end of three years, we fairly won out and got a big increase in output. I had no illusion at the end of that time as to my great ability or anything else. I knew that those workmen knew about ten times as much as I did about doing the work. I set out deliberately to get on our side some of that knowledge that those workmen had.

Mr. William Sellers was the president, and he was a man away beyond his generation in progress. I went to him and said, "I want to spend quite a good deal of money trying to educate ourselves on the management side of our works. I do not know much of anything, and I am just about in the same condition as all the rest of the foremen around here." Very reluctantly, I may say, he allowed us to start to spend money. That started the study of the art of cutting metals. At the end of six months, from the standpoint of how to cut the metal off faster, the study did not amount to anything, but we unearthed a gold mine of information. Mr. Sellers laughed at me, but when I was able to show him the possibilities that lay ahead of us, the number of things we could find out, he said, "Go ahead." So until 1889, that experiment went straight ahead day in and day out. That was done because it paid in dollars and cents.

After I left the Midvale Steel Works, we had no means of figuring those experiments except the information which we had already gotten. Ten different machines were built to develop the art of cutting metals, so that almost continuously from 1882 for twenty-six years, all sorts of experiments went on to determine the twelve great elements that go to make up the art of cutting metals. I am trying to show you just what is going to take place in every industry throughout this world. You must know those facts if you are going to manufacture cheaply, and the only way to know them is to pay for them . . .

THE EFFECT ON THE WORKMAN

Almost every one says, "Why, yes, that may be a good thing for the manufacturer, but how about the workmen? You are taking all the initiative away from that workman, you are making a machine out of him; what are you doing for him? He becomes merely a part of the machine." That is the almost universal impression. Again let me try to sweep aside the fallacy of that view by an illustration. The modern surgeon without a doubt is the finest mechanic in the world. He combines the greatest manual dexterity with the greatest knowledge of implements and the greatest knowledge of materials on which he is working. He is a true scientist, and he is a very highly skilled mechanic.

How does the surgeon teach his trade to the young men who come to the medical school? Does he say to them, "Now, young men, we belong to an older generation than you do, but the new generation is going to far outstrip anything that has been done in our generation; therefore, what we want of you is your initiative. We must have your brains, your thought, with your initiative. Of course, you know we old fellows have certain prejudices. For example, if we were going to amputate a leg, when we come down to the bone we are accustomed to take a saw, and we use it in that way and saw the bone off. But, gentlemen, do not let that fact one minute interfere with your originality, with your initiative, if you prefer an axe or a hatchet." Does the surgeon say this? He does not. He says, "You young men are going to outstrip us. but we will show you how. You shall not use a single implement in a single way until you know just which one to use, and we will tell you which one to use, and until you know how to use it, we will tell you how to use that implement, and after you have learned to use that implement our way, if you then see any defects in the implements, any defects in the method, then invent; but, invent so that you can invent upwards. Do not go inventing things which we discarded years ago."

That is just what we say to our young men in the shops. Scientific management makes no pretense that there is any finality in it. We merely say that the collective work of thirty or forty men in this trade through eight or ten years has gathered together a large amount of data. Every man in the establishment must start that way, must start our way, then if he can show us any better way, I do not care what it is, we will make an experiment to see if it is better. It will be named after him, and he will get a prize for having improved on one of our standards. There is the way we make progress under scientific management. There is your justification for all this. It does not dwarf initiative, it makes true initiative. Most of our progress comes through our workmen, but comes in a legitimate way.