SCIENTIFIC MANAGEMENT COURSE

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Frank Gilbreth
(et al)

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SCIENTIFIC MANAGEMENT COURSE

Y. M. C. A.

WORCESTER, MASS.

EFFICIENCY METHODS

LECTURE BY

Harrington Emerson

PRESIDENT OF

The Emerson Company

Standard Practice and Efficiency Engineers

NEW YORK CITY

ISSUED BY THE

Educational Department

C. W. HOBBS, Chairman
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STENOGRAPHIC REPORT
BY WALTER A. MORRILL

What is efficiency? Efficiency is a part, a division of the work whose aim is the welfare of humanity. The welfare of humanity can be divided into the welfare of the individual, the welfare of the clan, the welfare of the nation, and the welfare of all the nations. There is no clash, no irreconcilable conflict between the efficiency of the individual, and the efficiency of the clan, and the efficiency of the nation, and the efficiency of humanity; they supplement each other. The theory of efficiency is the same for all; it is the application that varies.

Welfare is promoted by certain acts and qualities that the best teachers in all ages have defined as virtues, and the welfare of the community is retarded by other acts that are called vices—qualities that are vicious, criminal and inefficient. A vice is a harm that a man does to himself. A crime is a harm that he does to someone else. No law against vice has ever been enforced. No law against crime has ever been repealed. Inefficiency is a negative quality. It is one of those things that we have left undone that we ought to have attained to.

I shall now briefly touch on the part of the individual, of the clan, and of the nation, and of humanity as to this work of efficiency. The individual is represented by himself, and also by his class. The nation is represented by the statesman, and also by the state as a whole, and the same is true with nations. They act individually, and they act collectively, and it is the individual action that counts far more than the collective action. A day or two ago, I read a letter in the New York Sun. A man stated that he and a friend had married sisters, about the same time. They had been married for ten years. He said: "My salary is $200 a year larger than that of my brother-in-law. He has children, and I have none. He lives on the same street on which I live. As far as I can see, he lives fully as well as I do. He has $6000 in the savings bank, and I owe $200. What has made the difference between my brother-in-law and his wife and myself and my wife?" He said: "They were thrifty, and we were not," and he went through a number of items showing how he went to the barber, while his brother-in-law shaved himself. He had the bootblack shine his shoes, and his brother-in-law shined his own shoes. He took his lunch at a restaurant; the brother-in-law took his lunch with him from home. He had servants; the brother-in-law's wife did her own work. Of course, those little indications of extravagance on the one hand and thrift on the other were multiplied through all the acts of those two families, and at the end of ten years it does not take many dollars a month to amount to $6000. Now, the individual can do far more for himself by becoming efficient. He can do far more than any aggregation of individuals can do for him, or than his employer can do for him, or than the state can do for

him; and no man has a right to look beyond himself for welfare, unless he is himself doing all he can to make his own life efficient, and then he has a right to take the second step and expect that a larger efficiency shall be opened up to him.

Individuals have a right to combine into unions. There is a place for unionism. I have seen, in my life, many instances where the individual needed the aggregation of other individuals to defend him in his rights, and my sympathy has gone out to those individuals who have been forced to turn to unions in order to secure the fair deal that was otherwise not being extended to them. The union has its place, to take up collectively what the individual is, perhaps, too weak to do for himself, but in unionism there is no place for dynamite, and for murder, and for riot, and for those other disturbances that have in the last few months made the name of the United States a byword among the other civilized nations of the world.

The individual employer can do an immense amount to promote efficiency in his own plant. It has been our experience that it is the individual that counts. Certain heads of great companies have made those companies peculiarly and remarkably efficient. I might mention in this connection Mr. Henry R. Towne of the Yale & Towne Co., Mr. Dodge, of the Link-Belt Co., my own friend, Mr. Logan, and the executives of the Santa Fe Railroad, the Curtis Publishing Company, Collier's Publishing Company, Jones & Laughlin, and a number of others, of whom I know quite a number who reside in Worcester, and whom I would like to mention by name, if I were better acquainted with them.

Employers collectively can do a great deal. Last Monday evening, I was at a banquet at Rochester, in which place a firm making men's clothing had opened a new model shop, surrounding their employees with very much better hygenic conditions, and they made this an occasion to invite their customers and competitors to see what they had done and derive benefit from it. They had nothing to hide. They showed them what they had done to reduce cost, and yet increase the welfare of their employees, and the whole note of the evening was one of co-operation among employers among the different manufacturers in that trade. The glad hand of fellowship, in which each pledged himself to help the other, not in clash with their employees, but to better the conditions of the employees, and better the general conditions of the trade. When we come to the nation, it is the same thing. There are individuals whom we owe immensely. A million dollars a year would be too little to pay for such a man as Thomas Jefferson, who gave us more than one-half of the United States. A million dollars a year would be too little to pay for a man like Abraham Lincoln, who held this Union together and made it free. There are individual statesmen today who by their initiative and power are accomplishing a tremendous work. Secretary Meyer, of the Navy, has succeeded in making the American battleship the most stupendous example of scientific management that the world has

even seen. Our battleships today are thirty-six hundred times as efficient as at the battle of Santiago, 14 years ago. Mr. Hitchcock, for the first time in many years, working under the same laws and the same conditions, has shown that the Post Office can be made self-supporting and turn over a surplus. The Secretary of Agriculture has added untold millions to the wealth of this country by sending out bulletins to the farmers, establishing schools, and enabling them to apply scientific management to the raising of crops, and they produce today one-half as much per acre as they produce in that northern bleak country of Germany that is opposite Labrador, that does not have our soil, that does not have our climate, that does not have the brains of our American farming class, and yet is so much more efficient than we are. Roosevelt, when he was President, by his own act as a man, brought to a close that war between two nations friendly to the United States—Japan and Russia. But the nations as a whole are beginning to combine together. They have combined in their efforts to check piracy, privateering, the slave trade, and now our President is trying to get them to combine in the treaties of arbitration, to banish war between the civilized nations.

There are four essentials for efficiency: aims, organization, equipment, and executive. Or, to put it in a somewhat different way, what we need is inspiration, action, and accomplishment. We have found that as we go out into industrial plants, very often the aims are vague, indefinite. Perhaps there are several aims. Perhaps the manufacturer one month is trying to produce the largest amount of product, irrespective of quality, and a lot of complaints come in, and he switches over, and tries to produce the high quality with a limited amount of product. Now, neither of the aims, the large amount of product of inferior or of mediocre quality, or the small product of high quality—neither is the definite aim. We try to combine them, and it is impossible to run the plant satisfactorily.

Then, the next thing necessary is an organization to attain and retain the aims, and there, again, we find organizations that are weak, one-sided, topheavy in certain directions, inharmonious, so that, even though the aims are definite, the organization is not working to the worthy accomplishment of the end.

What is the need of equipment? To enable the organization to attain its aims; and as a rule the United States is overequipped. We are lacking in definiteness of aim. We are lacking in definite organization, but we are, as a rule, not lacking in equipment. There is too much equipment for the work to be turned out. We put our faith in equipment, rather than in organization and aim; and those three things are insufficient—aims, organization, equipment, unless we have the strong executive who realizes the aims, who inspires and creates the organization, and furnishes the equipment in order to carry them out.

Finally, the strong executive has to choose between three

types of management. Mr. Kendall will give his lecture on the three types of management, and I can briefly pass over them, stating that the first is the strenuous, or individual, the second is the systematic, and the third is the efficient, scientific management. Efficiency is not strenuous; they are opposites. Strenuousness means accomplishing a slightly greater result at a greatly increased effort. Efficiency means accomplishing a very much greater result with a greatly diminished effort. System is not efficiency. System depends on precedent. System finds out what is; organization, what is to take care of what is, and then insists that what is to be shall fit in with the system. Trying to establish scientific management without system is one of the greatest stumbling-blocks that we ever run up against. It is like an architect who finds an old building on a site, and the owner wants it preserved, and he says: Can't you add something to this and keep what we have there? In reality, the architect would do much better if it was a vacant site without anything on it.

Whatever type of management is used, it is very much better to depend on principles than on methods and devices. Methods and devices are mere makeshifts that are to be replaced constantly by better methods and devices. We have in our own work a number of methods and devices of which we think a great deal, but we would be willing to waive them all tomorrow, if any better methods and devices could be brought forward. Principles are an entirely different thing. Principles underlie all correct management. I have collected various principles of management under 12 heads, which does not mean that somebody else might not as ably put them under 20, or 6 heads, but this is a convenient subdivision, like chapters in a book. I will outline six ethical principles, and six practical principles. The six ethical principles are: Firstly, ideals; secondly, common sense; thirdly, competent counsel; fourthly, discipline; fifthly, a fair deal; sixthly, efficiency reward.

If a burglar should come to me and ask me if I could benefit him and help him apply efficiency management to his work, I would say, Yes, undoubtedly I could benefit you; let us begin. I will take up the first principle—say, ideals. Your business, the burglarizing of bank safes, is not the kind of ideals we would approve of. Secondly, common sense. Is it a common sense kind of a business to follow? Thirdly, competent counsel. Would any lawyer, clergyman, police captain, or anybody else, advise you to take up that particular line of business? You are not supported by a competent counsel. Fourthly, discipline, in the sense of general welfare of society. Your business is absolutely subversive of society. Fifth, the fair deal. It is not a business based on the fair deal. Sixth, efficiency reward. Yes, you are practically safe, for you get that.

The six practical principles are: records, reliable, immediate, adequate, and permanent (and I have never been in any plant in the world where they had any records that I would consider reliable and immediate and adequate—must less, per-

manent); planning, scheduling, dispatching, standardized conditions, standardized operations.

We recently went into a large firm, and in checking over these principles (which is the first thing I do in order to know what I am going up against), I found that the man had ideals, and that he had taken competent counsel. His discipline was good. He was applying a fair deal to his relations with his employees. I asked him about his records, and he hadn't any! "Do you plan work in advance?" I asked. "No." "Work schedules?" "No." Did he dispatch the work? Did he standardize conditions and operations? No. Any method of efficiency reward? No, he hadn't done that yet. He had all the ethical principles, and all he had to do was to take up these practical ones. I knew at once that his efficiency could not help but be low, because it was all foundation for principles, but he had applied none. All he needed to do was to take up those different principles and apply them throughout his work; records, planning, dispatching, scheduling, and so on, and it would have been inevitable that his efficiency would have come up, that his costs would have gone down and his production increased.

An orchestra is a beautiful example of the application of scientific management. You will see from that that scientific management is nothing recent, for orchestras have been playing for a couple of hundreds of years, if not longer. The symphony is composed in advance. It is all reduced to writing. Then all the different parts are made up. Each part is then given to the individual performer, who is an expert in his own line, who masters his part. Each part defines just what the operator shall do, down to the fifth of a second, and not only as to time, but as to expression, force, as to how much push he shall put into it, or how much softer he shall play. They come together at the appointed hour. The leader is at the desk. They all start off—not a single man a second behind, for if he were, it would spoil the whole thing. Each man plays his own part in time. They play together when they ought to. They end together, and the piece is finished. The work has been perfect from one end to the other. It is a work that could be done only by experts, and I have never heard the members of an orchestra, even though unionized, complain that the stop-watch was being held over them, that their initiative was being destroyed, that they were being convertd into a company, that they were not allowed to show their individuality.

The problem of promoting efficiency would be more hopeless if it were not for what I will call the law of dependent sequences. A very little detriment will result in tremendous gain, owing to that law, and, also, a very slight inefficiency will result in a tremendous loss owing to that same law. The law of dependent sequence works a little according to the anecdote of a man who shared his secret with another man, and this friend came to him and said: "Might I tell it to my friend?" "Well," he said, "let us see." "I know it?" "Yes." "You know it?" "Yes." Then he said: "Now you are going to tell it to

your friend?" "Yes." "Well, that makes how many? "Three." "No, it doesn't, it makes 111." The effect of dependent sequence can be shown by the difference between simple and compound interest. If one single cent had been put at interest at 6 per cent. at the time of Christ, it would have earned, down to the present time, $114. If a cent had been put out at compound interest, it would have doubled about 160 times, and there would not be enough money in the world to pay the debt. The dependent sequence is a geometrical principle. I will illustrate the dependent sequence. Not far from here we went into a large textile mill. I was taken through the plant, and we walked first in the shop, and then in the mill, and then when we returned to the office, the gentlemen said, What do you think of it? I was more familiar with machine shops than with textile mills, and I unguardedly answered, "I do not think your machine shop is very efficient." The master mechanic said, "Do you realize that this is a repair shop? This is not a manufacturing plant. A machine is broken down in the mill, and we rush out the repair part as soon as we can and start up the whole mill again. We have no time for red tape, and planning, scheduling, and dispatching, and other things. The loss is too great. That would apply perfectly well in a manufacturing plant, where you are doing the same thing over and over again, but it would not apply here." They always say their conditions are peculiar, and that the principles will not apply to them. I was about to reply that I had been investigating machine shops for twenty years, and made due allowance for that, when one of them said: "Emerson, let us go out again, and show us what you mean." That was the call of the bluff, and I didn't know what I should find. I had walked through, as Mr. Logan says, "seeing, but not seeming to see," and out we went. The first machine that I walked up to was a little shaper. The man who was operating the machine had on it a small piece of steel, about 2x4 inches, and the tool was making a cut across this piece of steel, cutting air three-quarters of the length of the stroke, and cutting steel on the other one-quarter. The efficiency of the stroke was only 30 per cent. The tool was moving very slowly. It was an old machine that was built in the days of carbon tools, and it was moving slowly, instead of the rapid movement of the modern machines. The efficiency of speed was 33 1-3 per cent. The man was taking a feed of 1-64 inches—I don't know why he was not taking 1-8th inches. The efficiency of the feed, therefore, was 25 per cent. On account of this, he was taking four cuts, when two would answer—a roughing and a smoothing cut. The efficiency of the cut was 50 per cent. You multiply 33 1-3 by 30 per cent., and you get 10 per cent; you multiply that by 25 per cent. (of the feed), and it brings you to 2 1-2 per cent. You multiply that by 50 per cent. (the number of cuts), and it brings you to 1 1-4 per cent. The efficiency of that man was only 1 1-4 per cent. He was taking 80 times as long as was necessary. I said to the master

mechanic: "I don't know whether this is a repair job, or not. Perhaps this man is making something for his own automobile A shop run like this would permit of almost anything. We will assume that your machinery is shut down waiting for this repair part, and this man is taking eighty times as long on the work as he ought to. If this were my shop, he would not be cutting air three-quarters of the time, and cutting the steel only one-quarter of the time. He would not have this slow speed. He would not be taking four cuts instead of two." That is what I mean by dependent sequence. Each operation dependent upon the one which goes before. If you take four operations at 90 per cent., you come down to 65 as the end per cent. If you have four operations at 80 per cent, you come down to 40 per cent. If you have four operations at 70 per cent., you come down to the neighborhood of 26 per cent. or less, and a very slight improvement in one sequence would bring up the efficiency.

You have four inefficiencies as to every item of material, every item of labor, and every item of charge. You have the efficiency of price, of supply, of distribution, and of use.

One of my assistants recently got married, and he was telling me about his housekeeping and about trying to apply these principles to that. He said that he applied that question of dependent sequence of price, supply, distribution, and use, to the subject of buying lamb chops for their dinner. He said that they bought seven lamb chops, when they needed only six. There was inefficiency of supply. He bought them and paid 22 cents for them, when his wife said they ought to have been 20 cents. There was the inefficiency of price. They could have bought some other meat that would have cost only 15 cents, instead of paying 22 cents for lamb chops. There was the inefficiency of distribution. And, finally, they did not eat up all the lamb chops on their plates, and there was inefficiency of use. He figured that he was getting only 50 per cent. out of his money for the lamb chops.

Sometimes there are many more dependent sequences. In the use of coal on the railroad, there are 12 sequences—12 turns in the dependent sequence from the time the coal leaves the mine until the ashes are dumped into the ash pit, and as a consequence the railroads are using about three times as much coal as is necessary, for on the Erie Railroad, when they put a specialist on the switching engine, he brought down the consumption of coal from 2000 lbs. to 700 lbs. Also, on the Erie Railroad, they used 105 lbs. per mile on a passenger locomotive, and when they tested out a particular engine, they found that they required only 35 pounds. On the Atchison road, we found that they were charged with 267 lbs. of coal, and when they put the dynamometer car on, we could never get above 80, due to this long series of dependent sequences. You can imagine what a tremendous dependent sequence we have when we take those eight divisions with which I began, the efficiency of the individual, the efficiency of his class, the efficiency of the manufacturer

by whom he is employed, the efficiency of the manufacturers as a whole, the efficiency of the statesman, the efficiency of the state back of the statesman, the efficiency of the nation, and the efficiency of all the nations collectively.

Now the meeting is open to questions, and that will be the more interesting part of this meeting. We shall fill an hour in this way, and I am ready to answer your questions as best I can. Remember the notice that was posted in the ballroom: "Don't shoot the musician; he is doing the best he can!"

DISCUSSION

Mr. Logan has asked me to elaborate a little on the subject of the coal consumption on the Atchison road. I was called as counsellor by the Vice-President of the Atchison road. I had no authority except to advise, and at no time did I issue any orders. (Explanation by Mr. Logan: The man who was Vice-President of the Atchison road was Mr. John W. Kendrick, a native of Worcester, and a graduate of the Worcester Polytechnic Institute). The results that were accomplished on the Atchison road were due solely to the way the work was taken up and pushed through by Mr. Kendrick, in spite of enormous difficulties and opposition. The problems were very serious. They were not economic at all. A strike was about to be inaugurated, and the problem was to keep the locomotives and cars running with all the shop men out, and with the necessity of replacing them with such men as could be picked up. At one of the points, for instance, the master mechanic went up to the Navajo Indian Reservation and brought down a number of Indians and put them at work in the roundhouse to help do the work, which shows the straits in which the road was put to keep the locomotives pulling the mail trains and freights.

The second object was to meet the enormous increase of business that developed just about this time—1904. The business of the road increased 50 per cent. in two or three years, and there was no time in which to secure new equipment or shops to carry it, and the old shops had to carry the whole load.

The third object was to restore the relations between employee and employer, which had been disturbed for many years. That was considered one of the very important objects, but, naturally, subsidiary to the prime object of moving the freights for which the railroad was there.

Finally, the expenses and costs had been very high, and it would have been looked upon with welcome if the expenses could be reduced. Success was attained in all four of those directions, owing to the backing given by the higher officials of the road and the energetic way in which the work was taken up.

As to the matter of coal, the first thing we did was to put in records that we could depend upon. It was not known how much coal had been used, and we could take only the general records of the road, which gave the total amount of coal assigned to the locomotives, and divide this by the number of tons carried, and in that way ascertain the actual amount of coal used per 1000-ton miles. This averaged, when figured in this

way, 267 tons. The superintendent of motive power sent me a letter which he had received from the manager of the dynamometer car, a Mr. Marshall, representing the International Correspondence School, in which he claimed that a certain freight train had used only 80 tons of coal. He sent that letter to me for reply. I was fresh from these records showing an average consumption of 267 tons, and I got a little gay over the subject, and I said, "Ha, ha! You can tell that to somebody else. I know the average has been 267 tons, and you cannot persuade me that anybody can make the run with 80 tons of coal." This superintendent of motive power, who rather liked to cause trouble, or to start things up, sent this reply of mine to the man running the dynamometer car. He was a very large, broadminded man, and he telegraphed from out on the line where he was to some of the officers, and said: "I have received Mr. Emerson's letter, and he is the man I have been looking for. Let him come at once, or send one of his assistants ,and show us where we are in error, because that is the man above all others that we want." That was different. It was one thing to make fun of a record ,and another thing to show that it was not correct. I telegraphed to one of my assistants, and told him to ride one of the freight trains out of Chicago and determine the amount of coal used on that freight train every day during the week. I told him to count the shovelfuls, or estimate the coal as it was put in, and, in any case, to determine as accurately as possible the actual amount of coal, through observation and study. He reported to me 79 tons, 81 tons, 78 tons, etc., as a result. That satisfied me that this other man was correct, and that I was wrong. I then went and traveled on the dynamometer car and saw the records made, and they had on that car devices for getting information on the particular operations of running the trains, and their records were reliable, immediate, adequate, and permanent. Every shovelful of coal was counted. They knew what the steam gauge indicated; they knew the grades; they knew the time that it took between terminals, and they then set up a standard which it was our duty to approximate as closely as possible—namely, 80 tons. The first thing is to find out *what is,* the second thing is to establish a standard that can be attained, and then to evolve plans by which you can convert *what is* into *what ought to be,*—namely, the standard.

Question. It might be interesting to some of us in Worcester, if you could tell us something about the inefficiency of burning coal in power plants as you must have observed it, where you see black smoke pouring out of the various chimneys, and tell us whether it is not costing some people more to make a nuisance of themselves, than to burn coal and save it.

Answer. Our general experience in industrial power plants is that the item of power amounts to between four and six per cent. of the total cost. Therefore, as an item of expense, it is not a tremendously serious one. In one large plant, the cost of the power amounted to $623,000 a year, and it could have been reduced to $250,000 a year, owing to the dependent