number of those who were in attendance. Replies have brought an abundance of complimentary and gratifying opinions. Apparently nearly everyone received some measure of the inspiration described in the words of one of the correspondents: "I decided that, personally, I would take a new interest in the scientific management movement, possibly give it my main attention."

The criticisms and suggestions may be summed up as follows: the round table discussions should have been stenographically reported and provision made for their publication; the round-table discussions should have been distributed through more sessions so that members could have attended more of them; the program should have been more a description of mechanism and methods; the program should have provided for discussion of the labor problems in scientific management.

The Governing Board did not dare to face the financial risks involved in reporting and publishing the discussions. It knew that it had cost the Tuck School $500 to report and $1300 to publish the Conference of 1911, an expense which did not include payment for some four or five months of laborious work editing the copy which came from the stenographers. That the round-table discussions should have been distributed through more sessions, thereby enabling members to attend more of them, is acknowledged. It is now realized that round-table discussions constitute a most important element in such a conference.

The suggestion that the addresses and discussions should have been more detailed and descriptive presents a large problem. The Ann Arbor program was planned to accommodate a wide range of auditors: those who know nothing of the principles of scientific management; those who understand the principles but know nothing of the results of their application; those who think they understand the principles but do not, and so on. An exposition of the fundamental principles of scientific management was absolutely essential to the plan. The question arises whether an exclusively detailed and descriptive program would have been in the nature of the case possible. Is there not something in the nature of scientific management which limits conferences to discussions of principles, and which requires that detail methods be observed by visits to plants?

The concluding session of the conference seemed to demonstrate that inquiry concerning the relations of scientific management and labor must be given a place in every program; otherwise it will choose its place for itself. That session gave opportunity for frank expressions of opinion concerning scientific management and concerning the conference itself, by those who had been in attendance. It resolved itself practically into a discussion of the obligations of the Taylor Society to the public, with respect to providing for the investigation of and public discussions of the labor aspects of scientific management. Of course those who criticised the conference because lacking in opportunity for discussion of the labor problem, were not aware of the opportunities which had been afforded by other meetings of the Society, nor did they appreciate exactly the purposes of the Ann Arbor Conference. However, it is significant to note the direction taken by discussions at the final session, and also to note that the session "was frequently referred to as the most instructive session which had been held."

SCIENTIFIC METHODS OF MANAGEMENT APPLIED TO VARIOUS TYPES OF INDUSTRY[1]

By Sanford E. Thompson[2]

At a recent congress on industrial management, the subject of one of the papers was the limitations of scientific management. The author, a prominent man in his own line, public service utilities, discussed the subject, laying special emphasis on the *absurdity* of introducing scientific management into a machine shop handling miscellaneous work. Unfortunately for his argument, the man next on the program was Mr. Wilfred Lewis, Vice-President of the Tabor Manufacturing Company. He described the *success* of scientific management in his machine shop which handled miscellaneous kinds of work.

The breadth of the movement is shown by the very diversity of the industries which are adopting scientific methods to a greater or less degree—industries including machine shops, textile mills, paper mills, pulp mills, printing shops, box factories, clothing shops, automobile plants, shops making novelties, construction plants, clerical departments, and other processes almost too numerous to classify. The very fact that such varied industries can adopt principles fundamentally alike illustrates two things:

(1) The universal scope of the science of management and

(2) The diversity, yet identity in principle, of the system required for control.

Fundamental Principles of Scientific Management

An explanation of this unity, yet diversity, lies in the fact that management is not a system—it is not merely an art—but it is a science and a science based not on mere physical laws but consisting of a philosophy with the four great underlying principles brought out by the late Dr. Frederick W. Taylor.*

(1) The development of a science for each element of a man's work.

(2) The scientific selection of the workman.

(3) His scientific education and development.

(4) Intimate, friendly coöperation between management and men.

The science of management determines after thorough study and thorough investigation the best way of performing each individual operation; the proper sequence of operations; the tools and implements which give the best results; the proper material to use under different conditions; the quantities of materials required for a given quantity of product; the best method of distribution; the quality that must be obtained; the proper time to perform each operation; the type of workman suited for the job; the best method of instructing the workman; the plan of organization best fitted to establish and maintain the benefits derived from the mutual endeavors of the men and the management.

Take what industry you may choose, select any process in that industry, and you will find an opportunity for applying these fundamental principles; applying them in the standardizing of materials; applying them in the standardization of the processes; applying them in the distribution of the materials and the work; applying them in the determination of standards of quality; applying them in the organization. You will find, not merely opportunity, you will find on close examination a crying need for these things, and you will wonder how under the sun conditions have been going on for decade after decade following the rule-of-thumb methods with the idea that because it always has been done in a certain way it must be right. I tell you, gentlemen, it is almost a dead sure fact if a thing has always been done in a certain way, it is radically wrong.

[1] An address before the Taylor Society at the Ann Arbor Conference on Scientific Management, Ann Arbor, Mich., May 11, 1916.

[2] Member American Institute of Consulting Engineers, Boston, Mass.

* The Principles of Scientific Management, by Frederick W. Taylor, p. 36, Harper & Brothers, 1911.

It is then because of the fundamental nature of this science, because indeed of the fact that management is a science, that we have this search, this continued striving, for the attainment of the means for applying system to production.

The fundamental principles of the science of management frequently are confused with the machinery necessary for carrying the principles into effect. It is the machinery—the system—that is criticised. If we only could let scientific management blow down from the sky; if we could breathe into the souls of the management and men, the life-giving properties; if we could install, to automatically operate it, some system of air current or electrical control or, better still, some system of hydraulic pressure, there would be no question about its universal adoption.

But we must bear in mind one thing—to accomplish great things great efforts are necessary.

If scientific management would come in with the summer breezes, it would have been adopted universally long ago.

It is failure to appreciate the necessity for thoroughness,—it is, in fact, many times the failure to adopt what are really scientific methods that sometimes has put scientific management into disrepute. Not long ago I visited a paper mill where the installation of certain new methods had been made in a superficial way. I examined the records and noticed that the pay per hour of the same men varied anywhere from twenty-five to forty cents. I asked the reason for this,—whether there was such constant variation in the accomplishment of this man. "Oh, no," they said, "the character of the stock varied. This caused the difference." Now the trouble here was a very fundamental one—one that you run up against in case after case. The rates had been adopted, the department had been in a measure systematised without the adoption of standards. This is *not* scientific management.

In this case, so-called standards had been set on what had been done instead of on what can and should be done; time studies had been made on the process as practiced and not on the process developed through careful, analytical treatment designed to correct defects in machinery and workmanship.

In the scientific method we have the detailed analysis of each individual process; the thorough investigation of methods; the study of times required to produce the various units of work. As a result of this, we establish standards and it is these standards that enable us to accomplish the various results in elimination of waste, improvement in quality, and increase in output.

Now just as soon as we begin to establish accurate, refined standards,—standards of materials and standards of methods, it is evident that more complicated mechanism is necessary to maintain and control these standards.

We frequently hear a manufacturer say that he wants standard methods,—he wants exact piece rates but he doesn't want a complicated system. Now the trouble is, as I have already indicated, that you can't produce uniform results without well defined methods of management. You can't turn out hundreds of screws a minute on a common lathe,—you can't build 2000 automobiles a day in an ordinary machine shop.

Necessity for Mechanism

To illustrate how this necessity for mechanism presents itself, let us take first a simple manufacturing operation, the cutting of paper, and assume for the moment that the object is the setting of exact piece rates or tasks. To further illustrate this point, let us take after this another type of operation, the making of paper, where the best results can be obtained through uniformity of product. Although the character of these two operations is absolutely different, I want to show how the principles are fundamentally alike, and how both require a mechanism similar in principle but different in detail to carry out the science.

The cutting of paper as required in a printing establishment or in the finishing department of a paper mill seemingly is a very simple operation. The machine consists essentially of a table with a slot through which a long knife passes up and down at the will of the operative. The operation consists of taking, in several lifts, the sheets of paper from a truck, placing this on the cutting table until a thickness of about five inches is reached, cutting, turning the paper if more than one cut is needed, and placing the paper in a different number of lifts back on to another truck.

Very simple it is—placing the paper, cutting, and removing. But what do we find when we begin to make studies on the operation for the purpose of laying out, not a piece rate fixed by guess but a definite task adapted to the capacity of the machine and the operative?

We find at once when considering simply the very first operation of lifting on to the machine that the time is affected by the number of sheets taken to a lift. Study shows that the lift which a man can take is dependent upon the thickness of the paper, the size of the paper, the coating of the paper, and the way it is handled.

Before definite times can be fixed even for so simple an operation as cutting paper, a scientific investigation combined with the time study is necessary to allow for each one of these variables, and to find just how the sheets should be handled under all possible conditions. We find that to keep the machine running to the best advantage; to cut as one job sheets of the same size so as to avoid frequent setting of the machine; to arrange the count so as to know the amount run through; a definite scheme of planning and routing of the paper and moving it to and from the machine is absolutely necessary.

In connection with the scientific study and with the arrangement of the routing, but especially for the purpose of determining how much of each grade, size, and weight, should be handled in a given time, study of standard unit times for handling, cutting, turning, etc., must be made.

But having established the time for the job, having routed the materials in proper fashion, the work cannot be put through on time and of the required quality unless the operatives are instructed how much of each grade and size of paper to take at a lift, the thickness that can be cut in each case, the quickest way to manipulate the machines, and so on.

Furthermore, having given definite instructions to the worker, having laid out a task for him to do, which may be two or three times the volume of work previously done by day or by the piece—not because of "speeding up" but because of changes in methods—it is necessary to give him a reward based on accomplishment in the given time and according to the specified instructions.

You will see, and I want to bring out the facts that this simple operation of paper cutting brings into play the mechanism of standardization, planning, routing, time study,