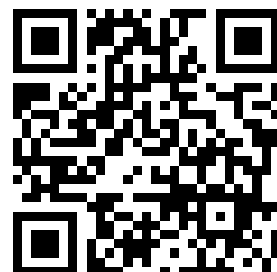

This is a reproduction of a library book that was digitized by Google as part of an ongoing effort to preserve the information in books and make it universally accessible.

GoogleTM books

<https://books.google.com>



GRAD
T
58
. T24



JUL 29 1926

NOV 20 1926

T
55
.T24

BULLETIN OF THE

TAYLOR SOCIETY

AN INTERNATIONAL SOCIETY TO PROMOTE THE SCIENCE
AND THE ART OF ADMINISTRATION AND OF MANAGEMENT

Testimony of Frederick W. ^{inspired} Taylor

at hearings before

Special Committee of the
House of Representatives

January, 1912

A classic of management literature reprinted
in full from a rare public document

Engineering Societies Building
29 W. Thirty-Ninth St.
New York

JUNE-AUGUST, 1926

VOL. XI, NOS. 3 and 4

Objects of the Taylor Society

The objects of this Society are, through research, discussion, publication and other appropriate means:

1. To secure—for the common benefit of the community, the worker, the manager and the employer—understanding and intelligent direction of the principles of administration and management which govern organized effort for accomplishing industrial and other social purposes.
2. To secure the gradual elimination of unnecessary effort and of unduly burdensome toil in the accomplishment of the work of the world.
3. To promote the scientific study and teaching of the principles governing organized effort, and of the mechanisms of their adaptation and application under varying and changing conditions.
4. To promote general recognition of the fact that the evaluation and application of these principles and mechanisms are the mutual concern of the community, the worker, the manager and the employer.
5. To inspire in labor, manager and employer a constant adherence to the highest ethical conception of their individual and collective responsibility.

Membership

The membership of the Society comprises Members, Junior Members, Fellows, Honorary Members, Life Members, Firm Members, Contributing Members and Student Associates. Application for membership should be made on a regular form which may be secured from the Society. New members may be elected directly to the grades marked*.

1. **Member*: An individual interested in the development of the science and the art of management as engineer, executive, operative, scientist, investigator or teacher. Minimum age 28. Initiation Fee, \$15. Annual dues including subscription to the Bulletin, \$20.
2. **Junior Member*: A younger member. A Junior Member may become a Member without payment of additional initiation fee at 28 years of age and must change to Member at 30 years. Initiation Fee, \$5. Annual dues including subscription to the Bulletin, \$10.
3. *Fellow*: A member elected Fellow in recognition of distinguished contribution to advancement of the science and the art of management. Annual dues including subscription to the Bulletin, \$20.
For any of the above grades a person engaged in educational work, state service, government service or the service of any other non-commercial enterprise of an eleemosynary nature shall pay one-half the initiation fee and one half the annual dues of the grade to which elected.
4. *Honorary Member*: A Fellow, over 50 years of age, who has rendered exceptionally distinguished service in the advancement of the science and the art of management.
5. **Life Member*: Any Fellow or Member who has prepaid all dues by the payment of \$500.
6. **Firm Member*: A firm or organization interested in the advancement of the science and the art of management which desires to make the service of the Society available to members of its organization. A firm member designates two representatives (who may be changed from time to time at the organization's discretion) who have all the rights and privileges of membership except the right to vote and to hold office. Annual dues, including two subscriptions to the Bulletin, \$40.
7. **Contributing Member*: Any individual, firm or organization desiring to promote the work of the Society by an annual contribution of \$100 or more. A contributing member has all the privileges of personal or firm membership, as the case may be, including one subscription to the Bulletin for each \$20 contributed.
8. **Student Associate*: A regularly enrolled student of management in any school of engineering, business administration, commerce or arts, of collegiate rank, or a graduate of such institution who has applied for membership not later than one year after graduation, elected upon recommendation of the instructor in charge of management courses. A Student Associate may become a Junior Member, without payment of initiation fee, any time after graduation and must become a Junior Member at the age of 25. Annual dues including subscription to the Bulletin, \$3.

All dues are payable in advance, either annually or in semi-annual installments. The fiscal year is November 1 to October 31. Members elected other than at the beginning of the fiscal year are charged pro rata (quarterly) for the first year.

BULLETIN OF THE TAYLOR SOCIETY

AN INTERNATIONAL SOCIETY TO PROMOTE THE SCIENCE
AND THE ART OF ADMINISTRATION AND OF MANAGEMENT

Published by the Taylor Society at
Engineering Societies Building
29 West Thirty-Ninth St.
New York

Copyrighted 1926, by the Taylor Society. Published every
other month. Per Year to Members \$2.50; to others \$3.00.
This Issue \$1.50.

Entered as second-class matter, Dec. 17, 1921, at the Post Office at New York
N. Y., under the Act of March 3, 1879.

VOL. XI JUNE-AUGUST, 1926 Nos. 3 and 4

Contents

Acknowledgment	89
Comment	89
Significance of the Investigation . .	90
By H. S. Person	
Testimony of Frederick W. Taylor at Hearings Before Special Committee of the House of Representatives to Investigate the Taylor and Other Sys- tems of Shop Management, Under Authority of H. R. 90—January, 1912	95

Acknowledgment

ON behalf of our members we make sincere acknowledgment to the Dennison Manufacturing Company for the availability in this issue of the reprint of a rare public document, a classic in management literature, the testimony given by Taylor in 1912 before a special committee of the House of Representatives. Appreciative of the value of the testimony as an exposition of a philosophy of management, and also of the rarity of the public document in which it appeared originally, executives of that company suggested that it should be made available to our members by a reprinting in the Bulletin. Furthermore, appreciative of the expense involved in the publication of so voluminous a document, the Dennison Manufacturing Company set the type in its own plant and contributed the composition towards the expense of publication. To that company therefore on behalf of our members we render acknowledgment.

Comment

ACCORDING to his biographer¹ this testimony represents "Taylor's most heroic attempt to elucidate the philosophy of scientific management in a popular way," and is important "not only because of the light it will throw on the general aims towards which all his workaday activities were directed from his early youth, but also because it is racy with the flavor of his personality." Apparently it was printed as a public document as reported by the official stenographer, without revision or editing, which accounts for the repetitions and looseness of structure. "To an unusual degree," says the same authority, "Taylor writing and Taylor talking were different persons. When he wrote, he habitually chose his words and constructed his sentences with exceeding care; when he spoke, he, equally as a matter of habit, just let himself drive."

THIS statement by Taylor was brought out by the following chain of circumstances. Tariffs calling for a general advance in rates had been filed with the Interstate Commerce Commission by the railroads of the northeastern section of the United States in the early summer of 1910. At hearings held in September, October and November dramatic testimony concerning scientific management was introduced by Louis D. Brandeis, an attorney for the shippers. Says Drury,² "The effect of the insertion of the scientific management argument into the rate hearings contest was felt almost instantaneously by the whole country. Only a few days after the introduction of the evidence, the early December reviews of current events gave great space to the dramatic testimony of some of the witnesses. By January, one of the leading railroad journals had begun a series of articles in which the railroads were defended against the implication that they were inefficiently managed. All through January, February, March and every month of 1911, the periodical press, popular as well as technical, was filled with explanation after explanation as to what scientific management is, why it is good, or why it is worthless. By the fall of 1911, Dartmouth College had arranged for a conference to spread information as to the merits of scientific management; while on the other hand, owing to the demands of organized labor, a special

¹Copley, "Frederick W. Taylor," Vol. I, p. 9.

²"Scientific Management" in *Columbia University Studies in History, Economics and Public Law*, Vol. LVI, No. 2, 1915, p. 18.

House committee was inquiring as to whether Congress should forbid the system in the government service."

This special house committee, appointed August 21, 1911, consisted of William D. Wilson, of Pennsylvania, Chairman, William C. Redfield, of New York, and John O. Tilson, of Connecticut. Public hearings began in Boston, October 4, 1911, and were concluded at Washington, D. C., February 12, 1912. Taylor's testimony³ began January 25 and was completed January 30, 1912.

The report of the Committee was essentially that "The selection of any system of shop management for the various Government works must be to a great extent a matter of administration, and your committee does not deem it advisable nor expedient to make any recommendations for legislation upon the subject at this time."

Significance of the Investigation

*The Management Movement—Taylor's Contribution—
—Why it Stimulated Investigation—
What the Investigation Brought Out*

By H. S. Person¹

THERE had been a quarter century of articulate "management movement" in the United States, chiefly among engineers. It had failed to attract public interest. Then in 1910, at the Eastern Rate Case hearings, attention of the public was focused on Taylor's contribution. Within a year investigation by a Congressional Committee was under way. Here is evidence that something of major significance and influence had been injected into the management movement. This was the investigation of a doctrine. There would have been no investigation of a doctrine had it not presented new concepts which were logical, practical, persuasive and pervasive; which threatened to disturb accustomed mental attitudes. Public investigation of a specific instance of alleged anti-social conduct is not infrequent, but public investigation of a doctrine is rare.

The management movement by which we mean a conscious, articulate recognition by industry that it is confronted by problems of management, arose

out of revolutionary industrial conditions which developed in the United States following the Civil War. The term industrial revolution usually connotes those industrial changes of the late eighteenth century caused by the invention of power machinery and characterized by the appearance of the factory system. But more important as explaining the generation of the management movement, was what we in the United States may for convenience designate as the second industrial revolution. Its characteristic was the rapid development of large-scale factories. Prior to the construction of new railroads following the Civil War, the United States had been an aggregate of more or less isolated regional markets. The restricted consuming capacity of any one of these markets, among other influences, had limited the output and therefore the size of enterprises. After the construction of railroads was well under way these regional markets gradually became consolidated into a national market with great potentiality for consumption. This gave opportunity and incentive to energetic managements for extension of their businesses. By 1880 ownership and management had come to be conscious of new problems of management arising out of the larger scale upon which industrial operations were becoming conducted.

The manner in which this consciousness became articulate, and therefore became a "movement," is of interest. The American Society of Mechanical Engineers had been organized in 1880. This afforded a forum for the engineers to discuss their problems. One of the interests of the engineers was the problem of management of large-scale plants, for it was the engineers who were designing, fabricating and installing power equipment in these plants, and it was logical that ownership and management should turn to them for assistance in solving the problem of managing the operations of the new equipment. The responsibility having been passed to the engineers, they at once utilized their new forum for consideration of these common problems. The classic address which may conveniently be selected to mark the beginning of the management movement was Henry R. Towne's "The Engineer as Economist," presented in 1886.² The thesis of this address constituted

³For incidents of this examination cf. Copley, II, p. 347.

¹Managing Director of Taylor Society.

²Cited because outstanding in range and perspective. However, one should not disregard other contributions of this period by Oberlin Smith, Henry Metcalfe, etc.

essentially a challenge to the engineers to investigate the economic problems of business—the management of industrial enterprises. Examination of *Transactions of the A.S.M.E.* and of periodicals such as *The Engineering Magazine* proves that the challenge was accepted and that for many years the A.S.M.E. afforded the principal forum of the management movement.

The first phase of the management problem to receive common attention on this forum was incentive systems of wage payment. This was the period when such systems as the Halsey, Towne-Halsey and Rowan Systems were devised. The concentration of attention upon differential or incentive wage systems proves that the outstanding phase of management which first appeared perplexing in large-scale enterprise was the securing of output.

There are four reasons why this was the perplexing problem. First; the methods of supervision of workers which had characterized household industry and the small factory were becoming inadequate. Workers operating power machines in large shops were proving to be too scattered for close contacts and supervision. Second; the larger the plant the more difficult becomes coordination; therefore unaccountable wastes were beginning to appear which we now know were the result of inefficient coordination of the work of individual machines and shops. This tended to reduce collective output. Third; there was undoubtedly a tendency towards deliberate restriction of output by workers,³ a mental attitude which had resulted from unhappy experience with unemployment and cutting of piece rates during the depression in the seventies. Fourth; numerous enterprises, which had become adjusted particularly to the scale of operations of local markets, were feeling keenly the competition of enterprises able to take advantage of the opportunities of the recently developed national market. By the middle eighties management was primarily concerned with output as a problem.

Recognizing that close supervision was impracticable, and not satisfied with the prevalent "drive" system of foremanship (the "boss" is a peculiarly American institution), engineering ingenuity turned towards a device of indirection for securing workers' incentive—the differential wage system.

Roughly from 1885 to 1895 this was the almost exclusive topic of discussion.

Then followed a period, roughly from 1895 to 1900, when cost accounting became the phase of management to which the greater attention was given. One likes to believe—and there is much evidence to support the belief—that study of differential wage systems had led to realization that comparative evaluation of such systems is impossible without comparative records of their effects and their influence on costs; and that this realization marked a step forward in the movement in that it represents the introduction of analytic method into the study of management.

A third period in the development of the management movement began when, about 1900, organization and system began to receive major attention. Discussion of differential wage systems and cost accounting continued—and have never ceased—but the new concepts of organization and system remained for a period the favorite topic. And well they should, for organization and system relate to fundamentals; wage systems and cost systems are more particularly but devices or tools.

Here again one likes to believe—and there is evidence for the belief—that another important forward step was taken in the management movement. The analytic method of investigation had disclosed the fact that devices were not the most important thing. Comparison of costs, let us assume, had disclosed that this combination and that permutation of factors or relationships in management have different values; that there are economical and uneconomical possibilities of relationship and of procedure; and that enterprise on a large scale is essentially cooperative and dependent on understanding of the relationship of parts as essential to coordination of the efforts of parts.

Such in brief were the outstanding features of the management movement in general from 1885 until 1910, when it received and was enriched by the impact of the genius of Taylor. (Taylor's influence, although he had begun his constructive work prior to 1880, did not become noteworthy until 1910.)

De Fremenville has called attention to the fact that Taylor's career represents the incursion by accident of an intellectualist into industry.⁴ We should add, not of one who entered industry tem-

³Cf pp. 96-102, 134-137.

⁴*Bulletin of the Taylor Society*, Vol. X, No. 1, p. 30.

porarily out of curiosity or for investigation and who never really became part of it, but of one who became completely incorporated into it. By intellectualist is meant that he was endowed with curiosity, inventiveness and a genius for scientific procedure, that he was reared in an atmosphere of culture in the home, and that he was prepared for college in one of our greatest schools. By accident is meant that overstudy at preparatory school so impaired his eyesight as to forbid further formal education of which the particular objective was the career of a lawyer. By "into industry" is meant that Taylor served his apprenticeships as pattern-maker and machinist, "got a job" as helper in a machine shop, and then worked up through machinist, assistant foreman, foreman and assistant engineer to chief engineer of a great steel plant—and in these latter capacities carried major executive responsibilities. During these early years in industry the intellectualist qualities appeared in his securing the M.E. degree from Stevens Institute by night study, and in the manner in which he attacked his problems of management.

Relative to the workers he was called upon to supervise, he was but a boy—a blond, blue-eyed, 22 year-old, 145 pound boy—when in 1878 he was made gang boss at Midvale. Yet he had the nerve to attempt to force greater production by the prevailing method of drive from a group of machinists experienced in meeting the methods of the then typical American boss. The struggle that ensued spiritually sickened but did not dishearten him. He resolved to find a remedy for this deplorable situation in industry—this custom of using force to secure reasonable output.⁵ Thereupon the intellectualist came to the fore. "I realized that the thing which we on the management's side lacked more than anything else was exact knowledge as to how long it ought to take the workman to do his work."⁶ Workers knew *how* and had considerable private knowledge as to *how long*; management knew simply *how*. Management should know also *how long*.

Young Taylor had no theories of management; the situation was that of a gang boss confronted by the practical problem of securing output. He resolved that it should be secured by suasion with the sanction of definite facts as to how long, in-

stead of by the force of drive with the sanction of arbitrary authority. But to the intellectualist it was apparent that how long required investigation.

It was fortunate that Taylor was gang boss of a small group of men performing a limited range of simple operations—the machining of locomotive tires and axles—in which machine time is long relative to handling time. Had the operations been more complex he might have been baffled in the effort to make a beginning of scientific investigation in an environment of shop operations which must not suffer interruption.

He began by withdrawing a machine from regular production and putting it to work on experiments in machining a vast quantity of waste metal which happened to be available. He adopted time as the standard of comparison and the stop watch as the measuring device.⁷ He broke operations into unit elements and timed these units separately. The best method found among the skilled workers studied for performing any unit of an operation (the shortest-time method) was noted, and these best unit methods were brought together as the standard method for the complete operation.⁸

It is important to note that these were *controlled* experiments, by which is meant that all variables (shafting and belting conditions, feeds, speeds, depth of cut, availability of materials, etc.), except the one being studied, were held constant. This enabled Taylor to discover at an early stage of experiment a combination of best conditions for each operation. Having discovered standard conditions and standard times for various operations, he had what he had set out to find—knowledge of how long. He had discovered what he later designated as an "art" for each operation studied.

There remained the more difficult problem of utilizing this knowledge throughout the shop. Any skilled workman could meet the requirements of the newly discovered art when working on the perfectly-conditioned experimental machine, but what about meeting those requirements when working on the machines throughout the shop? The answer lay in bringing all the machines to the same point of perfection in condition. This required systematic standardization and maintenance of standards. Shafting, belting and machines were brought to standard conditions and maintained

⁵Pp. 122-124. ⁶P. 124.

⁷P. 124. ⁸Pp. 124, 132, 150-152.

there by systematic inspection, and instructions relating to feeds, speeds and other elements of particular machine adjustment were formulated; in short, all the conditions in the shop were brought into line with those of the experimental machine on which standards of time had been determined.

The essential information was now available for control of shop capacity. The capacity of each machine and the work to be done being known, it was logically inevitable that work should be planned and laid out in such manner as to secure maximum utilization of facilities and elimination of waste. In the Midvale days Taylor himself performed this function, with the assistance of a clerk or two; as foreman he both planned and supervised operations. Not until later, at Bethlehem where the machine shop was large and the operations complicated, did circumstances require him to devise the planning room in which standardization, maintenance and planning functions were segregated.

But at Midvale, soon after the investigations were started, as early as 1880 or 1881, Taylor worked out all the basic mechanisms of his system, from which were later inducted the principles of scientific management. At Midvale he utilized the new knowledge to secure greater output, higher wages and harmonious relations with workers. Never again did he have controversy with workers under his supervision; later controversies were with leaders of organized labor on matters of doctrine.

We have said that Taylor started with no particular theories or doctrine concerning management;⁹ that he started as an ordinary foreman attempting to solve day-to-day problems. The difference between him and other foremen was this; being an intellectualist, he instinctively went to the fundamentals of his problems with respect to both objectives and methods of investigation. Later, when he had made contact with the A.S.M.E. (1885), and when he was stimulated by listening to the discussions of the nascent management movement, he began to analyze and write about the significance of his methods. In 1895 he presented "A Piece Rate System" to that organization, and in 1903 "Shop Management." These statements made little impression on his engineer audiences. It was the Eastern Rate Case hearings, and a strike at Watertown Arsenal, stimulated by leaders of labor out-

side the arsenal, which brought attention—public attention and investigation.

Taylor was not skilled as an expounder. His books show labored composition and are unbalanced and incomplete, although in substance they have never been equaled by any other exposition in their field. As an advocate he was even less skillful. His public addresses are on the whole paraphrases of his written expositions. They are interesting and substantial but they carry no fire of persuasion. But it was as a witness before the investigating committee that he was least successful. Nevertheless, the testimony printed in this issue is one of the most important documents in the entire field of management literature.

Had he been intellectually agile, or accustomed to argumentation, or a plain charlatan, he would have been more successful as a witness. He was none of these. What he achieved intellectually was achieved by sustained thinking and laborious experiment. He was not accustomed to disputation and intellectual gymnastic. His was a single track mind. And as for being a charlatan, no more absurd assumption could be raised; he was always terribly serious and convinced of the technical efficiency of his methods and the social beneficence of his doctrines. When criticized for the length of his public addresses—usually three hours—he replied that he would rather convince one man who stayed with him for three hours than please and half-convince five hundred who would not stay more than an hour.

A more agile intellect, or one skilled in disputation, would have perceived early in the cross-examination of the investigation that minds were not meeting, and would have framed his replies differently. But Taylor went his way on his single intellectual track, and most of the inquisitors went their way on their several tracks. For instance, at certain points in the examination questions were asked which indicated that the examiners were concerned over the workers opportunities for redress when mechanisms of scientific management might be used unscrupulously. Taylor's replies indicated that he was concerned only with the fact that such misuse would not be *scientific* management, but simply old-fashioned management borrowing and utilizing new devices, and certain as always in the past to run amuck and pay the penalty in so doing.

In this testimony is found the most compre-

⁹P. 125.

hensive and precise statement by Taylor of what scientific management is and is not.¹⁰ In it are found also—and this is what gives it special value—answers to many questions concerning scientific management suggested by but not answered in his published works. A summation of the most important of these should be helpful.

In the testimony he states that he was not the originator of scientific management; that it was the composite work of many men.¹¹ In this assertion he had in mind unquestionably the mechanisms of his system. Here and elsewhere he stated that they were gathered from many sources. We understand, however, that he never refused to accept credit for adopting and refining these mechanisms, integrating them into a systematic whole, and for inducting from this system a philosophy or doctrine of management.

In this testimony is evidence that Taylor was not thinking of management for a new social order. His system of management is for industry as we find it today—capitalistic, mechanized, with division of labor and specialization.¹² He himself was an investor in enterprise. He believed that any new regime of industry must evolve out of better management of industry as we find it today. Therefore he was concerned only with better management under the present system, not with some possible future system. But he was no partisan of the ownership and management which had developed under the present system. In this testimony he is throughout impartial in criticism, now of employers and now of labor, aimed at prevalent beliefs and practices.

The cornerstone of his doctrine of scientific management is intellectual revolution in management,¹³ a new mental attitude which on the one hand insists on utilization of scientific investigation of all problems of management, and on the other hand voluntarily submits to managerial conduct in accordance with laws discovered by these investigations.¹⁴ He advocated a reign of law, to which ownership, management and labor must be equally subservient, in place of a reign of arbitrary authority, to which only workers are subservient.

No factor or problem of management is too small for scientific investigation.¹⁵ Improvements

do not come by waiting for chance discoveries by managers or workers; progress is achieved by utilizing organized and specialized intelligence in investigation.¹⁶ Workers are and must be intelligent participants in investigation and experiment;¹⁷ and there may even well be organization of management and labor for joint investigation.¹⁸ But workers cannot be expected, on their sole initiative and by chance, to assume responsibility for improvement and progress. Even manufacturers of machine equipment, with their facilities for research, do not speed their machines correctly.¹⁹ Only organized research which results in standards can make workers' capacity for inventiveness effective.²⁰ In other words, a stimulating atmosphere must be created by the presence and functioning of organized, specialized intelligence. Workers, instead of becoming mechanized automations, become intellectually alert under scientific management.²¹

Because its cornerstone is a new mental outlook, stimulated by and sustained by scientific investigation, scientific management cannot be "installed." It must be developed. Time and patience are essential to the establishment of a "point of view."²² It is a problem of education. A ready-made system for quick installation is not expressive of scientific management. A false use of mechanisms, in themselves proper and effective when integrated in accordance with the new state of mind, is not scientific management.²³

Cooperation in effort is essential to scientific management,²⁴ which is a practical way of stating that it requires voluntary conduct in accordance with a reign of discovered law. Laws instead of arbitrary authority, and verified best practices instead of guess and opinion, must control managerial and operating conduct, but this control must be established by voluntary acceptance—there is no other way.²⁵ Therefore the necessity of consent and cooperation in scientific management. Without these it cannot exist

The extent to which Taylor in the doctrine and practices of scientific management anticipated the point of view of personnel work and industrial psychology, developed chiefly since his 'day, is

(Concluded on page 196)

¹⁰Pp. 102, 103, 107, 108. ¹¹P. 95. ¹²P. 166.

¹³Pp. 103, 104, 146, 161, 169, 185. ¹⁴P. 193. ¹⁵P. 132.

¹⁶Pp. 127, 128, 144. ¹⁷P. 162.

¹⁸P. 145. ¹⁹P. 131. ²⁰Pp. 121, 163. ²¹P. 163.

²²Pp. 127, 139, 184. ²³P. 105.

²⁴Pp. 109, 146. ²⁵Pp. 146, 148.

Taylor's Famous Testimony Before the Special House Committee¹

A Unique Exposition of Scientific Management, Rare With the Flavor of Personality
and Disclosing Historical Background and Motives

Washington, D. C., January, 1912

Thursday, January 25, 1912.

The committee met at 10.40 o'clock a. m.,
Hon. William B. Wilson (chairman) presiding.

Testimony of Mr. Frederick Winslow Taylor

The witness was duly sworn by the chairman.

The Chairman. Will you please give your
name and address to the stenographer, Mr.
Taylor?

Mr. Taylor. Frederick Winslow Taylor,
Highland Avenue, Chestnut Hill, Philadelphia,
Pa.

The Chairman. Mr. Taylor, are you the au-
thor or compiler of the system of shop manage-
ment generally known as the "Taylor system"?

Mr. Taylor. I have had a very great deal
to do with the development of the system of
management which has come to be called by
certain people the "Taylor system," but I am
only one of many men who have been in-
strumental in the development of this system.
I wish to state, however, that at no time have I
personally called the system the "Taylor sys-
tem," nor have I ever advocated the desirability
of calling it by that name. I have constantly
protested against it being branded either with
my name or the name of any other man, and I
believe it has been a very great injury to the
cause that it has been branded with any man's
name. I think it should be properly called by
some generic term which could be and ought to
be acceptable to the whole country. Many

self-respecting and able managers object to
working under the brand of any man's name,
whereas there is no management that could
properly object to working under the name, we
will say, of "scientific management."

The Chairman. In developing and collating
the different parts of this system and in intro-
ducing it in different establishments, by what
name have you designated it?

Mr. Taylor. The first general designation
was a "piece-rate system," because the promi-
nent feature—the feature which at that time
interested men most—was a new and radically
different type of piecework than anything in-
troduced before. I afterwards pointed out,
however, that piecework was really one of the
comparatively unimportant elements of our
system of management. The next paper written
by me on the subject was called "Shop manage-
ment," and in that paper the task idea—the
idea of setting a measured standard of work
for each man to do each day—was the most
prominent feature, and for some time after this
the system was called the "task system." The
word "task", however, had a severe sound and
did not at all adequately represent the senti-
ment of the system; it sounded as though you
were treating men severely, whereas the whole
idea underlying our system is justice and not
severity. So it was recognized that this desig-
nation was not the proper one, but at the time
no better name appeared. Finally the name
was agreed upon which I think is correct and
which does represent the system better than
any other name yet suggested, namely, "scien-
tific management."

¹Reprint of public document, *Hearings Before Social Com-
mittee of the House of Representatives to Investigate the
Taylor and Other Systems of Shop Management Under the
Authority of H. Res. 90; Vol. III, pp. 1377—1508.*

The Chairman. Would you state, for the information of the committee, how you developed this system, when you developed it, where you developed it, and what the essential features of it are when developed, and state it in your own way?

Mr. Taylor. Mr. Chairman, before beginning with the early steps which were taken and which led toward the development of scientific management, I should like to attempt to make it clear what the essence of scientific management is; what may be called the atmosphere surrounding it; the sentiments which accompany scientific management when real scientific management comes to exist, and which are appropriate to it; I wish to make clear those sentiments, on the one hand, which come to be most important for those on the management's side, and those sentiments, on the other hand, which come to be the essence and most important to the men working under scientific management, because a mere statement of details and of various steps taken one after another in developing the system, unless one understands the goal toward which they are converging, is apt to be misleading rather than enlightening.

The most important fact which is connected with the working people of this country and which has been forced upon my attention possibly more during the past year than it has in former years, is the fact that the average workman believes it to be for his interest and for the interest of his fellow workmen to go slow instead of going fast, to restrict output instead of turning out as large a day's work as is practicable.

Now, I find that this fallacy is practically universal with workingmen, and in using the term "workingmen" I have in mind only that class of workmen who are engaged in what may be called cooperative industries, in which several men work together. To illustrate, I have not in mind the coachman, the gardener, or the isolated workman of any kind. I do not mean to say that men outside the cooperative trades believe it to be for their best interest and for the best interest of their fellow workmen to go slow, but I do say that those engaged in cooperative trades generally so believe. Therefore, in using the word "workman" I hope it will

be understood that I am referring simply to that group of men cooperatively engaged, and that is rather a small group of men in any community. We who are engaged in cooperative industry have somehow gotten the impression that the whole world is engaged in the same sort of work, but the class of which I speak forms a rather small minority, but, nevertheless, a very important element of the community.

When you get almost any workingman to talking with you intimately and saying exactly what he believes and feels without reserve; I mean when he speaks without feeling that he is going to meet with an antagonistic opinion not in sympathy with him; to put this in still a third way, when you get that man to telling his real views, he will almost always state that he cannot see how it could be for the interest of his particular trade—that is, for the interest of those men associated with him, and with whose work he is familiar—to very greatly increase their output per day.

The question the workman will ask you, if you have his confidence, is: "What would become of those of us in my particular trade who would be thrown out of work in case we were all to greatly increase our output each day?" Each such man in a particular working group feels that in his town or section or particular industry there is, in the coming year, only about so much work to be done. As far as he can see, if he were to double his output, and if the rest of the men were to double their output tomorrow or next week or next month or next year, he can see no other outcome except that one-half of the workmen engaged with him would be thrown out of work.

That is the honest viewpoint of the average workman in practically all trades. And let me say here that this is a strictly honest view; it is no fake view; there is no hypocrisy about it. This is a firm conviction on the part of almost all workingmen. Holding those views and acting upon them, the workmen cannot be blamed for impressing upon other workmen their conviction that it is not for their mutual interest to greatly increase the output in their particular trade. And as a result they almost all come to the conclusion that it would be humane, it would be a kindly thing, it would be

acting merely in the best interests of their brothers, to restrict output rather than to materially increase their output.

Now, I think that is the view of the great majority of the workingmen of this country, and I do not blame them for it. I think I may say that for the almost universality with which this view is found among workingmen, and still more for the fact that this view is growing instead of diminishing, that the men who are not themselves working in cooperative industry and who belong, we will say, taking a single example, to the literary classes, men who have the leisure time for study and investigation and the opportunity for knowing better, are mainly to blame. Some one is surely to blame for the fact that workingmen hold this view, because it is a fallacy which some one should have taken the trouble to point out long ago. This view is directly the opposite of the truth. This view is false from beginning to end, and I say again that for this fallacy on the part of the working people the men who have the leisure and the opportunity to educate themselves, the men whose duty it is—or ought to be—to see that the community is properly educated and told the truth, are mainly to blame. I know of very few men in this country who have taken the trouble to bring out the truth of this fact and make it clear to the working people.

On the contrary, the men who are immediately in contact with the workmen—most of all the labor leaders—are teaching the workmen just the opposite of the facts in this respect, and yet I want to say right here, gentlemen, that while I shall have to say quite a little in the way of blame as to the views and acts of certain labor leaders during my talk, in the main I look upon them as strictly honest, upright, straightforward men. I think you will find as many good men among them as you will in any class, but you will also find many misguided men among them, men whose prejudices are carrying them away in the wrong direction, just as you will find with men of other classes. And please note here that I am using the words “class” or “classes” throughout in the sense of groups of men and women with somewhat similar aims in life, and not at all with the “upper and lower class” distinctions which are some-

times given to these words. So that when I say the labor leaders are misdirecting their followers, are giving them wrong views, are teaching wrong doctrines to their men, I say this with no idea of imputing wrong motives to labor leaders. They themselves are as ignorant of the underlying truths of political economy as the workmen whom they are teaching. I say this quite advisedly because I have talked with a great many of them and I find that they are as firmly convinced of the truth of this fallacy as to the restriction of output as the workmen themselves. Therefore, I repeat again, the teaching of this doctrine by almost all labor leaders is the result of honest conviction and not of any less praiseworthy motive.

And yet, in spite of the fact that nearly all labor leaders are teaching this doctrine, and that almost no one in this country is giving much, if any, time to counteracting the evil effects—and they are tremendous—of this fallacy, that it is for the interest of the workman to go slow. In spite of this fact, I may say that all that is necessary to do to prove the direct contrary of this fallacy is to investigate the facts of any trade, whatever that trade may be. I do not care what trade you go into, get back to the basic facts, the fundamental truths connected with that trade, and you will find that every time there has been an increased output per individual workman in that trade produced by any cause that it has made more work in the trade and has never diminished the number of workmen in the trade. All you have to do is to go back into the history of any trade and look up the facts and you will find it to be true; that in no case has the permanent effect of increasing the output per individual in the trade been that of throwing men out of work, but the effect has always been to make work for more men.

Now, that is the history of every trade, but in spite of that fact the world at large, both on the workman's side and on the manufacturer's side believes this fallacy (and I find a great many men who ought to know better completely misinformed on the side of the management). And yet this is a fallacy, and a blighting fallacy, as far as the interests of the workingmen and the interests of the whole country are con-

cerned. Now, I feel it important or desirable to give just one illustration to show that an increase in output does not throw men out of work, and I could give thousands, simply thousands, of such illustrations.

Take any trade, go back through the history of it, and see whether increase of output on the part of the workman has resulted in throwing men out of work. That is what people generally believe; that is what these working people who have testified here believe. They believe if they were to increase their output it would result in throwing a lot of them out of their jobs. And I have had much sympathy with the workingmen who have testified before your committee, because I feel that they firmly believe that it would not be for their best interests to turn out a larger output. I believe these men are honestly mistaken, just as the rest of the world has been honestly mistaken in many other instances.

Let us examine the actual facts in one trade—the cotton trade, for instance. It is as well known, perhaps, and as well understood as any trade in the whole list. The power loom was invented some time between 1780 and 1790, I think it was; I am not quite sure about that date, but it was somewhere about that time. It was very slow in coming into use. Somewhere about the year 1840—the exact date is immaterial, and I give that as about the time of the occurrence—there were in round numbers 5,000 cotton weavers in Manchester, England. About that time these weavers became convinced that the power loom was going to win out, that the hand looms which they were operating were doomed. And they knew that the power loom would turn out per man about three times the output. That is a general figure. I do not wish to say that this ratio is exact, but in any case it is nearly so. Those men knew the possibilities of the power loom and realized that when it was introduced it would turn out a very much larger output per man than was being then turned out by the hand loom.

Now, what could they see? They were certain, those men were honestly certain, and it was a natural conviction on their part, that nothing could happen through the introduction

of this power loom except that after it was in, after it was fully installed and doing three times the work that the hand loom did, that instead of there being 5,000 weavers in Manchester they would be reduced to 1,500 or 2,000, and that 3,000 weavers would be thrown out of a job. Now, those men felt fully convinced of that; with them there was no doubt about it; it was a matter of certainty, and they did in kind just what all of us would be apt to do in kind if we were convinced that three-fifths of our working body were to have our means of livelihood taken away from us. What I mean to say is that, broadly speaking, we would adopt the same general policy of opposition that they adopted. I am not advocating violence, arson, or any of the wrong things that were done by these men when I say that we would in a general way have done, broadly speaking, what they did. We would have opposed the introduction of any such policy by every means in our power. What the Manchester weavers did was to break into the establishments where these power looms were being installed. They smashed up the looms. They burned down the buildings in which they were being used. They beat up the scabs using them, and they did almost everything that was in their power to prevent the introduction of the power loom.

And even after that exhibition of fearful violence, gentlemen, I do not hesitate to say that I do not feel very bitterly toward those men. I believe that they were misguided. I feel a certain sympathy for them, not in their violence—I do not endorse that for one moment—but I cannot help but feel a certain sympathy for the men who believe, with absolute certainty, that their means of livelihood is being taken away from them. You cannot help but feel sympathy for men who believe that, even if you thoroughly disapprove of their acts. I do not want to be misquoted in this. These men did murder, violence, and arson. I do not believe in anything of that sort under any circumstances.

Now, gentlemen, the power loom came into use just as every labor-saving device that is a real labor-saving device is sure to come at all times. In spite of any opposition that may come

from any source whatever, I do not care what the source is, I do not care how great the opposition, or what it may be, any truly labor-saving device will win out. All that you have to do to find proof of this is to look at the history of the industrial world. And, gentlemen, scientific management is merely the equivalent of a labor-saving device; that is all it is; it is a means, and a very proper and right means, of making men more efficient than they now are, and without imposing materially greater burdens on them than they now have, and if scientific management is a device for doing that it will win out in spite of all the labor opposition in the world; in spite of any opposition that may be brought to bear against it from any quarter whatever, from any class of people, or from the whole people, it will win out. If scientific management is right, and I believe it is right; if it is a labor-saving device for enabling men to do more work with no greater effort on their part, then it is going to win out.

Now, let us see what happened from the introduction of the power loom in 1840, or thereabouts. Did it throw men out of work; did it make work for a less number of men? In Manchester, England, now—and, again, the figures I am giving are merely the broadest kind of general figures, as I am not personally familiar with the cotton industry. The data I have has been given to me by a man who is familiar with it, but I do not want to quibble over the exact figures, as they are not material. It is the broad general facts that count. In Manchester, England, today, the average weaver turns out, I am told, from 8 to 10 times the yardage of cotton cloth formerly turned out by the old hand weaver; the man who does his work with this modern machinery turns out 8 to 10 times the yardage formerly turned out by the hand weaver. The man who told me of the conditions said these figures were well within the limit. In Manchester, England, in 1840, there were 5,000 operatives, and in Manchester, today there are 265,000 operatives. Now, in the light of those figures has the introduction of the power loom, has the introduction of labor-saving machinery thrown men out of work?

What has happened in the cotton industry is

typical of what happens in every industry, it makes no difference what that industry is. Broadly speaking, all that you have to do is to bring wealth into the world, and the world uses it. Now, real wealth, as you all know, has but very little to do with money; money is the least important element in wealth. The wealth of the world comes from two sources—from what comes out of the ground or from beneath the surface of the earth, on the one hand, and what is produced by man on the other hand. And the broad fact is that all you have to do is to bring wealth into the world and the world uses it. This is just what happened in the cotton industry.

If you will multiply the figures given in the Manchester illustration you will see that in each day now in Manchester there are 400 or 500 yards of cotton cloth coming out for every single yard that came out each day in 1840, whereas the population of England certainly has not more than doubled; I do not know exactly, but my impression is that it has not more than doubled since 1840. Suppose we even granted that it has trebled and the fact would still be astounding that there now comes out of Manchester, England, 400 to 500 yards of cotton cloth for every single yard that came out in 1840. The true meaning of this great production is that just that much more wealth is being unloaded on the world. This is the fundamental meaning of increase in output in all trades, namely, that additional wealth is coming into the world. Such wealth is real wealth, for it consists of those things which are most useful to man; those things that man needs for his everyday happiness, for his prosperity, and his comfort. The meaning of increased output, whether it be in one trade or another, is always the same, the world is just receiving that much more wealth.

Let us see, now, in a definite way what the increased output of cotton goods means to the American workman. None of us probably appreciate now that in 1840 the ordinary cotton shirt or dress made, for example, from Manchester cottons was a luxury to be worn only by the middle classes, as the English describe it, and that cotton goods were worn by the poor people only as a rare luxury. Now the

cotton shirt and the cotton dress, cotton goods generally, have become an absolute daily necessity of all classes of mankind all over the civilized world. And this magnificent result (more magnificent for the working people than for any other portion of the community) has been brought about solely by this great increase in output so stubbornly fought against by the cotton weavers in 1840. It is in those changes which directly affect the poor—which give them a higher standard of living and make from the luxuries of one generation the necessities of the next that we can best see the meaning of an increase in the wealth of the world. And the most important fact of this whole subject is that any association of men, whether it be a group of workmen or a group of capitalists or manufacturers, a manufacturers' association, or whatever it may be, any men who deliberately restrict the output in any industry are robbing the people. And they rob the people of the wealth that justly belongs to them, whether they restrict output honestly, believing it to be for the interest of their trade, or dishonestly for any other reason. There is one point along this line which I want to make clear, gentlemen—that is, that many people believe the ridiculous nonsense that the wealth of the world is enjoyed by the rich. The fact is, that of the real wealth of the world, of the real necessities of life, of practically all the good things of this world, nineteen-twentieths are consumed and used by the working people, and only about one-twentieth by the rich people. Therefore that group of men who prevent wealth from coming into the world are robbing the working people of this nineteen-twentieths and the rich people of but one-twentieth. In fact I doubt if they are robbing the rich people at all. That, after all, is the essence of the whole matter—the robbing of the poor through restriction of output—and I want to try and make it clear that I believe it is quite as much a crime for a manufacturer to restrict output for the sake of holding up prices as it is for the workman to restrict output for this or any other reason.

I don't mean to say for one instant that times may not come in every industry when it is wise to restrict output temporarily, but when that

is true it is due merely to a lack of balance in the output of the world and lack of proper poise in industrial conditions. It is perfectly clear that there is such a thing as overproduction; that is no myth, but overproduction, in 99 cases out of 100, properly translated, means a lack of balance, a lack of evenness in production, a failure to maintain a fair balance between the necessities of life and production. It is a special condition, not a normal one. The world doesn't want, for example, 20 times the cotton goods that it has used in the past manufactured all at once. If there then were to be a fair balance maintained at all times between the various necessities of life and the amount of their production, then it would not be necessary to restrict output at any time. It is true, however, that the world seems to get out of kilter at certain fairly regular times; these periods appear to come at intervals of about 20 years. At such times we wake up to find that the world has attempted to start more new enterprises than there is available capital to handle these enterprises with. This condition is not confined to this country, but all over the world and in every class of trade and industry; men make their estimates in a reckless way about new things they will attempt. They start so many new enterprises and on such a large scale that the world's capital and credit is insufficient to carry them through, and then there is a panic. The whole world becomes over-anxious, and there follows a period of depression.

No, I do not mean to say that overproduction does not at times exist and should be checked, but I do mean to say that, as a guiding policy—that is, a permanent policy on the part of workingman or manufacturer to restrict the world's output to just so much and no more is mere robbery; it is deliberate robbery of the poor people of those things to which they are entitled and which they can get only from the real wealth of the world.

Now, gentlemen, the firm conviction on the part of workmen that an increase in output on their part would inevitably result in throwing many of their brother workmen out of work is only one of the two great reasons why the working people are, generally speaking, re-

stricting their output by deliberately going slow instead of working at proper speed. I am now going to discuss the second great reason why workmen deliberately turn out a small instead of a large output. For this second cause I doubt whether either the manufacturer or the workman is directly to blame. I feel that any blame for this second cause should attach to the faulty system of management in general use; certainly the workmen cannot be blamed. Now, we will say you are manufacturing this article which I hold in my hand, a fountain pen, and we will assume that it is possible for one man to make that pen—to do all the work himself; I will assume this in order to have a simple case, for we know that it is not possible for one man alone to make it.

We will say that the workman is employed on daywork—that is, he is paid by the day, not by piecework; and is turning out 10 of these pens a day and is paid \$2.50 a day for his work. If he has a foreman who is wide awake and interested both in the workman and the company he is working for, as he ought to be, that foreman will probably suggest to the workman that instead of making this pen on daywork that he should make it on piecework, manufacture it by the piece; in other words, that he should be paid 25 cents each for the 10 pens that he makes each day, and so be allowed to earn \$2.50 a day, just as he has earned in the past, the only change being from day's wages to piecework. Now, the foreman's object and the workman's object in changing from daywork to piecework is, on the one hand, to enable the workman to get higher wages, and, on the other hand, to get an increased output for the factory. At the end of, perhaps, a year, through the energy of the workman, through his ingenuity and the help of his foreman, through the advice he gets by talking with other workmen, instead of turning out 10 pens a day he finds himself turning out 20 a day. Now, if the foreman amounts to anything, if he is at all a decent kind of a fellow, he feels very glad of the fact that the workman is earning \$5 a day where before he only earned \$2.50, and he is also pleased that the company is getting such an increase in output from its plant that it is also making more money. It

must be understood that this increase in the output will enable the company to earn more money, in spite of the fact that it is paying the same wages per pen that were originally paid. That foreman, if he is any kind of a man, must feel very happy over this state of things. Now, gentlemen, something of this sort happens; I have seen it happen a great many times: There are some members on the board of directors of the company who think that at certain intervals it is necessary or desirable for them to look over the pay roll and see how things are going. And I think that I may say that to the horror of some of those directors, they find that this workman making pens is earning \$5 a day, where before he only got \$2.50 a day. That is all those directors can see to it. Now, there are just as good men and as conscientious men in the boards of directors of our companies as anywhere else in the world, no better and no worse, yet from a lack of understanding of all sides of the problem they feel genuinely a certain horror at finding that one of their workmen is getting \$5 a day where before he only got \$2.50. And I have heard them say, and I do not think it is at all an uncommon view for them to hold, "We are spoiling the labor market in this part of the country by paying such wages." What they fear is that if workmen in their part of the country come to receive \$5 a day, while those of their competitors are paid only \$2.50, that they will be unable to compete. And as a result they order their foreman to see that he doesn't "continue to spoil the labor market in that part of the country." Now, the foreman, acting on the orders of the board of directors, cuts the price per pen down until the workman finds himself turning out 20 pens a day where before he only turned out 10, and is receiving perhaps \$2.50, or at most \$2.75 or \$3, when before he was receiving \$2.50 a day.

Now, gentlemen, I have no sympathy whatever with the blackguarding that workmen are receiving from a good deal of the community; there are a great many people who look upon them as greedy, selfish, grasping, and even worse, but I don't sympathize with this view in the least. They are not different in the least from any other class in the com-

munity; they are no more grasping and selfish, nor are they less so than other classes of people. It may be a debatable question as to whether they are or are not more grasping than other people. There is one thing, however, we can be perfectly sure of and that is, whatever else they are or they are not, they are not fools. And let me tell you that a workman, after having received one cut of that sort in his wages as a reward for turning out a larger day's work, is a very extraordinary man if he doesn't adopt soldiering and deliberately going slow instead of fast as a permanent policy so as to keep his employer from speeding him up and then cutting his piecework price. I soldiered when I was a workman, and I believe that even many of the most sensible workmen, understanding the conditions as I have outlined them, will inevitably adopt the policy of going slow. Under those conditions it would take an exceedingly broadminded man to do anything else than adopt soldiering as his permanent policy. I will not say that this soldiering is the best policy for the workman to adopt, even for his own best interest in the long run, but I do say that I do not blame him for doing it. In spite of the miserable policy of cutting piecework prices when men increase their output, I believe that those workmen who do not adopt the policy of restricting output and going slow, i. e., soldiering, will in the end be far better off than those who soldier. Certainly, this whole situation is no fault of theirs; they didn't introduce the system which makes soldiering seem to be necessary, and if blame rests anywhere it certainly does not rest with the working people, but somewhere else.

Now, the first thing that I want to make clear, then, before starting in to describe what scientific management, or, as you, Mr. Chairman, have called it, the "Taylor system," is (if you will allow me, however, I will substitute the term scientific management for the "Taylor system"), with the understanding that the two are equivalent in the future—the fact that I wish to make clear is, first, that this restriction of output, that this going slow on the part of the workman is an almost universal fact in this country, and that from the workmen's point of view there is ample justification for

the policy which, in the main, they have adopted. That is what I wish to make clear as a foundation for what I shall say later. Now, let me first, in the broadest kind of way outline or describe what I look upon as the essence of scientific management.

There are many elements of scientific management, many details connected with scientific management, that it is utterly impossible to go into details in a hearing of this kind; but I want to try and make clear before going much further into the history of the development of scientific management—I want to make clear what may be called the essence of it so that when I use the words "scientific management," you men who are listening may have a clear, definite idea of what is in my own mind, because I know that what is in your mind when the words "scientific management" are used has a totally different meaning from what is in my mind, and I want you to know what is in my mind when I use these words. I want to clear the deck, sweep away a good deal of rubbish first by pointing out what scientific management is not. I think that will clear the deck a good deal.

Scientific management is not any efficiency device, not a device of any kind for securing efficiency; nor is it any bunch or group of efficiency devices. It is not a new system of figuring costs; it is not a new scheme of paying men; it is not a piecework system; it is not a bonus system; it is not a premium system; it is no scheme for paying men; it is not holding a stop watch on a man and writing things down about him; it is not time study; it is not motion study nor an analysis of the movements of men; it is not the printing and ruling and unloading of a ton or two of blanks on a set of men and saying, "Here's your system; go use it." It is not divided foremanship or functional foremanship; it is not any of the devices which the average man calls to mind when scientific management is spoken of. The average man thinks of one or more of these things when he hears the words "scientific management" mentioned, but scientific management is not any of these devices. I am not sneering at cost-keeping systems, at time study, at functional foremanship, nor at any new and improved scheme

of paying men, nor at any efficiency devices, if they are really devices that make for efficiency. I believe in them; but what I am emphasizing is that these devices in whole or in part are not scientific management; they are useful adjuncts to scientific management, so are they also useful adjuncts of other systems of management.

Now, in its essence, scientific management involves a complete mental revolution on the part of the workingman engaged in any particular establishment or industry—a complete mental revolution on the part of these men as to their duties toward their work, toward their fellow men, and toward their employers. And it involves the equally complete mental revolution on the part of those on the management's side—the foreman, the superintendent, the owner of the business, the board of directors—a complete mental revolution on their part as to their duties toward their fellow workers in the management, toward their workmen, and toward all of their daily problems. And without this complete mental revolution on both sides scientific management does not exist.

That is the essence of scientific management, this great mental revolution. Now, later on, I want to show you more clearly what I mean by this great mental revolution. I know that perhaps it sounds to you like nothing but bluff—like buncombe—but I am going to try and make clear to you just what this great mental revolution involves, for it does involve an immense change in the minds and attitude of both sides, and the greater part of what I shall say today has relation to the bringing about of this great mental revolution. So that whether the details may be interesting or uninteresting, what I hope you will see is that this great change in attitude and viewpoint must produce results which are magnificent for both sides, just as fine for one as for the other. Now, perhaps I can make clear to you at once one of the very great changes in outlook which come to the workmen, on the one hand, and to those in the management on the other hand.

I think it is safe to say that in the past a great part of the thought and interest both of the men, on the side of the management, and of those on the side of the workmen in

manufacturing establishments has been centered upon what may be called the proper division of the surplus resulting from their joint efforts, between the management on the one hand, and the workmen on the other hand. The management have been looking for as large a profit as possible for themselves, and the workmen have been looking for as large wages as possible for themselves, and that is what I mean by the division of the surplus. Now, this question of the division of the surplus is a very plain and simple one (for I am announcing no great fact in political economy or anything of that sort). Each article produced in the establishment has its definite selling price. Into the manufacture of this article have gone certain expenses, namely, the cost of materials, the expenses connected with selling it, and certain indirect expenses, such as the rent of the building, taxes, insurance, light and power, maintenance of machinery, interest on the plant, etc. Now, if we deduct these several expenses from the selling price, what is left over may be called the surplus. And out of this surplus comes the profit to the manufacturer on the one hand, and the wages of the workmen on the other hand. And it is largely upon the division of this surplus that the attention of the workman and of the management has been centered in the past. Each side has had its eye upon this surplus, the working man wanting as large a share in the form of wages as he could get, and the management wanting as large a share in the form of profits as it could get; I think I am safe in saying that in the past it has been in the division of this surplus that the great labor troubles have come between employers and employees.

Frequently, when the management have found the selling price going down they have turned toward a cut in the wages—toward reducing the workman's share of the surplus—as their way of getting out whole, of preserving their profits intact. While the workman (and you can hardly blame him) rarely feels willing to relinquish a dollar of his wages, even in dull times, he wants to keep all that he has had in the past, and when busy times come again very naturally he wants to get more. Thus it is over this division of the surplus that

most of the troubles have arisen; in the extreme cases this has been the cause of serious disagreements and strikes. Gradually the two sides have come to look upon one another as antagonists, and at times even as enemies—pulling apart and matching the strength of the one against the strength of the other.

The great revolution that takes place in the mental attitude of the two parties under scientific management is that both sides take their eyes off of the division of the surplus as the all-important matter, and together turn their attention toward increasing the size of the surplus until this surplus becomes so large that it is unnecessary to quarrel over how it shall be divided. They come to see that when they stop pulling against one another, and instead both turn and push shoulder to shoulder in the same direction, the size of the surplus created by their joint efforts is truly astounding. They both realize that when they substitute friendly cooperation and mutual helpfulness for antagonism and strife they are together able to make this surplus so enormously greater than it was in the past that there is ample room for a large increase in wages for the workmen and an equally great increase in profits for the manufacturer. This, gentlemen, is the beginning of the great mental revolution which constitutes the first step toward scientific management. It is along this line of complete change in the mental attitude of both sides; of the substitution of peace for war; the substitution of hearty brotherly cooperation for contention and strife; of both pulling hard in the same direction instead of pulling apart; of replacing suspicious watchfulness with mutual confidence; of becoming friends instead of enemies; it is along this line, I say, that scientific management must be developed.

The substitution of this new outlook—this new viewpoint—is of the very essence of scientific management, and scientific management exists nowhere until after this has become the central idea of both sides; until this new idea of cooperation and peace has been substituted for the old idea of discord and war.

This change in the mental attitude of both sides toward the “surplus” is only a part of the great mental revolution which occurs under

scientific management. I will later point out other elements of this mental revolution. There is, however, one more change in viewpoint which is absolutely essential to the existence of scientific management. Both sides must recognize as essential the substitution of exact scientific investigation and knowledge for the old individual judgment or opinion, either of the workman or the boss, in all matters relating to the work done in the establishment. And this applies both as to the methods to be employed in doing the work and the time in which each job should be done.

Scientific management cannot be said to exist, then, in any establishment until after this change has taken place in the mental attitude of both the management and the men, both as to their duty to cooperate in producing the largest possible surplus and as to the necessity for substituting exact scientific knowledge for opinions or the old rule-of-thumb or individual knowledge.

These are the two absolutely essential elements of scientific management.

What has scientific management accomplished? It has been introduced in a great number and variety of industries in this country, to a greater or less degree, and in those companies which have come under scientific management it is, I think, safe and conservative to say that the output of the individual workman has been, on the average, doubled. This doubling of the output has enabled the manufacturer to earn a larger profit, because it has cheapened the cost of manufacture; and, in addition to enabling the manufacturer to earn a larger profit, it has in many cases—in fact, in most cases—resulted in a very material lowering of the selling price of the article. Through this lowering of the selling price the whole public, the buyer and user, of the joint product of the labor and machinery have profited by getting what they buy cheaper. This is the greatest interest that the general public has in scientific management—that in the end they will get more for their money than they are now getting—in other words, that scientific management will in the end enable us all to live better than we are now living. Through scientific management, then,

the manufacturer has already profited, and the general public has also profited.

The greatest gain has come, however, in my judgment, to the workmen who have been working under scientific management. They have received from 30 to 100 per cent higher wages than they received in the past; and, in addition, I do not recall a single case in which they have ever worked longer hours than they did before, but I do recall many instances in which the hours of work were shortened. Perhaps the greatest gain, however,—and I say it without hesitation—is not the increase in wages received by the workmen, but the fact that those who are working under scientific management have come to look upon their employers as their best friends instead of their enemies. They have come to realize that friendship and cooperation are better than war.

Now, this, of course, is a mere assertion. By way of proving this fact, however, I wish to state that until this last year, during the 30 years that scientific management has been gradually developed—has been in process of evolution—there has never been a single strike of employees working under scientific management—never one in all the 30 years in which it has been used.

Scientific management has been introduced in competitive industries. Among their competitors, situated in many cases right alongside of them, who have not adopted scientific management, there have been repeated strikes. Yet even during the very difficult period of changing from the old type of management to the new, until last year, there has never been a strike among the men working under the principles of scientific management, while in corresponding establishments not working under scientific management there have been repeated strikes.

Thereupon, at 12 o'clock noon, the committee took a recess until 2 o'clock.

After Recess.

The committee reconvened 2.05 o'clock p. m., pursuant to taking a recess, Hon. William B. Wilson (chairman) presiding.

The Chairman. You may go ahead, Mr. Taylor.

Mr. Taylor. It must be realized that during the many years that scientific management has been in process of evolution that much of the mechanism—which has improperly come to be looked upon by many people as the essence of scientific management—has been adopted and used by those who were in no way engaged in working under the principles of scientific management. And that the false use, if I may speak of it in this way, of elements which have been associated with scientific management have led to strikes. I shall try to point out that many elements of what may be called the mechanism of scientific management are powerful when used by those on the management's side. These elements are powerful both for good and for bad, and it is impossible to be assured that even useful elements shall always be used in the right way. So that, in a number of cases, men who were out of sympathy with scientific management and yet who were using the elements which have been in the eyes of the public associated with scientific management have brought on strikes by using these elements entirely without any relation to the real, fundamental, and essential principles of scientific management. In order that the essential difference between the principles of scientific management and those of the older type of management may be made more clear, it seems to me desirable to first point out, or indicate, what I think you gentlemen will all recognize as representing the best of the older type of management.

If you have a company, say, employing from 500 to 1,000 men you will have among the employees of this company perhaps 15 or 20 different trades. Now, the men working at these different trades have probably learned all that they know, one may almost say, through tradition; that is, trades are now learned, not from books but just as they were 100 years ago; apprentices learn by watching and observing the way other men work, by imitating the best workmen, and by asking questions of those immediately around them. The apprentice learns by reading a little, by some teaching on the part of the foreman and superintendent, but

mainly by imitating the best methods of those workmen with whom he comes closely into contact. Trades, then, are learned now practically as they were in the Middle Ages. They are transmitted from hand to eye and comparatively little is learned from books. I think I may truthfully say that during the two apprenticeships I served, one as a pattern maker and one as a machinist, I did not spend more than two and a half hours in reading books about my work. Of course there are many more books and more useful books published now about the different trades than there were 37 years ago; but, still, my impression is that the same fact remains true. I have had the object lesson of watching my own son, who left college at the end of his freshman year and is working a year in a machine shop under the sad, baleful conditions of scientific management as they have been pictured by some of the witnesses before this committee, in which he is obliged to do a severe task every day. I have given this boy as many books as I could on the machinist's trade, but I do not think he has yet spent an hour reading the books we have put before him; so that my opinion remains the same about the present-day apprentice as it was about the old one; that is, that he is learning almost all that he gets through the old traditional channels.

Notwithstanding this fact the knowledge which every journeyman has of his trade is his most valuable possession. It is his great life's capital, and none the less valuable—perhaps even more valuable—from the fact that it is attained in the old-fashioned traditional way rather than through such study as is to be had at school or college. In my judgment, then, the manager who really understands the problem which is before him must appreciate that the most important thing for him to do under the old type of management which is in common use is to get what may be called the initiative of his workmen, and by this I mean the workman's hard work, his good will, his ingenuity, his determination to do everything that he can to further his employer's interest. Now, owing to the fact, as I have tried to explain at the opening of my testimony, that practically all of the workingmen of this coun-

try are fully convinced that it is for their interest to go slow and to restrict output instead of turning out a maximum output, no manager who really understands conditions as they exist in our shops would dream that he could get the true initiative of his workmen unless he did something more and better for them than is done by employers in the average shop—unless he gave his workmen some special incentive, some reason, for wishing to do more work than is done in the ordinary shop. Because, as I have already stated, the average workman is engaged during a very considerable part of his time in watching the clock to be sure that he doesn't work so fast as to spoil a piecework rate; to be sure that he is not doing what he would look upon as an injustice to himself and his fellow workmen.

There are a few manufacturers, perhaps not more than one manufacturer in a hundred, however, who are large enough minded and whose hearts are kindly enough disposed to lead them to honestly desire that their employees should be better off than the employees of their competitors; to lead them to try and arrange matters so that their employees can earn higher wages than the employees of their competitors. And if these employers will only persist long enough in deliberately paying their men higher wages than are paid to the workmen of their competitors, it has been my observation that invariably the workmen respond by giving them their real initiative, by working hard and faithfully, by using their ingenuity to see how they can turn out as much work as possible, instead of using their ingenuity, as they ordinarily do, to convince their employers that they are working hard and yet not work hard enough to spoil any piecework job.

Now, this special case, this rare case, in which the management deliberately treat their employees far better than the employees of their competitors are treated, to my mind represents the best of the older types of management. And I again assert that any manufacturer who will only persist long enough in treating his employees in this way will succeed in getting their true initiative. I have known a good many employers to set out to adopt this scheme of paying higher wages than their com-

petitors and become discouraged because their employees did not immediately respond by doing their share under this new arrangement. It must be remembered, however, that workmen are naturally and very properly suspicious of their employers. If they have lived long in this world, they have seen or heard of a great many tricks being played by employers. Now, again, gentlemen, I do not wish to be quoted as saying that all employers are tricky, but I do wish to say that, in my judgment, employers are just as tricky as workmen are tricky, neither more nor less so.

All of you men here who are workmen know that there are a whole lot of tricky workmen, and all you men here who are employers know that there are a whole lot of tricky employers; not that any very large portion of workmen are tricky, and not that a large portion of employers are tricky men, but tricky men are there just the same, on both sides. You cannot blame, therefore, any set of workmen for being slow in responding to even this kindly treatment; what they suspect is—and they can almost all point to some personal experience or to some friend's experience to warrant their suspicion—what they suspect is that this is merely a trick on the part of their employer to get them to work at a higher rate of speed and then, through some infernal excuse or reason or flimflam game, that ultimately the piece-work price will be cut down and they will find themselves working at a high rate of speed for the same old pay.

Thereupon, at 2.28 o'clock p. m. the committee took a recess for 30 minutes.

After Recess.

The committee reconvened at 2.58 o'clock p. m., pursuant to taking a recess, Hon. William B. Wilson (chairman) presiding.

Mr. Taylor. What I want to try to prove to you and make clear to you is that the principles of scientific management when properly applied, and when a sufficient amount of time has been given to make them really effective, must in all cases produce far larger and better results, both for the employer and the employees, than can possibly be obtained under even this very rare type of management which I have

been outlining, namely, the management of "initiative and incentive", in which those on the management's side deliberately give a very large incentive to their workmen, and in return the workmen respond by working to the very best of their ability at all times in the interest of their employers.

I want to show you that scientific management is even far better than this rare type of management.

The first great advantage which scientific management has over the management of initiative and incentive is that under scientific management the initiative of the workmen—that is, their hard work, their good will, their ingenuity—is obtained practically with absolute regularity, while under even the best of the older type of management this initiative is only obtained spasmodically and somewhat irregularly. This obtaining, however, of the initiative of the workmen is the lesser of the two great causes which make scientific management better for both sides than the older type of management. By far the greater gain under scientific management comes from the new, the very great, and the extraordinary burdens and duties which are voluntarily assumed by those on the management's side.

These new burdens and new duties are so unusual and so great that they are to the men used to managing under the old school almost inconceivable. These duties and burdens voluntarily assumed under scientific management, by those on the management's side, have been divided and classified into four different groups and these four types of new duties assumed by the management have (rightly or wrongly) been called the "principles of scientific management."

The first of these four groups of duties taken over by the management is the deliberate gathering in on the part of those on the management's side of all of the great mass of traditional knowledge, which in the past has been in the heads of the workmen, and in the physical skill and knack of the workman, which he has acquired through years of experience. The duty of gathering in of all this great mass of traditional knowledge and then recording it, tabulating it, and, in many cases, finally reduc-

ing it to laws, rules, and even to mathematical formulae, is voluntarily assumed by the scientific managers. And later, when these laws, rules, and formulae are applied to the everyday work of all the workmen of the establishment, through the intimate and hearty cooperation of those on the management's side, they invariably result, first, in producing a very much larger output per man, as well as an output of a better and higher quality; and, second, in enabling the company to pay much higher wages to their workmen; and, third, in giving to the company a larger profit. The first of these principles, then, may be called the development of a science to replace the old rule-of-thumb knowledge of the workmen; that is, the knowledge which the workmen had, and which was, in many cases, quite as exact as that which is finally obtained by the management, but which the workmen nevertheless in nine hundred and ninety-nine cases out of a thousand kept in their heads, and of which there was no permanent or complete record.

A very serious objection has been made to the use of the word "science" in this connection. I am much amused to find that this objection comes chiefly from the professors of this country. They resent the use of the word science for anything quite so trivial as the ordinary, every-day affairs of life. I think the proper answer to this criticism is to quote the definition recently given by a professor who is, perhaps, as generally recognized as a thorough scientist as any man in the country—President McLaurin, of the Institute of Technology, of Boston. He recently defined the word science as "classified or organized knowledge of any kind." And surely the gathering in of knowledge which, as previously stated, has existed, but which was in an unclassified condition in the minds of workmen, and then the reducing of this knowledge to laws and rules and formulae, certainly represents the organization and classification of knowledge, even though it may not meet with the approval of some people to have it called science.

The second group of duties which are voluntarily assumed by those on the management's side, under scientific management, is the scientific selection and then the progressive develop-

ment of the workmen. It becomes the duty of those on the management's side to deliberately study the character, the nature, and the performance of each workman with a view to finding out his limitations on the one hand, but even more important, his possibilities for development on the other hand; and then, as deliberately and as systematically to train and help and teach this workman, giving him, wherever it is possible, those opportunities for advancement which will finally enable him to do the highest and most interesting and most profitable class of work for which his natural abilities fit him, and which are open to him in the particular company in which he is employed. This scientific selection of the workman and his development is not a single act; it goes on from year to year and is the subject of continual study on the part of the management.

The third of the principles of scientific management is the bringing of the science and the scientifically selected and trained workmen together. I say "bringing together" advisedly, because you may develop all the science that you please, and you may scientifically select and train workmen just as much as you please, but unless some man or some men bring the science and the workman together all your labor will be lost. We are all of us so constituted that about three-fourths of the time we will work according to whatever method suits us best; that is, we will practice the science or we will not practice it; we will do our work in accordance with the laws of the science or in our own old way, just as we see fit unless some one is there to see that we do it in accordance with the principles of the science. Therefore I use advisedly the words "bringing the science and the workman together." It is unfortunate, however, that this word "bringing" has rather a disagreeable sound, a rather forceful sound; and, in a way, when it is first heard it puts one out of touch with what we have come to look upon as the modern tendency. The time for using the word "bringing," with a sense of forcing, in relation to most matters, has gone by; but I think that I may soften this word down in its use in this particular case by saying that nine-tenths of the trouble with

those of us who have been engaged in helping people to change from the older type of management to the new management—that is, to scientific management—that nine-tenths of our trouble has been to “bring” those on the management’s side to do their fair share of the work and only one-tenth of our trouble has come on the workman’s side. Invariably we find very great opposition on the part of those on the management’s side to do their new duties and comparatively little opposition on the part of the workmen to cooperate in doing their new duties. So that the word “bringing” applies much more forcefully to those on the management’s side than to those on the workman’s side.

The fourth of the principles of scientific management is perhaps the most difficult of all of the four principles of scientific management for the average man to understand. It consists of an almost equal division of the actual work of the establishment between the workmen, on the one hand, and the management, on the other hand. That is, the work which under the old type of management practically all was done by the workman, under the new is divided into two great divisions, and one of these divisions is deliberately handed over to those on the management’s side. This new division of work, this new share of the work assumed by those on the management’s side, is so great that you will, I think, be able to understand it better in a numerical way when I tell you that in a machine shop, which, for instance, is doing an intricate business—I do not refer to a manufacturing company, but, rather, to an engineering company; that is, a machine shop which builds a variety of machines and is not engaged in manufacturing them, but, rather, in constructing them—will have one man on the management’s side to every three workmen; that is, this immense share of the work—one-third—has been deliberately taken out of the workman’s hands and handed over to those on the management’s side. And it is due to this actual sharing of the work between the two sides more than to any other one element that there has never (until this last summer) been a single strike under scientific management. In a machine

shop, again, under this new type of management there is hardly a single act or piece of work done by any workman in the shop which is not preceded and followed by some act on the part of one of the men in the management. All day long every workman’s acts are dovetailed in between corresponding acts of the management. First, the workman does something, and then a man on the management’s side does something; then the man on the management’s side does something, and then the workman does something; and under this intimate, close, personal cooperation between the two sides it becomes practically impossible to have a serious quarrel.

Of course I do not wish to be understood that there are never any quarrels under scientific management. There are some, but they are the very great exception, not the rule. And it is perfectly evident that while the workmen are learning to work under this new system, and while the management is learning to work under this new system, while they are both learning, each side to cooperate in this intimate way with the other, there is plenty of chance for disagreement and for quarrels and misunderstandings, but after both sides realize that it is utterly impossible to turn out the work of the establishment at the proper rate of speed and have it correct without this intimate, personal cooperation, when both sides realize that it is utterly impossible for either one to be successful without the intimate, brotherly cooperation of the other, the friction, the disagreements, and quarrels are reduced to a minimum. So I think that scientific management can be justly and truthfully characterized as management in which harmony is the rule rather than discord.

There is one illustration of the application of the principles of scientific management with which all of us are familiar and with which most of us have been familiar since we were small boys, and I think this instance represents one of the best illustrations of the application of the principles of scientific management. I refer to the management of a first-class American baseball team. In such a team you will find almost all of the elements of scientific management.

You will see that the science of doing every little act that is done by every player on the baseball field has been developed. Every single element of the game of baseball has been the subject of the most intimate, the closest study of many men, and, finally, the best way of doing each act that takes place on the baseball field has been fairly well agreed upon and established as a standard throughout the country. The players have not only been told the best way of making each important motion or play, but they have been taught, coached, and trained to it through months of drilling. And I think that every man who has watched first-class play, or who knows anything of the management of the modern baseball team, realizes fully the utter impossibility of winning with the best team of individual players that was ever gotten together unless every man on the team obeys the signals or orders of the coach and obeys them at once when the coach gives those orders; that is, without the intimate cooperation between all members of the team and the management, which is characteristic of scientific management.

Now, I have so far merely made assertions; I have merely stated facts in a dogmatic way. The most important assertion I have made is that when a company, when the men of a company and the management of a company have undergone the mental revolution that I have referred to earlier in my testimony, and that when the principles of scientific management have been applied in a correct way in any particular occupation or industry that the results must, inevitably, in all cases, be far greater and better than they could possibly be under the best of the older types of management, even under the especially fine management of "initiative and incentive," which I have tried to outline.

I want to try and prove the above-stated fact to you gentlemen. I want to try now and make good in this assertion. My only hope of doing so lies in showing you that whenever these four principles are correctly applied to work, either large or small, to work which is either of the most elementary or the most intricate character, that inevitably results follow which are not only greater, but enormously greater, than

it is possible to accomplish under the old type of management. Now, in order to make this clear I want to show the application of the four principles first to the most elementary, the simplest kind of work that I know of, and then to give a series of further illustrations of one class of work after another, each a little more difficult and a little more intricate than the work which preceded it, until I shall finally come to an illustration of the application of these same principles to about the most intricate type of mechanical work that I know of. And in all of these illustrations I hope that you will look for and see the application of the four principles I have described. Other elements of the stories may interest you, but the thing that I hope you will see and have before you in all cases is the effect of the four following elements in each particular case: First, the development of the science, i. e., the gathering in on the part of those on the management's side of all the knowledge which in the past has been kept in the heads of the workmen; second, the scientific selection and the progressive development of the workmen; third, the bringing of the science and the scientifically selected and trained men together; and, fourth, the constant and intimate cooperation which always occurs between the men on the management's side and the workmen.

I ordinarily begin with a description of the pig-iron handler. For some reason, I don't know exactly why, this illustration has been talked about a great deal, so much, in fact, that some people seem to think that the whole of scientific management consists in handling pig iron. The only reason that I ever gave this illustration, however, was that pig-iron handling is the simplest kind of human effort; I know of nothing that is quite so simple as handling pig-iron. A man simply stoops down and with his hands picks up a piece of iron, and then walks a short distance and drops it on the ground. Now, it doesn't look as if there was very much room for the development of a science; it doesn't seem as if there was much room here for the scientific selection of the man nor for his progressive training, nor for cooperation between the two sides; but, I can

say, without the slightest hesitation, that the science of handling pig-iron is so great that the man who is fit to handle pig-iron as his daily work cannot possibly understand that science; the man who is physically able to handle pig-iron and is sufficiently phlegmatic and stupid to choose this for his occupation is rarely able to comprehend the science of handling pig-iron; and this inability of the man who is fit to do the work to understand the science of doing his work becomes more and more evident as the work becomes more complicated, all the way up the scale. I assert, without the slightest hesitation, that the high class mechanic has a far smaller chance of ever thoroughly understanding the science of his work than the pig-iron handler has of understanding the science of his work, and I am going to try and prove to your satisfaction, gentlemen, that the law is almost universal—not entirely so, but nearly so—that the man who is fit to work at any particular trade is unable to understand the science of that trade without the kindly help and cooperation of men of a totally different type of education, men whose education is not necessarily higher but a different type from his own.

I dare say most of you gentlemen are familiar with pig-iron handling and with the illustration I have used in connection with it, so I won't take up any of your time with that. But I want to show you how these principles may be applied to some one of the lower classes of work. You may think I am a little highfalutin when I speak about what may be called the atmosphere of scientific management, the relations that ought to exist between both sides, the intimate and friendly relations that should exist between employee and employer. I want, however, to emphasize this as one of the most important features of scientific management, and I can hardly do so without going into detail, without explaining minutely the duties of both sides, and for this reason I want to take some of your time in explaining the application of these four principles of scientific management to one of the cheaper kinds of work, for instance, to shoveling. This is one of the simplest kinds of work, and I want to give you an

illustration of the application of these principles to it.

Now, gentlemen, shoveling is a great science compared with pig-iron handling. I dare say that most of you gentlemen know that a good many pig-iron handlers can never learn to shovel right; the ordinary pig-iron handler is not the type of man well suited to shoveling. He is too stupid; there is too much mental strain, too much knack required of a shoveler for the pig-iron handler to take kindly to shoveling.

You gentlemen may laugh, but that is true, all right; it sounds ridiculous, I know, but it is a fact. Now, if the problem were put up to any of you men to develop the science of shoveling as it was put up to us, that is, to a group of men who had deliberately set out to develop the science of doing all kinds of laboring work, where do you think you would begin? When you started to study the science of shoveling I make the assertion that you would be within two days—just as we were within two days—well on the way toward development of the science of shoveling. At least you would have outlined in your minds those elements which required careful, scientific study in order to understand the science of shoveling. I do not want to go into all of the details of shoveling, but I will give you some of the elements, one or two of the most important elements of the science of shoveling; that is, the elements that reach further and have more serious consequences than any other. Probably the most important element in the science of shoveling is this: There must be some shovel load at which a first-class shoveler will do his biggest day's work. What is that load? To illustrate: When we went to the Bethlehem Steel Works and observed the shovelers in the yard of that company, we found that each of the good shovelers in that yard owned his own shovel; they preferred to buy their own shovels rather than to have the company furnish them. There was a larger tonnage of ore shoveled in that works than of any other material and rice coal came next in tonnage. We would see a first-class shoveler go from shoveling rice coal with a load of 3½ pounds to the shovel to handling ore from the Massaba Range, with 38 pounds

to the shovel. Now, is $3\frac{1}{2}$ pounds the proper shovel load or is 38 pounds the proper shovel load? They cannot both be right. Under scientific management the answer to this question is not a matter of anyone's opinion; it is a question for accurate, careful, scientific investigation.

Under the old system you would call in a first-rate shoveler and say, "See here, Pat, how much ought you to take on at one shovel load?" And if a couple of fellows agreed, you would say that's about the right load and let it go at that. But under scientific management absolutely every element in the work of every man in your establishment, sooner or later, becomes the subject of exact, precise, scientific investigation and knowledge to replace the old, "I believe so," and "I guess so." Every motion, every small fact becomes the subject of careful, scientific investigation.

What we did was to call in a number of men to pick from, and from these we selected two first-class shovelers. Gentlemen, the words I used were "first-class shovelers." I want to emphasize that. Not poor shovelers. Not men unsuited to their work, but first-class shovelers. These men were then talked to in about this way, "See here, Pat and Mike, you fellows understand your job all right; both of you fellows are first-class men; you know what we think of you; you are all right now; but we want to pay you fellows double wages. We are going to ask you to do a lot of damn fool things, and when you are doing them there is going to be some one out alongside of you all the time, a young chap with a piece of paper and a stop watch and pencil, and all day long he will tell you to do these fool things, and he will be writing down what you are doing and snapping the watch on you and all that sort of business. Now, we just want to know whether you fellows want to go into that bargain or not? If you want double wages while that is going on all right, we will pay you double; if you don't all right, you needn't take the job unless you want to; we just called you in to see whether you want to work this way or not.

"Let me tell you fellows just one thing: If you go into this bargain, if you go at it, just remember that on your side we want no

monkey business of any kind; you fellows will have to play square; you fellows will have to do just what you are supposed to be doing; not a damn bit of soldiering on your part; you must do a fair day's work; we don't want any rushing, only a fair day's work and you know what that is as well as we do. Now, don't take this job unless you agree to these conditions, because if you start to try to fool this same young chap with the pencil and paper he will be onto you in 15 minutes from the time you try to fool him, and just as surely as he reports you fellows as soldiering you will go out of this works and you will never get in again. Now, don't take this job unless you want to accept these conditions; you need not do it unless you want to; but if you do, play fair."

Well, these fellows agreed to it, and, as I have found almost universally to be the case, they kept their word absolutely and faithfully. My experience with workmen has been that their word is just as good as the word of any other set of men that I know of, and all you have to do is to have a clear, straight, square understanding with them and you will get just as straight and fair a deal from them as from any other set of men. In this way the shoveling experiment was started. My remembrance is that we first started them on work that was very heavy, work requiring a very heavy shovel load. What we did was to give them a certain kind of heavy material ore, I think, to handle with a certain size of shovel. We sent these two men into different parts of the yard, with two different men to time and study them, both sets of men being engaged on the same class of work. We made all the conditions the same for both pairs of men, so as to be sure that there was no error in judgment on the part of either of the observers and that they were normal, first-class men.

The number of shovel loads which each man handled in the course of the day was counted and written down. At the end of the day the total tonnage of the material handled by each man was weighed and this weight was divided by the number of shovel loads handled, and in that way, my remembrance is, our first experiment showed that the average shovel load handled was 38 pounds, and that with this

load on the shovel the man handled, say, about 25 tons per day. We then cut the shovel off, making it somewhat shorter, so that instead of shoveling a load of 38 pounds it held a load of approximately 34 pounds. The average, then, with the 34 pound load, of each man went up, and instead of handling 25 he had handled 30 tons per day. These figures are merely relative, used to illustrate the general principles, and I do not mean that they were the exact figures. The shovel was again cut off, and the load made approximately 30 pounds, and again the tonnage ran up, and again the shovel load was reduced, and the tonnage handled per day increased, until at about 21 or 22 pounds per shovel we found that these men were doing their largest day's work. If you cut the shovel load off still more, say until it averages 18 pounds instead of 21½, the tonnage handled per day will begin to fall off, and at 16 pounds it will be still lower, and so on right down. Very well; we now have developed the scientific fact that a workman well suited to his job, what we call a first-class shoveler, will do his largest day's work when he has a shovel load of 21½ pounds.

Now, what does that fact amount to? At first it may not look to be a fact of much importance, but let us see what it amounted to right there in the yard of the Bethlehem Steel Co. Under the old system, as I said before, the workmen owned their shovels, and the shovel was the same size whatever the kind of work. Now, as a matter of common sense, we saw at once that it was necessary to furnish each workman each day with a shovel which would hold just 21½ pounds of the particular material which he was called upon to shovel. A small shovel for the heavy material, such as ore, and a large scoop for light material, such as ashes. That meant, also, the building of a large shovel room, where all kinds of laborers' implements were stored. It meant having an ample supply of each type of shovel, so that all the men who might be called upon to use a certain type in any one day could be supplied with a shovel of the size desired that would hold just 21½ pounds. It meant, further, that each day each laborer should be given a particular kind of work to which he was suited, and that he must

be provided with a particular shovel suited to that kind of work, whereas in the past all the laborers in the yard of the Bethlehem Steel Co. had been handled in masses, or in great groups of men, by the old-fashioned foreman, who had from 25 to 100 men under him and walked them from one part of the yard to another. You must realize that the yard of the Bethlehem Steel Co. at that time was a very large yard. I should say that it was at least 1½ or 2 miles long and, we will say, a quarter to a half mile wide, so it was a good large yard; and in that yard at all times an immense variety of shoveling was going on.

There was comparatively little standard shoveling which went on uniformly from day to day. Each man was likely to be moved from place to place about the yard several times in the course of the day. All of this involved keeping in the shovel room 10 or 15 kinds of shovels, ranging from a very small flat shovel for handling ore up to immense scoops for handling rice coal, and forks with which to handle coke, which, as you know, is very light. It meant the study and development of the implement best suited to each type of material to be shoveled, and assigning, with the minimum of trouble, the proper shovel to each one of the four to six hundred laborers at work in that yard. Now, that meant mechanism, human mechanism. It meant organizing and planning work at least a day in advance. And, gentlemen, here is an important fact, that the greatest difficulty which we met with in this planning did not come from the workmen. It came from the management's side. Our greatest difficulty was to get the heads of the various departments each day to inform the men in the labor office what kind of work and how much of it was to be done on the following day.

This planning the work one day ahead involved the building of a labor office where before there was no such thing. It also involved the equipping of that office with large maps showing the layout of the yards so that the movements of the men from one part of the yard to another could be laid out in advance, so that we could assign to this little spot in the yard a certain number of men and

to another part of the yard another set of men, each group to do a certain kind of work. It was practically like playing a game of chess in which four to six hundred men were moved about so as to be in the right place at the right time. And all this, gentlemen, follows from the one idea of developing the science of shoveling; the idea that you must give each workman each day a job to which he is well suited and provide him with just that implement which will enable him to do his biggest day's work. All this, as I have tried to make clear to you, is the result that followed from the one act of developing the science of shoveling.

In order that our workmen should get their share of the good that came from the development of the science of shoveling and that we should do what we set out to do with our laborers,—namely, pay them 60 per cent higher wages than were paid to any similar workmen around that whole district. Before we could pay them these extra high wages it was necessary for us to be sure that we had first-class men and that each laborer was well suited to his job, because the only way in which you can pay wages 60 per cent higher than other people pay and not overwork your men is by having each man properly suited and well trained to his job. Therefore, it became necessary to carefully select these yard laborers; and in order that the men should join with us heartily and help us in their selection it became necessary for us to make it possible for each man to know each morning as he came in to work that on the previous day he had earned his 60 per cent premium, or that he had failed to do so. So here again comes in a lot of work to be done by the management that had not been done before. The first thing each workman did when he came into the yard in the morning—and I may say that a good many of them could not read and write—was to take two pieces of paper out of his pigeonhole; if they were both white slips of paper, the workman knew he was all right. One of those slips of paper informed the man in charge of the tool room what implement the workman was to use on his first job and also in what part of the yard he was to work. It was in this way that

each one of the 600 men in that yard received his orders for the kind of work he was to do and the implement with which he was to do it, and he was also sent right to the part of the yard where he was to work, without any delay whatever. The old-fashioned way was for the workmen to wait until the foreman got good and ready and had found out by asking some of the heads of departments what work he was to do, and then he would lead the gang off to some part of the yard and go to work. Under the new method each man gets his orders almost automatically; he goes right to the tool room, gets the proper implement for the work he is to do, and goes right to the spot where he is to work without any delay.

The second piece of paper, if it was a white piece of paper, showed this man that he had earned his 60 per cent higher wages; if it was a yellow piece of paper the workman knew that he had not earned enough to be a first-class man, and that within two or three days something would happen, and he was absolutely certain what this something would be. Every one of them knew that after he had received three or four yellow slips a teacher would be sent down to him from the labor office. Now, gentlemen, this teacher was no college professor. He was a teacher of shoveling; he understood the science of shoveling; he was a good shoveler himself, and he knew how to teach other men to be good shovelers. This is the sort of man who was sent out of the labor office. I want to emphasize the following point, gentlemen: The workman, instead of hating the teacher who came to him—instead of looking askance at him and saying to himself, "Here comes one of those damn nigger drivers to drive me to work"—looked upon him as one of the best friends he had around there. He knew that he came out there to help him, not to nigger drive him. Now, let me show you what happens. The teacher comes, in every case, not to bulldoze the man, not to drive him to harder work than he can do, but to try in a friendly, brotherly way to help him, so he says, "Now, Pat, something has gone wrong with you. You know no workman who is not a high-priced workman can stay on this gang, and you will have to get off of it if we can't find out

what is the matter with you. I believe you have forgotten how to shovel right. I think that's all there is the matter with you. Go ahead and let me watch you awhile. I want to see if you know how to do the damn thing, anyway."

Now, gentlemen, I know you will laugh when I talk again about the science of shoveling. I dare say some of you have done some shoveling. Whether you have or not, I am going to try to show you something about the science of shoveling, and if any of you have done much shoveling, you will understand that there is a good deal of science about it.

There is a good deal of refractory stuff to shovel around a steel works; take ore, or ordinary bituminous coal, for instance. It takes a good deal of effort to force the shovel down into either of these materials from the top of the pile, as you have to when you are unloading a car. There is one right way of forcing the shovel into materials of this sort, and many wrong ways. Now, the way to shovel refractory stuff is to press the forearm hard against the upper part of the right leg just below the thigh, like this (indicating), take the end of the shovel in your right hand and when you push the shovel into the pile, instead of using the muscular effort of your arms, which is tiresome, throw the weight of your body on the shovel like this (indicating); that pushes your shovel in the pile with hardly any exertion and without tiring the arms in the least. Nine out of ten workmen who try to push a shovel in a pile of that sort will use the strength of their arms, which involves more than twice the necessary exertion. Any of you men who don't know this fact just try it. This is one illustration of what I mean when I speak of the science of shoveling, and there are many similar elements of this science. Now, this teacher would find, time and time again, that the shoveler had simply forgotten how to shovel; that he had drifted back to his old wrong and inefficient way of shoveling, which prevented him from earning his 60 per cent higher wages. So he would say to him, "I see all that is the matter with you is that you have forgotten how to shovel; you have forgotten what I showed you about shoveling some time ago. Now, watch me," he says, "this is the way to do the

thing." And the teacher would stay by him two, three, four, or five days, if necessary, until he got the man back again into the habit of shoveling right.

Now, gentlemen, I want you to see clearly that, because that is one of the characteristic features of scientific management; this is not nigger driving; this is kindness; this is teaching; this is doing what I would like mighty well to have done to me if I were a boy trying to learn how to do something. This is not a case of cracking a whip over a man and saying, "Damn you, get there." The old way of treating with workmen, on the other hand, even with a good foreman, would have been something like this: "See here, Pat, I have sent for you to come up here to the office to see me; four or five times now you have not earned your 60 per cent increase in wages; you know that every workman in this place has got to earn 60 per cent more wages than they pay in any other place around here, but you're no good and that's all there is to it; now, get out of this." That's the old way. "You are no good; we have given you a fair chance; get out of this," and the workman is pretty lucky if it isn't "get to hell out of this," instead of "get out of this."

The new way is to teach and help your men as you would a brother; to try to teach him the best way and show him the easiest way to do his work. This is the new mental attitude of the management toward the men, and that is the reason I have taken so much of your time in describing this cheap work of shoveling. It may seem to you a matter of very little consequence, but I want you to see, if I can, that this new mental attitude is the very essence of scientific management; that the mechanism is nothing if you have not got the right sentiment, the right attitude in the minds of the men, both on the management's side and on the workman's side. Because this helps to explain the fact that until this summer there has never been a strike under scientific management.

The men who developed the science of shoveling spent, I should say, four or five months studying the subject and during that time they investigated not only the best and most efficient movements that the men should make when they are shoveling right, but they also studied

the proper time for doing each of the elements of the science of shoveling. There are many other elements which go to make up this science, but I will not take up your time describing them.

Now, all of this costs money. To pay the salaries of men who are studying the science of shoveling is an expensive thing. As I remember it there were two college men who studied this science of shoveling and also the science of doing many other kinds of laboring work during a period of about three years; then there were a lot of men in the labor office whose wages had to be paid, men who were planning the work which each laborer was to do at least a day in advance; clerks who worked all night so that each workman might know the next morning when he went to work just what he had accomplished and what he had earned the day before; men who wrote out the proper instructions for the day's work for each workman. All of this costs money; it costs money to measure or weigh up the materials handled by each man each day. Under the old method the work of 50 or 60 men was weighed up together; the work done by a whole gang was measured together. But under scientific management we are dealing with individual men and not with gangs of men. And in order to study and develop each man you must measure accurately each man's work. At first we were told that this would be impossible. The former managers of this work told me "You cannot possibly measure up the work of each individual laborer in this yard; you might be able to do it in a small yard, but our work is of such an intricate nature that it is impossible to do it here."

I want to say that we had almost no trouble in finding some cheap way of measuring up each man's work, not only in that yard but throughout the entire plant.

But all of that costs money, and it is a very proper question to ask whether it pays or whether it doesn't pay, because, let me tell you, gentlemen, at once, and I want to be emphatic about it, scientific management has nothing in it that is philanthropic; I am not objecting to philanthropy, but any scheme of management which has philanthropy as one of its elements

ought to fail; philanthropy has no part in any scheme of management. No self-respecting workman wants to be given things, every man wants to earn things, and scientific management is no scheme for giving people something they do not earn. So, if the principles of scientific management do not pay, then this is a miserable system. The final test of any system is, does it pay?

At the end of some three and a half years we had the opportunity of proving whether or not scientific management did pay in its application to yard labor. When we went to the Bethlehem Steel Co. we found from 400 to 600 men at work in that yard, and when we got through 140 men were doing the work of the 400 to 600, and these men handled several million tons of material a year.

We were very fortunate to be able to get accurate statistics as to the cost of handling a ton of materials in that yard under the old system and under the new. Under the old system the cost of handling a ton of materials had been running between 7 and 8 cents, and all you gentlemen familiar with railroad work know that this is a low figure for handling materials. Now, after paying for all the clerical work which was necessary under the new system for the time study and the teachers, for building and running the labor office and the implement room, for constructing a telephone system for moving men about the yard, for a great variety of duties not performed under the old system, after paying for all these things incident to the development of the science of shoveling and managing the men the new way, and including the wages of the workmen, the cost of handling a ton of material was brought down from between 7 and 8 cents to between 3 and 4 cents, and the actual saving, during the last six months of the three and one-half years I was there, was at the rate of \$78,000 a year. That is what the company got out of it; while the men who were on the labor gang received an average of sixty per cent more wages than their brothers got or could get anywhere around that part of the country. And none of them were overworked, for it is no part of scientific management ever to overwork any man; certainly overworking these men could

not have been done with the knowledge of anyone connected with scientific management, because one of the first requirements of scientific management is that no man shall ever be given a job which he cannot do and thrive under through a long term of years. It is no part of scientific management to drive anyone. At the end of three years we had men talk to and investigate all of these yard laborers and we found that they were almost universally satisfied with their jobs.

Of course certain men are permanent grouches and when we run across that kind we all know what to expect. But, in the main, they were the most satisfied and contented set of laborers I have ever seen anywhere; they lived better than they did before, and most of them were saving a little money; their families lived better, and as to having any grouch against their employers, those fellows, every one, looked upon them as the best friends they ever had, because they taught them how to earn 60 per cent more wages than they had ever earned before. This is the round-up of both sides of this question. If the use of the system does not make both sides happier, then it is no good.

To give you one illustration of the application of scientific management to a rather high class of work, gentlemen, bricklaying, so far as I know, is one of the oldest of the trades, and it is a truly extraordinary fact that bricks are now laid just about as they were 2,000 years before Christ. In England they are laid almost exactly as they were then; in England the scaffold is still built with timbers lashed together—in many cases with the bark still on it—just as we see that the scaffolds were made in old stone-cut pictures of bricklaying before the Christian era. In this country we have gone beyond the lashed scaffold, and yet in most respects it is almost literally true that bricks are still laid as they were 4,000 years ago. Virtually the same trowel, virtually the same brick, virtually the same mortar, and, from the way in which they were laid, according to one of my friends, who is a brick work contractor and a student of the subject, who took the trouble to take down some bricks laid 4,000 years ago to study the way in which the mortar was

spread, etc., it appears that they even spread the mortar in the same way then as we do now. If, then, there is any trade in which one would say that the principles of scientific management would produce but small results, that the development of the science would do little good, it would be in a trade which thousands and thousands of men through successive generations had worked and had apparently reached, as far as methods and principles were concerned, the highest limit of efficiency 4,000 years ago. In bricklaying this would seem to be true since practically no progress has been made in this art since that time. Therefore, viewed broadly, one would say that there was a smaller probability that the principles of scientific management could accomplish notable results in this trade than in almost any other.

Mr. Frank Gilbreth is a man who in his youth worked as a bricklayer; he was an educated man and is now a very successful contractor. He said to me, some years ago, "Now, Taylor, I am a contractor, putting up all sorts of buildings, and if there is one thing I know it is bricklaying; I can go out right now, and I am not afraid to back myself, to beat any man I know of laying bricks for ten minutes, both as to speed and accuracy; you may think I am blowing, but that is one way I got up in the world. I cannot stand it now for more than ten minutes; I'm soft; my hands are tender, I haven't been handling bricks for years, but for ten minutes I will back myself against anyone. I want to ask you about this scientific management; do you think it can be applied to bricklaying? Do you believe that these things you have been shouting about (at that time it was called the 'task system'), do you believe these principles can be applied to bricklaying?" "Certainly," I said, "some day some fellow will make the same kind of study about bricklaying that we have made of other things, and he will get the same results." "Well," he said, "if you really think so, I will just tell you who is going to do it, his name is Frank Gilbreth."

I think it was about three years later that he came to me and said: "Now, I'm going to show you something about bricklaying. I have spent three years making a motion and time study of bricklaying, and not I alone did it; my

wife has also spent almost the same amount of her time studying the problems of bricklaying, and I think she has made her full share of the progress which has been made in the science of bricklaying." Then he said, "I will show you just how we went to work at it. Let us assume that I am now standing on the scaffold in the position that the bricklayer occupies when he is ready to begin work. The wall is here on my left, the bricks are there in a pile on the scaffold to my right, and the mortar is here on the mortar-board alongside of the bricks. Now, I take my stand as a bricklayer and am ready to start to lay bricks, and I said to myself, 'What is the first movement that I make when I start to lay bricks?' I take a step to the right with the right foot. Well, is that movement necessary? It took me a year and a half to cut out that motion—that step to the right—and I will tell you later how I cut it out. Now, what motion do I make next? I stoop down to the floor to the pile of bricks and disentangle a brick from the pile and pick it up off the pile. 'My God,' I said, 'that is nothing short of barbarous'. Think of it! Here I am a man weighing over 250 pounds, and every time I stoop down to pick up a brick I lower 250 pounds of weight down two feet so as to pick up a brick weighing 4 pounds, and then raise my 250 pounds of weight up again, and all of this to lift up a brick weighing 4 pounds. Think of this waste of effort. It is monstrous. It took me—it may seem to you a pretty long while—but it took a year and a half of thought and work to cut out that motion; when I finally cut it out, however, it was done in such a simple way that anyone in looking at the method which I adopted would say, 'There is no invention in that, any fool could do that; why did you take a year and a half to do a little thing like that?' Well, all I did was to put a table on the scaffold right alongside of me here on my right side and put the bricks and mortar on it, so as to keep them at all times at the right height, thus making it unnecessary to stoop down in picking them up. This table was placed in the middle of the scaffold with the bricklayer on one side of it, and with a walkway on the other side along which the bricks were brought by wheelbarrow or by hod to be

placed on the table without interfering with the bricklayer or even getting in his way." Then Mr. Gilbreth made his whole scaffold adjustable, and a laborer was detailed to keep all of the scaffolds at all times at such a height that as the wall goes up the bricks, the mortar, and the men will occupy that position in which the work can be done with the least effort.

Mr. Gilbreth has studied out the best position for each of the bricklayer's feet and for every type of bricklaying the exact position for the feet is fixed so that the man can do his work without unnecessary movements. As a result of further study both on the part of Mr. and Mrs. Gilbreth, after the bricks are unloaded from the cars and before bringing them to the bricklayer they are carefully sorted by a laborer and placed with their best edges up on a simple wooden frame, constructed so as to enable him to take hold of each brick in the quickest time and in the most advantageous position. In this way the bricklayer avoids either having to turn the brick over or end for end to examine it before laying it, and he saves also the time taken in deciding which is the best edge and end to place on the outside of the wall. In most cases, also, he saves the time taken in disentangling the brick from a disorderly pile on the scaffold. This "pack of bricks," as Mr. Gilbreth calls his loaded wooden frames, is placed by the helper in its proper position on the adjustable scaffold close to the mortar box.

We have all been used to seeing bricklayers tap each brick after it is placed on its bed of mortar several times with the end of the handle of the trowel so as to secure the right thickness for the joint. Mr. Gilbreth found that by tempering the mortar just right the bricks could be readily bedded to the proper depth by a downward pressure of the hand which lays them. He insisted that the mortar mixers should give special attention to tempering the mortar and so save the time consumed in tapping the brick.

In addition to this he taught his bricklayers to make simple motions with both hands at the same time, where before they completed a motion with the right hand before they followed it later with one made by the left hand. For example, Mr. Gilbreth taught his bricklayers to pick up a brick in the left hand at the

same time that he takes a trowel of mortar with the right hand. This work with two hands at the same time is, of course, made possible by substituting a deep mortar box for the old mortar-board, on which the mortar used to spread out so thin that a step or two had to be taken to reach it, and then placing the mortar box and the brick pile close together and at the proper height on his new scaffold.

Now, what was the practical outcome of all this study? To sum it up he finally succeeded in teaching his bricklayers, when working under the new method, to lay bricks with five motions per brick, while with the old method they used 18 motions per brick. And, in fact, in one exceedingly simple type of bricklaying he reduced the motions of his bricklayers from 18 to 2 motions per brick. But in the ordinary bricklaying he reduced the motions from 18 to 5. When he first came to me, after he had made this long and elaborate study of the motions of bricklayers, he had accomplished nothing in a practical way through this study, and he said, "You know, Fred, I have been showing all my friends these new methods of laying bricks and they say to me, 'Well, Frank, this is a beautiful thing to talk about, but what in the devil do you think it amounts to? You know perfectly well the unions have forbidden their members to lay more than so many bricks per day; you know they won't allow this thing to be carried out.'" But Gilbreth said, "Now, my dear boy, that doesn't make an iota of difference to me. I'm just going to see that the bricklayers do the right thing. I belong to the bricklayers' union in Boston, and the next job that I get in Boston this thing goes through. I'm not going to do it in any underhanded way. Everyone knows that I have always paid higher wages than the union scale in Boston. I've got a lot of friends at the head of the unions in Boston, and I'm not afraid of having any trouble."

He got his job near Boston, and he went to the leaders of the union and told them just what you can tell any set of sensible men. He said to them, "I want to tell you fellows some things that you ought to know. Most of my contracts around here used to be brick jobs; now, most of my work is in reinforced concrete

or some other type of construction, but I am first and last a bricklayer; that is what I am interested in, and if you have any sense you will just keep your hands off and let me show you bricklayers how to compete with the reinforced concrete men. I will handle the bricklayers myself. All I want of you leaders is to keep your hands off and I will show you how bricklayers can compete with reinforced concrete or any other type of construction that comes along."

Well, the leaders of the union thought that sounded all right, and then he went to the workmen and said to them, "No fellow can work for me for less than \$6.50 a day—the union rate was \$5 a day—but every man who gets on this job has got to lay bricks my way; I will put a teacher on the job to show you all my way of laying bricks and I will give every man plenty of time to learn, but after a bricklayer has had a sufficient trial at this thing, if he won't do my way or cannot do my way, he must get off the job." Any number of bricklayers were found to be only too glad to try the job, and I think he said that before the first story of the building was up he had the whole gang trained to work in the new way, and all getting their \$6.50 a day when before they only received \$5 per day; I believe those are the correct figures; I am not absolutely sure about that, but at least he paid them a very liberal premium above the average bricklayer's pay.

It is one of the principles of scientific management to ask men to do things in the right way, to learn something new, to change their ways in accordance with the science, and in return to receive an increase of from 30 to 100 per cent in pay, which varies according to the nature of the business in which they are engaged.

Thereupon, at 4.55 o'clock p. m., the committee adjourned until 11 o'clock a. m. Friday, January 26, 1912.

Friday, January 26, 1912.

The committee met at 11 o'clock a. m., Hon. W. B. Wilson (chairman) presiding.

There were also present Representatives Redfield and Tilson.

Mr. Taylor. After Mr. Gilbreth had trained his complete force of bricklayers so that they

were all working the new instead of the old way, a very great and immediate increase in the output per man occurred. So that during the latter part of the construction of this building the bricklayers—and I wish it distinctly understood that all of these men were union bricklayers; Mr. Gilbreth himself has for years insisted on having what is known as the closed shop on his work—who were engaged in building a 12-inch wall with drawn joints on both sides—which you gentlemen who understand bricklaying will recognize as a difficult wall to build; a 12-inch wall with drawn joints on both sides—these bricklayers averaged 350 bricks per man per hour, whereas the most rapid union rate up to that time had been 120 bricks per man per hour. And you will recognize, gentlemen, that this is due principally to the very great simplification of the work brought about thru Mr. Gilbreth's three years' of analysis and study of the art of bricklaying, which enabled him to reduce the number of motions made by the workman in laying a brick from 18 per brick to 5 per brick.

The immense gain which has been made through this study will be realized when it is understood that in one city in England the union bricklayers on this type of work have limited their output to 275 bricks per day per man, when on municipal work, and 375 bricks per day per man when on private work.

I want to make it clear to you gentlemen that this great increase in output on the part of Mr. Gilbreth's bricklayers could only be brought about, and was brought about, through the application of the four principles of scientific management to which I referred yesterday in my testimony.

In the first place, it is perfectly clear that unless Mr. Gilbreth had developed the science of bricklaying himself this could not have been done.

In the second place, unless the management cooperated in the most hearty way in the scientific selection of the workmen, and then in his progressive development—that is, first choosing the workmen (picking out those men who were able and willing to adopt the new methods in bricklaying), and then teaching them the

new movements—this result could not have been realized.

You will appreciate this fact when you know (as those of you who are familiar with bricklaying know) that practically the whole of a wall must go up at the same rate of speed; that it is impossible for the man working on the middle of the wall, for instance, to put his work up faster than the men working on either side of him. If he did, you would have the most horrible looking wall imaginable, unsightly, and with broken joints. Therefore, the whole wall must go up uniformly, and yet under the old system of management no one bricklayer has the authority to compel other men to adopt new methods and cooperate with him doing work faster.

Now, I have not the slightest doubt that during the last 4,000 years all the methods that Mr. Gilbreth developed have many, many times suggested themselves to the minds of bricklayers. I do not believe Mr. Gilbreth was the first man to invent those methods, and yet if any man or men had invented Gilbreth's improvements and methods prior to the time that the principles of scientific management were understood and accepted, no useful results could have come from them, because the adoption of Gilbreth's methods demands a degree of cooperation, coupled with a kind of leadership on the management's side, which is entirely impossible with the independent individualism which characterizes the old type of management. Under the old system a resourceful man might persuade some, or even most of your bricklayers to adopt the new and scientific methods, but one stubborn man, by refusing to join with the rest, could prevent a realization of any great increase in output. It therefore requires in the development of these methods that the management shall assume the responsibility for seeing that each workman either learns an entirely new method of doing his work or else gets off the job. This is something which no management ever thought of doing in the past.

In short, it requires the hearty cooperation of the management at all points with the workmen, and the voluntary assumption on the part of the management of new duties which they

never did before. To make this point clear, it requires the management to appoint men to go around and keep the scaffolding at a proper height, all day long, and to keep the bricklayers supplied with the right kind of brick, systematically placed near them with their right edge up, etc. Every care must be taken by the management to see that the mortar is tempered exactly for the particular kind of work which is to be done. Mr. Gilbreth puts on special men to see that all conditions under which his men work shall be the best that are known and that these perfect conditions shall be maintained at all times.

I want to emphasize the fact that it is due to the application of what I have pointed out as the four principles of scientific management that Mr. Gilbreth has accomplished his large results, namely:

First. The development—by the management, not the workmen—of the science of bricklaying, with rigid rules for each motion of every man, and the perfection and standardization of all implements and working conditions.

Second. The careful selection and subsequent training of the bricklayers into first-class men, and the elimination of all men who refuse to, or are unable to adopt, the best methods.

Third. Bringing the first-class bricklayer and the science of bricklaying together, through the constant help and watchfulness of the management, and through paying each man a large daily bonus for working fast and doing what he is told to do.

Fourth. An almost equal division of the work and responsibility between the workman and the management. All day long the management work almost side by side with the men, helping, encouraging, and smoothing the way for them, while in the past they stood one side, gave the men but little help, and threw on to them almost the entire responsibility as to methods, implements, speed, and harmonious co-operation.

Now, before I start on the last illustration—that is, the illustration of the application of these principles to the work of a machine shop—it may perhaps be better for me to explain the first steps that were taken toward scientific

management, because that will help you to understand how the science of cutting metals came to be developed. I defer entirely to your judgment, gentlemen, on that matter. If, on the contrary, it be your desire that I shall go ahead at once with machine-shop illustration, I will do so, and afterwards proceed with a description of how scientific management first started.

The Chairman. Proceed in your own way.

Mr. Taylor. Thank you. In 1878 I came to the Midvale Steel Works as a day laborer, after having served two apprenticeships as a pattern maker and a machinist. I came then as a laborer because I could not get work at my trade. Work at that time was very dull—it was toward the end of the long period of depression following the panic of 1873. I was assigned to work on the floor of the machine shop. Soon after I went there the clerk of the shop got mixed up in his accounts and they thought he was stealing—I never could quite believe that he was; I thought it was merely a mix-up—and they put me in to take his place, simply because I was able to do clerical work.

I did this clerical work all right, although it was distasteful to me, and after having trained another clerk to do the work of the shop I asked permission of the foreman to work as a machinist. They gave me a job on the lathe, because I had made good as a clerk when they needed one, and I worked for some time with the lathe gang.

Shortly after this they wanted a gang boss to take charge of the lathes and they appointed me to this position.

Now, the machine shop of the Midvale Steel Works was a piecework shop. All the work practically was done on piecework, and it ran night and day—five nights in the week and six days. Two sets of men came on, one to run the machines at night and the other to run them in the daytime.

We who were the workmen of that shop had the quantity output carefully agreed upon for everything that was turned out in the shop. We limited the output to about, I should think, one-third of what we could very well have done. We felt justified in doing this, owing to the piecework system—that is, owing to the

necessity for soldiering under the piecework system—which I pointed out yesterday.

As soon as I became gang boss the men who were working under me and who, of course, knew that I was onto the whole game of soldiering or deliberately restricting output, came to me at once and said, "Now, Fred, you are not going to be a damn piecework hog, are you?" I said, "If you fellows mean you are afraid I am going to try to get a larger output from these lathes" I said, "Yes; I do propose to get more work out." I said, "You must remember I have been square with you fellows up to now and worked with you. I have not broken a single rate. I have been on your side of the fence. But now I have accepted a job under the management of this company and I am on the other side of the fence, and I will tell you perfectly frankly that I am going to try to get a bigger output from those lathes." They answered, "Then, you are going to be a damn hog."

I said, "Well, if you fellows put it that way, all right." They said, "We warn you, Fred, if you try to bust any of these rates, we will have you over the fence in six weeks." I said, "That is all right; I will tell you fellows again frankly that I propose to try to get a bigger output off these machines."

Now, that was the beginning of a piecework fight that lasted for nearly three years, as I remember it—two or three years—in which I was doing everything in my power to increase the output of the shop, while the men were absolutely determined that the output should not be increased. Anyone who has been through such a fight knows and dreads the meanness of it and the bitterness of it. I believe that if I had been an older man—a man of more experience—I should have hardly gone into such a fight as this—deliberately attempting to force the men to do something they did not propose to do.

We fought on the management's side with all the usual methods, and the workmen fought on their side with all their usual methods. I began by going to the management and telling them perfectly plainly, even before I accepted the gang boss-ship, what would happen. I said, "Now these men will show you, and show you conclusively, that, in the first place, I know

nothing about my business; and that, in the second place, I am a liar, and you are being fooled, and they will bring any amount of evidence to prove these facts beyond a shadow of a doubt." I said to the management, "The only thing I ask of you, and I must have your firm promise, it that when I say a thing is so you will take my word against the word of any 20 men or any 50 men in the shop." I said, "If you won't do that, I won't lift my finger toward increasing the output of this shop." They agreed to it and stuck to it, although many times they were on the verge of believing that I was both incompetent and untruthful.

Now, I think it perhaps desirable to show the way in which that fight was conducted.

I began, of course, by directing some one man to do more work than he had done before, and then I got on the lathe myself and showed him that it could be done. In spite of this, he went ahead and turned out exactly the same old output and refused to adopt better methods or to work quicker until finally I laid him off and got another man in his place. This new man—I could not blame him in the least under the circumstances—turned right around and joined the other fellows and refused to do any more work than the rest. After trying this policy for a while and failing to get any results I said distinctly to the fellows, "Now, I am a mechanic; I am a machinist. I do not want to take the next step, because it will be contrary to what you and I look upon as our interest as machinists, but I will take it if you fellows won't compromise with me and get more work off of these lathes, but I warn you if I have to take this step it will be a durned mean one." I took it.

I hunted up some especially intelligent laborers who were competent men, but who had not had the opportunity of learning a trade, and I deliberately taught these men how to run a lathe and how to work fast and right. Every one of these laborers promised me, "Now if you will teach me the machinist trade, when I learn to run a lathe I will do a fair day's work," and every solitary man, when I had taught them their trade, one after another turned right around and joined the rest of the fellows and refused to work one bit faster.

That looked as if I were up against a stone wall, and for a time I was up against a stone wall. I did not blame even these laborers in my heart; my sympathy was with them all of the time, but I am telling you the facts as they then existed in the machine shops of this country and, in truth, as they still exist.

When I had trained enough of these laborers so that they could run the lathes, I went to them and said, "Now, you men to whom I have taught a trade are in a totally different position from the machinists who were running these lathes before you came here. Every one of you agreed to do a certain thing for me if I taught you a trade, and now not one of you will keep his word. I did not break my word with you, but every one of you has broken his word with me. Now, I have not any mercy on you; I have not the slightest hesitation in treating you entirely differently from the machinists." I said, "I know that very heavy social pressure has been put upon you outside the works to keep you from carrying out your agreement with me, and it is very difficult for you to stand out against this pressure, but you ought not to have made your bargain with me if you did not intend to keep your end of it. Now, I am going to cut your rate in two tomorrow and you are going to work for half price from now on. But all you will have to do is to turn out a fair day's work and you can earn better wages than you have been earning."

These men, of course, went to the management, and protested I was a tyrant, and a nigger driver, and for a long time they stood right by the rest of the men in the shop and refused to increase their output a particle. Finally, they all of a sudden gave right in and did a fair day's work.

I want to call your attention, gentlemen, to the bitterness that was stirred up in this fight before the men finally gave in, to the meanness of it, and the contemptible conditions that exist under the old piecework system, and to show you what it leads to. In this contest, after my first fighting blood which was stirred up through strenuous opposition had subsided, I did not have any bitterness against any particular man or men. My anger and hard feelings were stirred up against the system; not

against the men. Practically all of those men were my friends, and many of them are still my friends. As soon as I began to be successful in forcing the men to do a fair day's work, they played what is usually the winning card. I knew that it was coming. I had predicted to the owners of the company what would happen when we began to win, and had warned them that they must stand by me; so that I had the backing of the company in taking effective steps to checkmate the final move of the men. Every time I broke a rate or forced one of the new men whom I had trained to work at a reasonable and proper speed, some one of the machinists would deliberately break some part of his machine as an object lesson to demonstrate to the management that a fool foreman was driving the men to overload their machines until they broke. Almost every day ingenious accidents were planned, and these happened to machines in different parts of the shop, and were, of course, always laid to the fool foreman who was driving the men and the machines beyond their proper limit.

Fortunately, I had told the management in advance that this would happen, so they backed me up fully. When they began breaking their machines, I said to the men, "All right; from this time on, any accident that happens in this shop, every time you break any part of a machine you will have to pay part of the cost of repairing it or else quit. I don't care if the roof falls in and breaks your machine, you will pay all the same." Every time a man broke anything I fined him and then turned the money over to the mutual benefit association, so that in the end it came back to the men. But I fined them, right or wrong. They could always show every time an accident happened that it was not their fault and that it was an impossible thing for them not to break their machine under the circumstances. Finally, when they found that these tactics did not produce the desired effect on the management, they got sick and tired of being fined, their opposition broke down, and they promised to do a fair day's work.

After that we were good friends, but it took three years of hard fighting to bring this about. I was a young man in years, but I give you my

word I was a great deal older than I am now with worry, meanness, and contemptibleness of the whole damn thing. It is a horrid life for any man to live, not to be able to look any workman in the face all day long without seeing hostility there and feeling that every man around is his virtual enemy. These men were a nice lot of fellows and many of them were my friends outside of the works. This life was a miserable one, and I made up my mind either to get out of the business entirely, and go into some other line of work, or to find some remedy for this unbearable condition.

When I came to think over the whole matter, I realized that the thing which we on the management's side lacked more than anything else was exact knowledge as to how long it ought to take the workman to do his work. I knew how to do the work about as well as the rest of the workmen (many of them were better mechanics than I was, but on the whole I knew well enough how the work ought to be done in the shop). I could take any workman and show him how to run his lathe, but when it came to telling a man how long it ought to take him to do his work there was no foreman who at that time could do this with any degree of accuracy even if he knew ten times as much about the time problem as I did. You will remember, of course, that the chief object of the men in soldiering was to keep their foreman ignorant of how fast the work could be done. Realizing this deficiency on my part, I asked permission from Mr. William Sellers, the president of the Midvale Steel Company to make a series of careful scientific experiments to find out how quickly the various kinds of work that went into the shop ought to be done.

Now, these experiments were started along a variety of lines. One of the types of investigation which was started at that time was that which has come to be generally known as "motion study" or "time study". A young man was given a stop watch and ruled and printed blanks like those shown after page 160 of the red bound book written by me, entitled "Shop Management", which is in the hands of your committee. This man for two years and one half, I think, spent his entire time in analyzing the motions of the workmen in the machine

shop in relation to all the machine work going on in the shop—all the operations, for example, which were performed while putting work into and taking work out from the machines were analyzed and timed. I refer to the details of all such motions as are repeated over and over again in machine shops. I dare say you gentlemen realize that while the actual work done in the machine shops of this country is infinite in its variety, and that while there are millions and millions of different operations that take place, yet these millions of complicated or composite operations can be analyzed intelligently and readily resolved into a comparatively small number of simple elementary operations, each of which is repeated over and over again in every machine shop. As a sample of these elementary operations which occur in all machine shops, I would cite picking up a bolt and clamp and putting the bolt head into the slot of a machine, then placing a distance piece under the back end of the clamp and tightening down the bolt. Now, this is one of the series of simple operations that take place in every machine shop hundreds of times a day. It is clear that a series of motions such as this can be analyzed, and the best method of making each of these movements can be found out, and then a time study can be made to determine the exact time which a man should take for each job when he does his work right, without any hurry and yet who does not waste time. This was the general line of one of the investigations which we started at that time.

At the same time, another series of investigations was started which I shall describe later, and which resulted in developing the art or science of cutting metals.

Before starting to describe these experiments, however, I want to make it clear to you that these scientific experiments, namely, accurate motion and time study of men and a study of the art of cutting metals, which were undertaken to give the foreman of the machine shop of the Midvale Steel Works knowledge which was greatly needed by him, in order to prevent soldiering and the strife that goes with it, marked the first steps which were taken in the evolution of what is called scientific management. These steps were taken in an earn-

est endeavor to correct what I look upon as one of the crying evils of the older systems of management. And I think that I may say that every subsequent step which was taken and which has resulted in the development of scientific management was in the same way taken, not as the result of some preconceived theory by any one man or any number of men, but in an equally earnest endeavor to correct some of the perfectly evident and serious errors of the older type of management. Thus scientific management has been an evolution in which many men have had their part, and I feel that this fact should be emphasized. Personally I am profoundly suspicious of any new theory, my own as well as any other man's theory, and until a theory has been proved to be correct from practical experience, it is safe to say that in nine cases out of ten it is wrong.

Scientific management, then, is no new or untried theory. Far from being a mere theory, on the contrary, the theory of scientific management has only come to be a matter of interest and of investigation during the past few years, whereas this type of management itself has been in process of evolution during a period of about 30 years, through actual use in shops, through being tried out, experimented with, and improved in the most practical way by hundreds, almost thousands of men. Scientific management, then, is not a theory, but is the practical result of a long evolution.

The illustrations of shoveling and bricklaying which I have given you have thus far been purposely confined to the more elementary types of work, so that a very strong doubt must still remain as to whether this kind of cooperation is desirable in the case of more intelligent mechanics, that is, in the case of men who are more capable of generalization, and who would therefore be more likely, of their own volition, to choose the more scientific and better methods. The following illustration will be given for the purpose of demonstrating the fact that in the higher classes of work the scientific laws which are developed are so intricate that the high-priced mechanic needs—even more than the cheap laborer—the cooperation of men better educated than himself in finding the laws, and then in selecting, developing, and training

him to work in accordance with these laws. This illustration should make perfectly clear my original proposition that in practically 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 to actually doing the work is incapable, either through lack of education or through insufficient mental capacity of understanding this science.

A doubt, for instance, will remain in your minds—in the case of an establishment which manufactures the same machine year in and year out in large quantities and in which, therefore, each mechanic repeats the same limited series of operations over and over again—whether the ingenuity of each workman and the help which he from time to time receives from his foreman will not develop such superior methods and such a personal dexterity that no scientific study which could be made would result in a material increase in efficiency.

A number of years ago a company employing in one of their departments about 300 men, which had been manufacturing the same machine for 10 to 15 years, sent for my friend Mr. Barth to report as to whether any gain could be made in their work through the introduction of scientific management. Their shops had been run for many years under a good superintendent and with excellent foremen and workmen on piece work. The whole establishment was, without doubt, in better physical condition than the average machine shop in this country. The superintendent was distinctly displeased when Mr. Barth told him that through the adoption of scientific management the output, with the same number of men and machines, could be more than doubled. He said that he believed that any such statement was mere boasting, absolutely false, and instead of inspiring him with confidence he was disgusted that anyone would make such an impudent claim. He, however, readily assented to Mr. Barth's proposition that he should select any one of the machines whose output he considered as representing the average of the shop, and that Mr. Barth should then demonstrate on this machine

that through scientific methods its output could be more than doubled.

The machine selected by the superintendent fairly represented the work of the shop. It had been run for 10 or 12 years past by a first-class mechanic, who was more than equal in his ability to the average workmen in the establishment. In a shop of this sort, in which similar machines are made over and over again, the work is necessarily greatly subdivided, so that no one man works upon more than a comparatively small number of parts during the year. A careful record was therefore made, in the presence of both parties, of the time actually taken in finishing each of the parts which this man worked upon. The total time required by the old-fashioned skilled lathe hand to finish each piece, as well as the exact speeds and feeds which he took, were noted, and a record was kept of the time which he took in setting the work in the machine and in removing it. After obtaining in this way a statement of what represented a fair average of the work done in the shop, Mr. Barth applied to this one machine the principles of scientific management.

The first thing that Mr. Barth did was to study the proper speed at which this machine ought to be run. I am well within the limit, gentlemen, in saying that not one machine in twenty in the average shop in this country is properly speeded. This may seem incredible, and yet I make this statement with a great deal of confidence, because the Tool Builders' Association of the United States—the men who manufacture the machine tools of this country—last spring asked me to address their annual convention. I told them, just as I have told you, that not one in twenty of the machines in their shops was properly speeded; and I added, "You gentlemen know whether I am telling the truth or not, and I challenge anyone who thinks I am wrong in this statement to go into his own shop and let me show him how far wrong the speeds of his machines are." Not a man took up this challenge. And these tool builders are the men who make and sell the machines used in our machine shops.

I have here four quite elaborate slide rules, which have been developed especially to make

a rapid study of machine tools. The one which I have marked "A" takes care of all the belting problems connected with machine tools. The one marked "B" solves all of the problems connected with gearing. The slide rule marked "C" determines accurately the pressure which the chip or shaving which is being cut from the metal exerts on the top of the tool. The one marked "D" shows just how fast the lathe or other metal-cutting machine ought to run while the tool is taking any given kind of cut.

By means of these four quite elaborate slide rules, which have been especially made for the purpose of determining the all-round capacity of metal-cutting machines, Mr. Barth made a careful analysis of every element of this machine in its relation to the work in hand. Its pulling power at its various speeds, its feeding capacity, and its proper speeds were determined by means of the slide rules, and changes were then made in the countershaft and driving pulleys so as to run the lathe at its proper speed. Tools, made of high-speed steel and of the proper shapes were properly dressed, treated, and ground. It should be understood, however, that in this case the high-speed steel which had heretofore been in general use in the shop was also used in Mr. Barth's demonstration. Mr. Barth then made a large special slide rule, by means of which the exact speeds and feeds were indicated at which each kind of work could be done in the shortest possible time in this particular lathe. After preparing in this way so that the workman should work according to the new method, one after another, pieces of work were finished in the lathe, corresponding to the work which had been done in the preliminary trials, and the gain in time made through running the machine according to scientific principles ranged from two and one-half times the speed in the slowest instance to nine times the speed in the highest.

Thereupon, at 12 o'clock noon, a recess was taken until 2 o'clock p. m.

After Recess

The Committee met at 2 o'clock p. m., Hon. William B. Wilson (chairman) presiding.

Mr. Taylor. The change from rule-of-thumb management to scientific management involves,

however, not only a study of what is the proper speed for doing the work and a remodeling of the tools and the implements in the shop, but also a complete change in the mental attitude of all the men in the shop toward their work and toward their employers. The physical improvements in the machines necessary to insure large gains and the motion study followed by minute study with a stop watch of the time in which each workman should do his work can be made comparatively quickly. But the change in the mental attitude and in the habits of the 300 or more workmen can be brought about only slowly and through a long series of object lessons, which finally demonstrates to each man the great advantage which he will gain by heartily cooperating in his everyday work with the men in the management. Within three years, however, in this shop the output had been more than doubled per man and per machine. The men had been carefully selected and in almost all cases promoted from a lower to a higher order of work and so instructed by their teachers—the functional foremen—that they were able to earn higher wages than ever before. The average increase in the daily earnings of each man was about 35 per cent, while at the same time the sum total of the wages paid for doing a given amount of work was lower than before. This increase in the speed of doing the work, of course, involved a substitution of the quickest hand methods for the old independent rule-of-thumb methods and an elaborate analysis of the hand work done by each man. By hand work is meant such work as depends upon the manual dexterity and speed of a workman and which is independent of the work done by the machine. The time saved by scientific hand work was in many cases greater even than that saved in machine work.

It seems important to fully explain the reason why, with the aid of a slide rule, and after having studied the art of cutting metals, it was possible for the scientifically equipped man, Mr. Barth, who had never before seen these particular jobs, and who had never worked on this machine, to do work from two and one-half to nine times as fast as it had been done before by a good mechanic who had spent his whole

time for some 10 to 12 years in doing this very work upon this particular machine. In a word, this was possible because the art of cutting metals involves a true science of no small magnitude, a science, in fact, so intricate that it is impossible for any machinist who is suited to running a lathe year in and year out either to understand it or to work according to its laws without the help of men who have made this their specialty. Men who are unfamiliar with machine-shop work are prone to look upon the manufacture of each piece as a special problem, independent of any other kind of machine work. They are apt to think, for instance, that the problems connected with making the parts of an engine require the especial study one may say almost the life study, of a set of engine-making mechanics, and that these problems are entirely different from those which would be met with in machining lathe or planer parts. In fact, however, a study of those elements which are peculiar either to engine parts or to lathe parts is trifling compared with the great study of the art, or science, of cutting metals, upon a knowledge of which rests the ability to do really fast machine work of all kinds.

The real problem is how to remove chips fast from a casting or a forging, and how to make the piece smooth and true in the shortest time, and it matters but little whether the piece being worked upon is part, say, of a marine engine, a printing press, or an automobile. For this reason, the man with the slide rule, familiar with the science of cutting metals, who had never before seen this particular work, was able completely to distance the skilled mechanic who had made the parts of this machine his specialty for years.

It is true that whenever intelligent and educated men find that the responsibility for making progress in any of the mechanic arts rests with them, instead of upon the workmen who are actually laboring at the trade, that they almost invariably start on the road which leads to the development of a science where in the past has existed mere traditional or rule-of-thumb knowledge. When men whose education has given them the habit of generalizing and everywhere looking for laws, find themselves con-

fronted with a multitude of problems, such as exist in every trade and which have a general similarity one to another, it is inevitable that they should try to gather those problems into certain logical groups, and then search for some general laws or rules to guide them in their solution. As I have tried to point out, however, the underlying principles of the management of "initiative and incentive"—that is, the underlying philosophy of this management necessarily leaves the solution of all of these problems in the hands of each individual workman, while the philosophy of scientific management places their solution in the hands of the management. The workman's whole time is each day taken in actually doing the work with his hands, so that, even if he had the necessary education and habits of generalizing in his thought, he lacks the time and the opportunity for developing these laws, because the study of even a simple law involving, say, time study requires the cooperation of two men, the one doing the work while the other times him with a stop watch. And even if the workman were to develop laws where before existed only rule-of-thumb knowledge, his personal interest would lead him almost inevitably to keep his discoveries secret so that he could, by means of this special knowledge, personally do more work than other men and so obtain higher wages.

Under scientific management, on the other hand, it becomes the duty and also the pleasure of those who are engaged in the management not only to develop laws to replace rule-of-thumb, but also to teach impartially all of the workmen who are under them the quickest ways of working. The useful results obtained from these laws are always so great that any company can well afford to pay for the time and the experiments needed to develop them. Thus, under scientific management, exact scientific knowledge and methods are everywhere, sooner or later, sure to replace rule-of-thumb, whereas under the old type of management working in accordance with scientific laws is an impossibility.

The development of the art or science of cutting metals is an apt illustration of this fact. In the early eighties, about the time that I

started to make the investigations above referred to to determine the proper movements to be made by machinists in putting their work into and removing it from machines and time required to do this work, I also obtained the permission of Mr. William Sellers, the president of the Midvale Steel Co., to make a series of experiments to determine what angles and shapes of tools were the best for cutting steel, and also to try to determine the proper cutting speed for steel. At the time that these experiments were started it was my belief that they would not last longer than six months, and, in fact, if it had been known that a longer period than this would be required, the permission to spend a considerable sum of money in making them would not have been forthcoming.

A 66-inch diameter vertical boring mill was the first machine used in making these experiments, and large locomotive tires, made out of hard steel of uniform quality, were day after day cut up into chips in gradually learning how to make, shape, and use the cutting tools so that they would do faster work. At the end of six months sufficient practical information had been obtained to far more than repay the cost of materials and wages which had been expended in experimenting. And yet the comparatively small number of experiments which had been made served principally to make it clear that the actual knowledge attained was but a small fraction of that which still remained to be developed and which was badly needed by us in our daily attempt to direct and help the machinists in their work.

Experiments in this field were carried on, with occasional interruptions, through a period of about 26 years, in the course of which 10 different experimental machines were especially fitted up to do this work. Between 30,000 and 50,000 experiments were carefully recorded, and many other experiments were made of which no record was kept. In studying these laws more than 800,000 pounds of steel and iron was cut up into chips with the experimental tools, and it is estimated that from \$150,000 to \$200,000 was spent in the investigation.

Work of this character is intensely interesting to anyone who has any love for scientific

research. It should be fully appreciated that the motive power which kept these experiments going through many years and which supplied the money and the opportunity for their accomplishment was not an abstract search after scientific knowledge, but was the very practical fact that we lacked the exact information which was needed every day in order to help our machinists to do their work in the best way and in the quickest time.

All of these experiments were made to enable us to answer correctly the two questions which face every machinist each time that he does a piece of work in a metal-cutting machine, such as a lathe, planer, drill press, or milling machine. These two questions are:

In order to do the work in the quickest time, at what cutting speed shall I run my machine? and what feed shall I use?

These questions sound so simple that they would appear to call for merely the trained judgment of any good mechanic. In fact, however, after working 26 years, it has been found that the answer in every case involves the solution of an intricate mathematical problem, in which the effect of 12 independent variables must be determined.

Each of the 12 following variables has an important effect upon the answer. The figures which are given with each of the variables represent the effect of this element upon the cutting speed. For example, after the first variable (A) I quote:

The proportion is as 1 in the case of semi-hardened steel or chilled iron to 100 in the case of a very soft low-carbon steel.

The meaning of this quotation is that soft steel can be cut one hundred times as fast as the hard steel or chilled iron. The ratios which are given, then, after each of these elements indicate the wide range of judgment which practically every machinist has been called upon to exercise in the past in determining the best speed at which to run his machine and the best feed to use.

(A) The quality of the metal which is to be cut, i. e. its hardness or other qualities which affect the cutting speed. The proportion is as 1 in the case of semi-hardened steel or chilled

iron to 100 in the case of very soft, low-carbon steel.

(B) The chemical composition of the steel from which the tool is made, and the heat treatment of the tool. The proportion is as 1 in tools made from tempered carbon steel to 7 in the best highspeed tools.

(C) The thickness of the shaving, or the thickness of the spiral strip or band of metal which is to be removed by the tool. The proportion is as 1 with thickness of shaving three-sixteenths of an inch to $3\frac{1}{2}$ with thickness of shaving one sixty-fourth of an inch.

(D) The shape or contour of the cutting edge of the tool. The proportion is as 1 in a thread tool to 6 in a broad-nosed cutting tool.

(E) Whether a copious stream of water or other cooling medium is used on the tool. The proportion is as 1 for tool running dry to 1.41 for tool cooled by a copious stream of water.

(F) The depth of the cut. The proportion is as 1 with one-half inch depth of cut to 1.36 with one-eighth inch depth of cut.

(G) The duration of the cut, i. e., the time which a tool must last under pressure of the shaving without being re-ground. The proportion is as 1 when tool is to be ground every one and one-half hours to 1.20 when tool is to be ground every 20 minutes.

(H) The lip and clearance angles of the tool. The proportion is as 1 with lip angle of 68° to 1.023 with lip angle of 61° .

(J) The elasticity of the work and of the tool on account of producing chatter. The proportion is as 1 with tool chattering to 1.15 with tool running smoothly.

(K) The diameter of the casting or forging which is being cut.

(L) The pressure of the chip or shaving upon the cutting surface of the tool.

(M) The pulling power and the speed and feed changes of the machine.

It may seem preposterous to many people that it should have required a period of 26 years to investigate the effect of these 12 variables upon the cutting speed of metals. To those, however, who have had personal experience as experimenters it will be appreciated that the great difficulty of the problem lies in

the fact that it contains so many variable elements. And, in fact, the great length of time consumed in making each single experiment was caused by the difficulty of holding 11 variables constant and uniform throughout the experiment, while the effect of the twelfth variable was being investigated. Holding the 11 variables constant was far more difficult than the investigation of the twelfth element.

As, one after another, the effect upon the cutting speed of each of these variables was investigated, in order that practical use could be made of this knowledge, it was necessary to find a mathematical formula which expressed in concise form the laws which had been obtained. As examples of the 12 formulae which were developed, the 3 following are given.

$$P = 45,000 D^{1\frac{1}{2}} F^{\frac{1}{2}}$$

$$V = \frac{90}{T^{\frac{1}{2}}}$$

$$V = \frac{11.9}{F^{0.8} \left(\frac{48D}{3} \right)^{0.2373 + \frac{2.4}{18+24D}}}$$

After these laws had been investigated and the various formulae which mathematically expressed them had been determined there still remained the difficult task of how to solve one of these complicated mathematical problems quickly enough to make this knowledge available for everyday use. If a good mathematician who had these formulae before him were to attempt to get the proper answer (i. e. to get the correct cutting speed and feed by working in the ordinary way), it would take him from two to six hours, say, to solve a single problem; far longer to solve the mathematical problem than would be taken in most cases by the workman in doing the whole job in his machine.

Thus a task of considerable magnitude which faced us was that of finding a quick solution of this problem, and as we made progress in its solution the whole problem was from time to time presented by me to one after another of the noted mathematicians in this country. They were offered any reasonable fee for a rapid, practical method to be used in its solution. Some of these men merely glanced at it;

others, for the sake of being courteous, kept it before them for some two or three weeks. They all gave us practically the same answer, that in many cases it was possible to solve mathematical problems which contained 4 variables and in some cases problems with 5 or 6 variables, but that it was manifestly impossible to solve a problem containing 12 variables in any other way than by the slow process of "trial and error."

A quick solution was, however, so much of a necessity in our everyday work of running machine shops that in spite of the small encouragement received from the mathematicians we continued at irregular periods, through a term of 15 years, to give a large amount of time searching for a simple solution. Four or five men at various periods gave practically their whole time to this work (among these men were Mr. Sinclair, Mr. Gault, and Mr. Barth) and finally, while we were at the Bethlehem Steel Co. the slide rule was developed, which is illustrated on folder No. 11 of the paper "On the art of cutting metals," which is in the hands of your committee and is described in detail in the paper presented by Mr. Carl G. Barth to the American Society of Mechanical Engineers, entitled "Slide rules for the machine shop, as a part of the Taylor system of management" (Vol. XXV of The Transactions of the American Society of Mechanical Engineers). By means of this slide rule one of these intricate problems can be solved in less than half a minute by any good mechanic, whether he understands anything about mathematics or not, thus making available for everyday practical use the years of experimenting on the art of cutting metals.

This is a good illustration of the fact that some way can always be found of making practical, everyday use of complicated scientific data which appears to be beyond the experience and the range of the technical training of ordinary practical men. These slide rules have been for years in constant daily use by machinists having no knowledge of mathematics.

A glance at the intricate mathematical formulae which represent the laws of cutting metals should clearly show the reason why it is impos-

sible for any machinist, without the aid of these laws and who depends upon his personal experience, correctly to guess at the answer to the two questions:

What speed shall I use?

What feed shall I use?

even though he may repeat the same piece of work many times.

To return to the case of the machinist who had been working for 10 to 12 years in machining the same pieces over and over again, there was but a remote chance in any of the various kinds of work which this man did that he should hit upon the one best method of doing each piece of work out of the hundreds of possible methods which lay before him. In considering this typical case it must also be remembered that the metal-cutting machines throughout our machine shops have practically all been speeded by their makers by guesswork and without the knowledge obtained through a study of the art of cutting metals. As I have said before, in the machine shops systemized by us we have found that there is not one machine in twenty which is speeded by its makers at anywhere near the correct cutting speed. So that, in order to compete with the science of cutting metals the machinist, before he could use proper speeds, would first have to put new pulleys on the countershaft of his machine and also make in most cases changes in the shapes and treatment of his tools, etc. Many of these changes are matters entirely beyond his control, even if he knows what ought to be done.

If the reason is clear to you why the rule-of-thumb knowledge obtained by the machinist who is engaged on repeat work cannot possibly compete with the true science of cutting metals, it should be even more apparent why the high-class mechanic, who is called upon to do a great variety of work from day to day, is even less able to compete with this science. The high-class mechanic who does a different kind of work each day, in order to do each job in the quickest time, would need, in addition to a thorough knowledge of the art of cutting metals, a vast knowledge and experience in the quickest way of doing each kind of handwork. And by calling to mind the gain which was made by Mr. Gilbreth through his motion and time study in

laying bricks, you will appreciate the great possibilities for quicker methods of doing all kinds of handwork which lie before every tradesman after he has the help which comes from a scientific motion and time study of his work.

For nearly 30 years past time-study men connected with the management of machine shops have been devoting their whole time to a scientific motion study, followed by accurate time study with a stop watch of all elements connected with the machinist's work. When, therefore, the teachers, who form one section of the management, and who are cooperating with the workingmen, are in possession both of the science of cutting metals and of equally elaborate motion-study and time-study science connected with this work, it is not difficult to appreciate why even the highest-class mechanic is unable to do his best work without constant daily assistance from his teachers.

Now, gentlemen, what I have been trying to illustrate is the effect which the development of a great science has upon the workman's daily life. The sciences of shoveling and of bricklaying are comparatively small, and yet their effect upon the workman is great. The science of cutting metals required 26 years of constant effort to develop, and what I have been trying to show you is that when a large science, such as this, is applied to the work of a first-class mechanic, even though he be a man having a good high-school education, that the effect of science upon the work of this man is quite as great as the effect of the smaller science, such as that of bricklaying, upon a less intellectual and less well-educated man.

You will remember that Mr. Barth, with the knowledge obtained from the science of cutting metals, was able to show the high-class mechanic how to do work from two and one-half to nine times as fast as he had formerly done it, and this with no greater effort to himself than he had exerted before.

Now, gentlemen, the development of the science of cutting metals is merely typical of what is going to take place in all of the great industries of this country during the next twenty to thirty years. Already bleaching has been taken out of the old rule-of-thumb methods and developed into a science, and the dyeing

business is now being studied scientifically, and right at this minute probably 10 to 15 other large and important sciences are receiving the same minute, painstaking study which will ultimately result in developing a science where now exists mere traditional rule-of-thumb knowledge. And in each of these cases results will be accomplished which are fairly comparable with those achieved under the science of cutting metals.

The development of a science sounds like a formidable undertaking, and in fact, anything like a thorough study of a science such as that of cutting metals necessarily involves many years of work. The science of cutting metals, however, represents in its complication, and in the time required to develop it, almost an extreme case in the mechanic arts. Yet even in this very intricate science within a few months after starting enough knowledge had been obtained to much more than pay for the work of experimenting. This holds true in the case of practically all scientific development in the mechanic arts. The first laws developed for cutting metals were crude and contained only a partial knowledge of the truth, yet this imperfect knowledge was vastly better than the utter lack of exact information or the very imperfect rule-of-thumb which existed before, and it enables the workmen, with the help of the management, to do far quicker and better work.

For example, a very short time was needed to discover one or two types of tools which, though imperfect as compared with the shapes developed years afterwards, were superior to all other shapes and kinds in common use. These tools were adopted as standard and made possible an immediate increase in the speed of every machinist who used them. These types were superseded in a comparatively short time by still other tools which remained standard until they in turn made way for later improvements.

The science which exists in most of the mechanic arts is, however, far simpler than the science of cutting metals. In almost all cases, in fact, the laws or rules which are developed are so simple that the average man would hardly dignify them with the name of a science. In

most trades the science is developed through a comparatively simple analysis and time study of the movements required by the workmen to do some small part of his work, and this study is usually made by a man equipped merely with a stop watch and a properly ruled notebook. Hundreds of these "time study men" are now engaged in developing elementary scientific knowledge where before existed only rule-of-thumb. Even the motion study of Mr. Gilbreth in bricklaying involves a much more elaborate investigation than that which occurs in most cases. The general steps to be taken in developing a simple law of this class are as follows:

First. Find, say, 10 to 15 different men (preferably in as many separate establishments and different parts of the country) who are especially skillful in doing the particular work to be analyzed.

Second. Study the exact series of elementary operations or motions which each of these men uses in doing the work which is being investigated, as well as the implements each man uses.

Third. Study with a stop watch the time required to make each of these elementary movements and then select the quickest way of doing each element of the work.

Fourth. Eliminate all false movements, slow movements, and useless movements.

Fifth. After doing away with all unnecessary movements, collect into one series the quickest and best movements, as well as the best implements.

This new method, involving that series of motions which can be made quickest and best, is then substituted in place of the 10 or 15 inferior series which were formerly in use. This best method becomes standard and remains standard, to be taught first to the teachers (or functional foremen) and by them to every workman in the establishment until it is superseded by a quicker and better series of movements. In this simple way one element after another of the science is developed.

In the same way each type of implement used in a trade is studied. Under the philosophy of the management of "initiative and incentive" each workman is called upon to use his own

best judgment so as to do the work in the quickest time, and from this results, in all cases, a large variety in the shapes and types of implements which are used for any specific purpose. Scientific management requires, first, a careful investigation of each of the many modifications of the same implement, developed under rule-of-thumb; and second, after a time study has been made for speed attainable with each of these implements that the good points of several of them shall be united in a single standard implement, which will enable the workman to work faster and with greater ease than he could before. This one implement, then, is adopted as standard in place of the many different kinds before in use, and it remains standard for all workmen to use until superseded by an implement which has been shown, through motion and time study, to be still better.

With this explanation it will be seen that the development of a science to replace rule-of-thumb is in most cases by no means a formidable undertaking and that it can be accomplished by ordinary, everyday men without any elaborate scientific training; but that, on the other hand, the successful use of even the simplest improvement of this kind calls for records, system, and cooperation where in the past existed only individual effort.

Now, what I want to bring out and make clear to you is that under scientific management there is nothing too small to become the subject of scientific investigation. Every single motion of every man in the shop sooner or later becomes the subject of accurate, careful study to see whether that motion is the best and quickest that can be used, and as you see, this is a new mental attitude assumed by the employer which differs radically from the old. The old idea, both of employer and employee, was to leave all of these details to someone's judgment. The new idea is that everything requires scientific investigation, and that is what I am trying to make clear to you.

There are a number of facts connected with scientific management which I think can be better brought out under cross-examination than by direct statement.

The Chairman. Well, if you have con-

cluded your direct statement, Mr. Taylor, we will adjourn the committee until 11 o'clock tomorrow morning, when we will proceed with the cross-examination.

Saturday, January 27, 1912

The committee met at 11 o'clock a. m.

Present: Messrs. William B. Wilson (chairman), and John Q. Tilson.

The Chairman. The committee will be in order. Mr. Taylor, did you serve your apprenticeship as a machinist in the Midvale plant?

Mr. Taylor. No, sir; I served my apprenticeship in a small shop. It was under the management of the firm of Ferrell & Jones, a shop in which steam pumps were made and a variety of miscellaneous machinery, but yet a very small shop.

The Chairman. How long did you serve as an apprentice?

Mr. Taylor. I started in 1874 and finished in 1878, the end of 1878.

The Chairman. Making four years?

Mr. Taylor. Four years of work; yes, sir.

The Chairman. How old were you when you began your apprenticeship?

Mr. Taylor. About 18 years old.

The Chairman. You were a journeyman machinist when you went to the Midvale plant, were you?

Mr. Taylor. Yes; I may say, Mr. Chairman, that my father had some means, and owing to the fact that I worked during my first year of apprenticeship for nothing, the second year for \$1.50 a week, the third year for \$1.50 a week, and the fourth year for \$3 a week, I was given, perhaps, special opportunities to progress from one kind of work to another; that is, I told the owners of the establishment that I wanted an opportunity to learn fast rather than wages, and for that reason, I think, I had specially good opportunities to progress. I am merely saying that to explain why in four years I was able to get through with my apprenticeship as a pattern maker and as a machinist. That is a very short time, as you will realize. I may add that I do not think I was a very high order of journeyman when I started in.

The Chairman. How long did you work as

a journeyman machinist at the Midvale plant before you were promoted to the position of gang foreman?

Mr. Taylor. My remembrance is not very clear in the matter, but I should not think it was more than two months.

The Chairman. How long had you worked as a journeyman machinist before that at this other plant?

Mr. Taylor. That is the first work I had after I got through with my apprenticeship.

The Chairman. You went right from there to the Midvale plant as a journeyman machinist?

Mr. Taylor. Yes, sir.

The Chairman. And worked at the Midvale plant two months as a journeyman machinist before you were promoted to the position of gang foreman?

Mr. Taylor. Gang boss; yes.

The Chairman. During the time that you were working as a journeyman machinist you worked exactly as the other men in the plant worked?

Mr. Taylor. Oh, yes; absolutely.

The Chairman. You found there a disposition on the part of the workmen to soldier?

Mr. Taylor. We all soldiered; it is safe to say that there was not a man in the shop that did not soldier.

The Chairman. Yourself included?

Mr. Taylor. Certainly, sir.

The Chairman. You did not while there do any greater amount of work than the other machinists?

Mr. Taylor. Well, there may have been a shade of difference between my work and that of the rest of the men. I will not say that I did work harder. Possibly I did a little more work, but it was not enough to cause my brother workmen to feel that I was breaking rates and making a hog of myself, as they would put it then.

The Chairman. But you were there long enough and worked with them long enough to feel that the workmen were soldiering?

Mr. Taylor. I absolutely knew it; there was no question about it. I saw the same thing, Mr. Chairman, all through my apprenticeship, from the time I started as an apprentice until I

got through; the thing was practically universal in the shop.

The Chairman. And when you became a gang foreman, having this information, you determined to take strong measures to break up that soldiering?

Mr. Taylor. I determined to try to get a larger output from the machines, but I do not think I had in mind what measures I was going to take; at first I do not think I had any policy clearly in mind. I thought at first that I would be able to persuade a lot of my friends to do more work, but I soon found that was out of the question.

The Chairman. Did you find during that time that the workmen themselves admitted that they were soldiering?

Mr. Taylor. Of course they did.

The Chairman. They admitted that to the foreman?

Mr. Taylor. I do not know what they admitted to the other foreman (the old gentleman, as we called him; the old man was an old English gentleman of more than 70 years of age). I really do not know what they admitted to him; but all through the time that I was their foreman or their gang boss and was trying to get them to do a larger day's work there was no denying the matter at all with me; they knew that I knew it, and they justified it, and so did I justify it, Mr. Chairman, in view of prevailing conditions, and my sympathies were with them through-out the whole performance. Now, that may sound like an anomaly, but I am telling you the fact. My sympathies were with the workman, and my duty lay to the people by whom I was employed. My sympathies were so great that when, as I have told you before, they came to me for personal advice as a friend and asked me in a serious, sober way, "Fred, if you were in my place, would you do what you are asking me to do, turn out a bigger output?" my answer was, as I have said in the record before, "If I were in your place, I would do just what you are doing; I would fight against this as hard as any of you are; only," I said, "I would not make a fool of myself; when the time comes that you see that I have succeeded, or the men on our side have succeeded, in forcing or compelling you to do a larger day's work, I

would not then make a fool of myself. When that time comes I would work up to proper speed." I told them that over and over again. Our official relations were of the most strained and most disagreeable and contemptible nature, but my personal relations with most of the men throughout that fight were agreeable.

The Chairman. Let me find out whether your conception of what is meant by the term "soldiering" and my conception are the same. Do you mean by the term "soldiering" a failure on the part of the workman to do as much work as he could do without physical or mental injury to himself?

Mr. Taylor. Would it not be better for me to quote from what I have written on the matter? What I have written has been very carefully prepared to express my exact views.

The Chairman. I just wanted to get your conception as to what constitutes soldiering. If that fits your conception, of course we will be glad to hear it.

Mr. Tilson. What we want is your present idea of that term; and if it is expressed in your book, we will be glad to have it.

Mr. Taylor. It is expressed in my book better than I could state it extemporaneously; I could state it in a shorter way, but I do not want to have people coming back at me and misrepresenting my real views because of any brief extemporaneous statement that I may make. There are several kinds of soldiering, and they are described in my book; if you want a full definition of soldiering, I beg to refer to my book.

The Chairman. We would like to have your whole view about soldiering.

Mr. Taylor. Well, I will read from my book as follows:

On the part of the men the greatest obstacle to the attainment of this standard is the slow pace which they adopt, or the loafing or "soldiering", marking time, as it is called. This loafing or soldiering proceeds from two causes. First, from the natural instinct and tendency of man to take it easy, which may be called natural soldiering. Second, from more intricate second thought and reasoning caused by

their relations with other men, which may be called systematic soldiering.

I might add that in England it is called "hanging it out" and in Scotland "ca' cannie," and every man in England, let me tell you, hangs it out, and every man in Scotland will ca' cannie.

(Reading:)

There is no question that the tendency of the average man (in all walks of life) is toward working at a slow, easy gait, and that it is only after a good deal of thought and observation on his part or as a result of example, conscience, or external pressure that he takes a more rapid pace.

There are, of course, men of unusual energy, vitality, and ambition who naturally choose the fastest gait, set up their own standards, and who will work hard, even though it may be against their best interests. But these few uncommon men only serve by affording a contrast to emphasize the tendency of the average.

This common tendency to "take it easy" is greatly increased by bringing a number of men together on similar work and at a uniform standard rate of pay by the day. Under this plan the better men gradually but surely slow down their gait to that of the poorest and least efficient. When a naturally energetic man works for a few days beside a lazy one, the logic of the situation is unanswerable: "Why should I work hard when that lazy fellow gets the same pay that I do and does only half as much work?"

A careful time study of men working under these conditions will disclose facts which are ludicrous as well as pitiable.

To illustrate: The writer has timed a naturally energetic workman who, while going and coming from work would walk at a speed of from 3 to 4 miles per hour, and not infrequently trot home after a day's work. On arriving at his work he would immediately slow down to a speed of about one mile an hour. When, for example, wheeling a loaded wheelbarrow he would go at a good fast pace even up hill in order to be as short a time as possible

under load, and immediately on the return walk slow down to a mile an hour, improving every opportunity for delay short of actually sitting down. In order to be sure not to do more than his lazy neighbor he would actually tire himself in his effort to go slow.

These men were working under a foreman of good reputation and one highly thought of by his employer who, when his attention was called to this state of things, answered: "Well, I can keep them from sitting down, but the devil can't make them get a move on while they are at work."

The natural laziness of men is serious, but by far the greatest evil from which both workmen and employers are suffering, is the systematic soldiering which is almost universal under all of the ordinary schemes of management and which results from a careful study on the part of the workmen of what they think will promote their best interests.

The writer was very much interested recently to hear one small but experienced golf caddy boy of 12 explaining to a green caddy who had shown special energy and interest the necessity of going slow and lagging behind his man when he came up to the ball, showing him that since they were paid by the hour, the faster they went the less money they got, and finally telling him that if he went too fast the other boys would give him a licking.

This represents a type of systematic soldiering which is not, however, very serious, since it is done with the knowledge of the employer, who can quite easily break it up if he wishes.

The greater part of the systematic soldiering, however, is done by the men with the deliberate object of keeping their employers ignorant of how fast work can be done.

So universal is soldiering for this purpose that hardly a competent workman can be found in a large establishment, whether he works by the day or on piecework, contract work or under any of the ordinary systems of compensating labor, who does not devote a considerable part of his time to studying just how slowly he can work and still convince his employer that he is going at a good pace.

The causes for this are, briefly, that practi-

cally all employers determine upon a maximum sum which they feel it is right for each of their classes of employees to earn per day, whether their men work by the day or by the piece.

Each workman soon finds out about what this figure is for his particular case, and he also realizes that when his employer is convinced that a man is capable of doing more than he has done, he will find sooner or later some way of compelling him to do it with little or no increase of pay.

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. In many cases the employer will feel almost certain that a given job can be done faster than it has been, but he rarely cares to take the drastic measures necessary to force men to do it in the quickest time, unless he has an actual record, proving conclusively how fast the work can be done.

It evidently becomes for each man's interest, then, to see that no job is done faster than it has been in the past. The younger and less experienced men are taught this by their elders, and all possible persuasion and social pressure is brought to bear upon the greedy and selfish men to keep them from making new records which result in temporarily increasing their wages, while all those who come after them are made to work harder for the same old pay.

Under the best daywork of the ordinary type, when accurate records are kept of the amount of work done by each man and of his efficiency, and when each man's wages are raised as he improves, and those who fail to rise to a certain standard are discharged and a fresh supply of carefully selected men are given work in their places, both the natural loafing and systematic soldiering can be largely broken up. This can be done, however, only when the men are thoroughly convinced that there is no intention of establishing piecework even in the remote future, and it is next to impossible to make men believe this when the work is of such a nature that they believe piecework to be prac-

licable. In most cases their fear of making a record which will be used as a basis for piecework will cause them to soldier as much as they dare.

It is, however, under piecework that the art of systematic soldiering is thoroughly developed. After a workman has had the price per piece of the work he is doing lowered two or three times as a result of his having worked harder and increased his output he is likely to entirely lose sight of his employer's side of the case and to become imbued with a grim determination to have no more cuts if soldiering can prevent it. Unfortunately for the character of the workman, soldiering involves a deliberate attempt to mislead and deceive his employer, and thus upright and straightforward workmen are compelled to become more or less hypocritical. The employer is soon looked upon as an antagonist, if not as an enemy, and the mutual confidence which should exist between a leader and his men—the enthusiasm, the feeling that they are all working for the same end and will share in the results—is entirely lacking.

The feeling of antagonism under the ordinary piecework system becomes in many cases so marked on the part of the men that any proposition made by their employers, however reasonable, is looked upon with suspicion. Soldiering becomes such a fixed habit that the men will frequently take pains to restrict the product of the machines which they are running when even a large increase in output would involve no more work on their part.

The Chairman. Now, with that definition of soldiering before us I want to ask whether I understood your direct testimony correctly to be that after you became foreman you ultimately succeeded in breaking up that soldiering, destroying the loafing, and removing the slow pace which you had found existing both in this automatic and systematic form, and thereby increased productivity?

Mr. Taylor. Yes, sir; to a large extent, but not entirely. I did not succeed in entirely breaking up the soldiering; I did not expect to succeed in that. As I told you before, we had the work in that shop laid out so that I think we were doing about one-third of a full

day's work, and I succeeded in doubling the output of those men on the whole, I should say. It is many years ago and I make this statement in round numbers.

The Chairman. But you had succeeded in increasing the pace to such an extent that you did increase the productivity?

Mr. Taylor. Doubled it.

The Chairman. Never having worked yourself at that increased pace, would you think it possible for you to determine the soreness of muscle or the tiredness of brain which the increased pace brought to the workmen?

Mr. Taylor. I had many times done work at full speed, just as practically all of the workmen in the shop had worked at full speed. They all did work at full speed. We would not have known what full speed was unless we had worked at full speed, but we invariably did that when there was no one around to watch us and when there would be no record kept of it which could be used to break a rate to our own disadvantage. In this way we all knew what the right pace was, and then we settled upon what we thought the company ought to have in the way of work.

The Chairman. Is it not a fact when you speeded up for a comparatively short time and did the work rapidly that you thereby determined the length of time in which the work could be done rather than the length of time in which it should be done?

Mr. Taylor. Mr. Chairman, in my statement of what I believed was a proper day's work for that shop I stated what ought to be done and what could be done—what ought to be done as a fair day's work—that is, what could be done and kept up through a long term of years without any injury to the man, but what, on the contrary, would develop him—make him stronger, happier, and more contented in doing it. It was perfectly proper pace and a pace such as you and I would be willing to take.

The Chairman. But that conclusion was arrived at by observation on your part, was it not, rather than by actual experience?

Mr. Taylor. By working myself and noting that I was not hurried; that I was perfectly contented; that I did not feel driven. It was personal experience and the experience of my

friends who were working on their jobs in the same way. It was not watching anyone else so much as it was our own personal experience, and then we interchanged our views.

The Chairman. Would not the fact that your people were in better financial circumstances than the average workingman remove from your mind the same fear of ultimate exhaustion that would be continually in the mind of the workman who was dependent entirely upon his day's wages for his living?

Mr. Taylor. Well, I never had in mind ultimate exhaustion. I never had such a thing in my mind, and I do not think any of us in that shop had any fear of ultimate exhaustion. I never heard anyone talk about it. There was no fear that I ever heard expressed of anyone being overworked in that shop. That was not the fear.

The Chairman. Is it not true that a workman must provide for himself through his earning capacity for his entire lifetime; or, if from any cause he fails to provide for himself through his earnings he becomes a public charge and what is known as a pauper?

Mr. Taylor. Certainly, sir.

The Chairman. Would it not naturally, then, be in the mind of the workingman who has no other resources except his earnings from day to day that he must conserve his earning power so as to last him through the longest possible period of his life?

Mr. Taylor. It certainly should be, Mr. Chairman. Perhaps I could make the matter clearer to you by telling you that in machine work—running machine tools—it is next to impossible to overwork a man. In working on the average machine tool, of necessity the greater part of the day is spent by the man standing at his machine doing nothing except watch his machine work. I think I would be safe in saying that not more than three hours of actual physical work would be the average that any machinist would have to do in running his machine—not more than three hours' actual physical work in the day. The rest of the time the machine is working, and he simply stands there watching it. So there is no fear of overwork in the machine shop. Perhaps I can make it clearer to you by telling you that I

worked the whole winter of 1895, I think it was, in running a machine myself. I went back and ran a machine for the whole winter in making a series of experiments in developing the "art of cutting metals," which I described to you in my direct testimony, and during this time I worked more steadily on that lathe than I had ever worked in my whole lifetime as a workman. I worked the same hours as the other workmen, and I tell you it was the easiest and happiest year I have had since I got out of my apprenticeship—that year of going back and working on a lathe. I worked hard from the machinist's standpoint and harder than I had ever worked before in my life as a mechanic. I was known to be a manager, and the men knew I was in there conducting some of the series of experiments that I have told you about on the art of cutting metals, and yet some of the men came to me and begged me not to set too fast a pace or the other fellows might have their rate cut as a result.

I give you my word, Mr. Chairman, that during that winter there was never a day that I was overworked, and I was physically soft; I was a comparatively middle-aged man and had not done any work by hand for 12 or 14 years, and yet I was not in the slightest degree overworked.

The Chairman. Is it not the purpose of the advocates of scientific management to apply it to all classes of work whether it is machine work or any other kind of work?

Mr. Taylor. It certainly is, sir.

The Chairman. So that the explanation which you have made would only apply to those cases where machines are used and where physical and mental energy is not required in handling the machines?

Mr. Taylor. It might apply to some other cases; it certainly would apply to the cases you speak of. But I know of a good many kinds of handwork, that is, work done without any machine, in which it is next to impossible to overwork, such, as for instance, very light, delicate work in which the muscular effort is so slight that it is next to impossible for a man to overwork himself physically. In work of this type he might overwork himself mentally or become tired mentally, but not physically.

The Chairman. Now, having removed, to some extent, the soldiering which occurred and thereby cheapened the cost of production, by what method does the public at large get the benefit of that cheapened cost of production?

Mr. Taylor. Usually the manufacturer who is manufacturing his goods, we will say at half the price he did formerly, wishes to enlarge his sales and so lowers the price in order to get a greater proportion of the business, and in that way the public profits by the lowering of the cost; that is the usual course.

Mr. Tilson. If everybody used the same system and thereby reduced the cost of production his competitors in business would force him to sell cheaper to the public, would they not?

Mr. Taylor. Yes, sir.

The Chairman. I am trying to bring out the inception of this thing. If an establishment reduces the cost by this process would the owner of the establishment sell the goods produced in the shop at any lower rate than the rate that was necessary to enable him to undersell his competitor and secure the trade?

Mr. Taylor. Naturally, he would not; in nine cases out of ten he would lower his price just enough to get the order. And you gentlemen who have had to do with the selling side of business know that the sales department is exceedingly slow in lowering prices, that is, making cuts in prices; they will usually wait until they get a big order before they cut at all, and so the process of lowering the price to the public is usually a slow one.

The Chairman. So that until other establishments introduced the system and thereby cut the cost of production competition between the manufacturers would not be sufficiently keen to enable the public to receive the entire benefit?

Mr. Taylor. Mr. Chairman, I think in the course of your question you used the term "introduced the system." I wish it clearly understood that everything I have said up to now during this cross examination bears no relation whatever to scientific management; it refers to just the opposite; it refers to the most unscientific management; it is the beastly management of the past that I have been referring to, and this has nothing to do with scientific management. All that I have had to say has relation

to the brutal thing that I had to deal with in the early days, while in charge of the shop of the Midvale Steel Works, and that system was just the opposite of scientific management. I was trying to place before you the horror of the older system of management; it was the horror of this system which started me to take the first steps which, as time went on, finally produced the evolution of scientific management. I want that clearly understood. No one dislikes the older system of management more than I do.

The Chairman. However, if I understood your testimony correctly, you found this soldiering going on in this establishment and you took the methods which you have described to abolish that soldiering?

Mr. Taylor. Yes, sir.

The Chairman. And growing out of the experience thus arrived at you undertook to develop a scientific system by which the method of production could be improved, including, among other things, the automatic removal of soldiering by the system itself?

Mr. Taylor. My whole object was to remove the cause for antagonism between the boss and the men who were under him; to try to make both sides friends in the place of tactical enemies. Now, under this old system those men were my personal friends, but when we came to business, the moment that we went thru the gate of that place we were enemies—we were bitter enemies. I was trying to drive them and they were not going to be driven. I told you my early experience in the machine shop perfectly frankly, so as to try and make clear to you the sad and unfortunate mental attitude that accompanies the older type of management.

The Chairman. Now, having developed this system of management by which the advocates of it declare the cost of production is reduced we have already gotten to the point when it is introduced in one shop the owner of which in selling the product will simply sell low enough to secure the trade, and I want to get to the point at which the public at large receives all the benefit that can possibly come thru it.

Mr. Taylor. The time when the public at large gets the benefit?

The Chairman. Yes.

Mr. Taylor. That occurs with absolute certainty when dull times come along, if not before. In the iron and steel business—in the early years of the iron and steel business—when ever dull times came along, so far as my knowledge of it went, with few exceptions, prices fell to such a point that it was not a question of how much money you could make, but how little you must lose. The owners of the steel works and iron works practically all recognized that they must lose a certain amount of money in dull years, and the only question was how small they could make that loss. The competition was so keen during the dull years in the iron and steel business that it brought about this result; on the other hand, when busy times came along, when a good year came again, I have known them to earn right off 50 per cent in profits, and in that way largely make up the losses which came in dull times.

The Chairman. Now, assuming a case like the Midvale steel plant, where, I understand, this system was developed; assuming that the Midvale steel plant had scientific management and thereby reduced the cost of production, when a dull period came would not the fact that the Midvale Steel Co. had this reduced cost of production as compared with other competitors enable them to secure a very much larger share of the contracts, a proportionately larger share of the contracts and the work than they had formerly secured?

Mr. Taylor. That would be the theory, Mr. Chairman, but, as a rule, I think it has been true that your competitor meets your cuts in prices and he is willing to go to the verge of ruination in meeting your cuts, even though he loses more money than you are losing. Even though you may be making a little bit of money while he is losing a great deal of money, he, generally speaking, meets your cut; and that is a very unfortunate part of the competitive feature of industry. That has been an unfortunate feature and has led in the past to the survival of the fittest and to driving of many of the weaker companies to the wall.

The Chairman. Would it not be true, however, under the circumstances described, that if the competitors still continued to hold their share of the business, assuming that the

Midvale Steel Co. were selling at cost and not under cost, it would only be a question of time until the entire capital of the competitors would be used up?

Mr. Taylor. If the dull times went on through a long enough term of years that would be true, but, fortunately, in most cases they did not continue for a great length of time. Fortunately, the dull times, during which you had to sell at low cost, did not last long enough so that many people were entirely ruined, although many of them came out battered and scarred, in bad financial condition, and overloaded with debt, and so on.

The Chairman. Now, assuming that they have not been driven to the wall by the dull times, those who are competitors of the Midvale Steel Co., which we are using as an illustration, and industrial activity and prosperity recurs, would not the same condition, so far as the benefits to the people who are concerned, exist after the restoration of industrial activity as existed prior to the industrial depression, unless the other establishments also introduced a system by which the cost would be reduced?

Mr. Taylor. If I understand you right, I think it would, sir, but I do not know that it is altogether clear in my mind just what you mean. I think I should agree with you that the conditions would return approximately to where they were before the dull times came on. I think that has been the history of it.

The Chairman. Now, it has taken, as I understand, 30 years of development to reach the stage in which scientific management now exists. I believe you made that statement, Mr. Taylor, or words to that effect?

Mr. Taylor. To be exact, I should say 29 years, I can mark the starting of it; it started in 1882; in the fall of 1882, if I remember rightly, the first steps were taken and that would be, perhaps, 29 years and 2 or 3 months.

The Chairman. Now, Mr. Taylor, is it not a fact that when any great improvement in machinery takes place or any system is introduced that requires less men to produce the same material, and while the public ultimately will receive the benefit of the improvement, that until it reaches the time when the public does secure the entire benefit there is a dis-

turbed condition in the trades affected by the improvements and that a readjustment must take place and that the workmen who have been working in that trade or industry have to bear the entire burden until the readjustment does take place?

Mr. Taylor. I think a careful study of the history of the introduction of labor-saving machinery would indicate that the larger part of the benefits from the introduction of new machinery first come to the employers or capitalists and that the workmen who were running the new machines, on the whole, have not, upon the immediate introduction of new machinery, profited to the extent to which they ought to have profited in an increase in wages and a betterment of conditions; that is, not immediately; but without any question, ultimately not only those workmen who are working at the particular trade affected, but all of the collateral workmen affected by it do profit and profit immensely through increased production, which brings more wealth into the world for them to use; but the immediate effect has been that the workmen running the machine have not profited as they should have profited, in my judgment, through the introduction of labor-saving machinery.

And right here I want to point out the essential difference between scientific management and the management of the past. I have never heard that through the introduction of labor-saving machinery any manufacturer, under the old system of management, has insisted, as a part of the introduction of the labor-saving machinery, that his men should be paid from 30 to 100 per cent higher wages than are being paid to the same type of workmen working in similar industries in the immediate neighborhood. Manufacturers have in the past, on the contrary, been very careful to pay their men no higher wages than were paid in competitive industries right around them. In contrast to this, all of those men who are interested in the introduction of scientific management insist that the workmen shall get from 30 to 100 per cent higher wages as their share of this new scheme. The workmen get this great increase in wages right off; they do not have to ask for it—it is voluntarily and gladly given to them. And you

will realize that under the old system of management an increase, say of 50 per cent, in wages could only come as a result of six or eight successful strikes, and that the average workman under the old system would not reach the goal in a lifetime. Now, if you will genuinely investigate—I am not speaking of you personally, Mr. Chairman, because anything you investigate is genuinely investigated, but some of the witnesses who have testified before this committee have not genuinely investigated it—the history of the introduction of scientific management, you will find that it is the truth that the 30 per cent to 100 per cent increase in wages which the workman receives as his share has been carefully awarded him right off; and that marks the difference in the history of the introduction of labor-saving contrivances of all kinds, such as new machinery and improved processes, on the one hand, and the introduction of this new labor-saving device on the other hand, namely, scientific management—a study of the motions of men and the simplification of their movements and acts. The introduction of labor-saving machinery has rarely been accompanied by a direct increase in wages, while the introduction of scientific management has always netted the workman an increase of 30 per cent to 100 per cent in wages.

The Chairman. Stating a hypothetical case, Mr. Taylor, there are something over 700,000 coal miners in the United States, producing approximately 500,000,000 tons of coal; suppose that by the introduction of scientific management or the improvement of machinery, or by any other process, you were able to create conditions whereby 400,000 men produced the 500,000,000 tons of coal, would not the 300,000 men thereby temporarily displaced have to be provided for in some other way until a complete readjustment had taken place?

Mr. Taylor. Most certainly, providing those men were thrown out of a job all at once; but the history of the introduction of labor-saving machinery, as well as the history of the introduction of scientific management, indicates that in no industry is it possible to make any sudden change. In the case of scientific management, if you will read what I have written about it, I have carefully emphasized the fact that even in

the most elementary work to make this great change is a question of not a month, not of a year, but two or three years, even in the most elementary work, and that in an intricate establishment it is a matter of not less than five years before a great increase in the output per man can be made. While the change in the type of management is going on, and while the increase in output per man grows and the cost gradually goes down, the history of the world shows that the world uses more and more of the new materials created. The introduction of labor-saving machinery does not tend to throw men out of work; that is not the history of the industrial world, nor even the history of any individual industry, and I challenge you gentlemen to state a case in which it is not true that the introduction of labor-saving machinery in the end has made work for more men, instead of throwing men out of work. The history of all industries indicates that labor-saving machinery, which enables a man to turn out a larger output, makes work for more men in those industries, and it would do the same thing in the coal trade as in any other trade.

The Chairman. I believe it is generally admitted on all sides that the ultimate cheapening of the cost of production results in a greater consumption of the article and consequently a greater amount of production of the article, but is it not true that that increased consumption is itself a matter of growth; that it does not come suddenly?

Mr. Taylor. Yes, Mr. Chairman, that is true; but a study of industrial history indicates that consumption grows about as fast as production; that is the history of the world, I think. And, Mr. Chairman, as a matter of interest, I would call your attention to a very remarkable book on the law of wages which deals with statistics in the coal trade. This book was recently sent to me, and I have been reading it during the past few days; it shows statistically the effect of the introduction of labor-saving machinery on the wages of workmen in the coal trade, showing that the larger the amount of labor-saving machinery used in the industry the higher the wages. It is a most interesting book called "The Law of Wages," and it was published quite recently. Its author is Mr. A.

L. Moore. I think you will be greatly interested in it, particularly in the conclusions or summaries of the last chapter; it is the most illuminating book statistically on the effect of various elements on wages that I have been able to get hold of.

The Chairman. Notwithstanding the fact that production keeps pace with consumption and consumption, to a certain extent, keeps pace with production, is it not true that when labor-saving machinery is introduced in any industry or any improvement in method introduced which reduces the number of men necessary to produce a given amount of material until the readjustment takes place, that a great many workmen are thrown out of employment and must be absorbed in some other lines until the growth in that line takes them back again?

Mr. Taylor. Yes; I think that is almost universally true. I think, however, it mainly comes about in this way; that the workmen who for years were accustomed to working in a certain way find that the new method of doing the work is irksome to them or sometimes that they are unable to do the work in the new way. These men find themselves not only seriously inconvenienced but they are sometimes brought to actual suffering from this cause; I think the introduction of labor-saving machinery is always accompanied by some unfortunate occurrences of that sort.

The Chairman. Now, then, what method has been developed or evolved by scientific management for taking care of the workmen thus displaced until the readjustment has taken place?

Mr. Taylor. I think I may say that in those establishments in which scientific management has been introduced there is not a single case that I can recall in which, after scientific management was introduced, there were less men employed than before. Not a single case, that is, in which the total number of men employed in the establishment were less than before. Sometimes many of the men who under the old system of management were workmen have been transferred from the working side to the management side, you understand, and in that case there may have been fewer workmen employed. By workmen, I mean those who are

actually doing the work with their hands. But in this case the men who formerly did the work with their hands have been transferred to the management side, they have become teachers, guiders, and helpers. However, I do not think I can mention a single case in which there have been fewer men employed. I believe that in our arsenals, when scientific management will have been introduced, there will be more men at work than formerly; and I believe that in our navy yards the same result will follow. I believe that workmen from the arsenals and the navy yards who have appeared before your committee are laboring under an entire misapprehension as to the results which will follow the introduction of scientific management into the arsenals and into the navy yards, though scientific management has not been, and is not being introduced in the navy yards, according to Secretary Meyer. The results will be just the same there as everywhere else. I say there will be more men employed in the navy yards.

The Chairman. Then it is your belief that if this system of scientific management was universally adopted that no readjustment would be necessary so far as the employment of men is concerned?

Mr. Taylor. Mr. Chairman, there is a very great readjustment which necessarily follows from the very principles of scientific management. As I tried to outline at the beginning of my testimony, these principles involve a very careful study on the part of the management of the capacity and possibilities of each workman, and an entire change in that man's work if it becomes necessary, and it is necessary in most cases, in order to give each man the type of work to which he is best suited. So that scientific management does involve a series of very great changes in the workmen. I know of no system in which the changes are so great, but they almost all involve better conditions and more prosperity for the workmen; they are nine-tenths in the direction of good; they mean better work, higher wages, and more interesting work; those changes tend to make the workmen more efficient and make them into higher types of men. There are changes in plenty, but they are all to the good.

The Chairman. Is it not true that a number

of men who have been eliminated from certain classes because they were considered not to be best suited for that class of work have been principally taken care of by virtue of the fact that the system in itself is only applied in a comparatively small percentage of the work to be done?

Mr. Taylor. Do you mean a comparatively small percentage of the work to be done in the world?

The Chairman. In the community at large?

Mr. Taylor. No, sir. If you will ask me about specific cases that you have in mind, I will tell you what happened to the men who were laid off. For instance, it may be in your mind to know what became of the 400 or 600 workmen in the yard of the Bethlehem Steel Co. that I spoke to you about and who were reduced finally to 140 men. There is a specific case.

The Chairman. In order that you may know what is running in my mind, I will say that I am not so particularly interested in any specific case as I am interested in what would be the general condition if this system was generally applied, and knowing from observation and experience the readjustment that has to take place when labor-saving machinery is introduced and knowing about the hardships that have to be borne by the workmen pending the readjustment, I wanted to find out—and that is what all this line of questioning has been leading up to—whether this scientific management has evolved any method by which the workmen could be taken care of during the period of readjustment.

Mr. Taylor. I have tried to explain that, Mr. Chairman, by saying that under scientific management we make a definite and careful study of each workman in the place; men are appointed in all of these establishments whose chief duty is to make this study of the workmen, of their possibilities and their character, and then to deliberately train each of those workmen to do that work for which he is best fitted. Under this system, then, instead of treating them brutally, they are treated as kindly as we know how. The only case that is at all usual, in which men suffer under this system, is this: there are certain men in all establishments who

are lazy—one may say incorrigibly lazy. Now when such a man as that is found every effort is made to induce him to cease to be lazy and to work as he ought to work, and generally you are successful in this if you will only keep at the man long enough. I have in mind now several cases in which the worst shirkers under the old system have been finally trained men and developed into foremen, under scientific management, because under persistent, firm but kindly treatment, and with hope of advancement before them, they became such energetic men and developed such an interest in their work. But there are a few men who remain, you might say, incorrigibly lazy, and when those men are proved to be unchangeable shirkers they have to get out of the establishment in which scientific management is being introduced. Scientific management has no place for them.

Thereupon the committee adjourned to meet Tuesday, January 30, 1912, at 2 o'clock p. m.

Tuesday, January 30, 1912

The committee met at 2 o'clock p. m., Hon. W. B. Wilson (chairman) presiding.

There were also present Representatives Redfield and Tilson.

The Chairman. Mr. Taylor, what percentage of the increased efficiency under scientific management is due to the systematizing of the work and what per cent to the speeding up of the workman?

Mr. Taylor. In the ordinary sense of "speeding up," there is no increase in efficiency due to that. Using the term "speeding up" in its technical meaning, it means getting the workmen to go faster than they properly ought to go. There is no speeding up that occurs under scientific management in this sense.

The Chairman. How much in the sense in which it has been used—that the workman is required to go faster than he normally did go prior to the introduction of the system? Using it in that sense, what percentage of the increased efficiency is due to the systematizing of work and what percentage to the speeding up of the workmen under the definition which I have given?

Mr. Taylor. That depends, Mr. Chairman, upon the workman and the extent to which the workman was soldiering beforehand—that is, upon whether he was purposely going slow or not. As I have indicated, the amount of soldiering that takes place varies with the varying conditions, and there is no standard or uniform condition with relation to soldiering.

In some trades there is a very great deal of soldiering, in other trades there is less soldiering, so that the question can only be answered in its relation to some specific case. There is no general rule that I know of.

The Chairman. What social or economic necessity is there for speeding up the workman beyond the normal conditions under which he worked before the introduction of these scientific systems?

Mr. Taylor. Again, in its technical sense, there is no "speeding up" that occurs under scientific management. There is merely the elimination of waste movements—the elimination of soldiering, and the substitution of the very quickest, best, and easiest way of doing each thing for the older, inefficient way of doing the same thing; and this does not involve what is known as "speeding up."

The Chairman. If I recall your direct testimony, Mr. Taylor, you have stated that you found a condition of soldiering existing in the plants that you had to do with?

Mr. Taylor. Yes.

The Chairman. Does not your system propose to eliminate that soldiering?

Mr. Taylor. It certainly does.

The Chairman. Who is to determine what constitutes soldiering and what constitutes a proper amount of physical energy to be expended?

Mr. Taylor. The determination of what it is right for the man to do, of what constitutes a proper day's work, in all trades, is a matter for accurate, careful scientific investigation. It must be done by men who are earnest, honest, and impartial, and the standards which are gradually adopted by men who are undertaking this scientific investigation of every movement of every man connected with every trade establishes in time standards which are accepted

both by the workmen and the management as correct.

—The Chairman. Would not an employer be an interested party because he might profit or lose, as the circumstances might be?

Mr. Taylor. I can conceive that a dishonest employer or a heartless employer might very likely desire, in his ignorance of facts, to set a task which was too severe for the workman; but that man would be brought up with a round turn, because he would find that his workmen would not carry out unjust and unfair tasks; and an attempt at injustice on the part of such a man would wind up by his being a complete loser in the transaction. Therefore, the man who attempts any overdriving of that sort would simply fail.

The Chairman. The employer being a profiter by the expenditure of additional energy on the part of the workmen and not having the additional physical discomfort of the workmen to guide him in determining what constitutes a proper day's work, and what is soldiering—in what manner could the workman protect himself against an improper day's work being imposed upon him?

Mr. Taylor. By simply refusing to work at the pace set. He always has that remedy under scientific management; and as you know under scientific management he gets his regular day's pay, whether he works at the pace set or not. When he falls short of the day's work asked of him he merely fails to earn the extra premium of 30 to 100 per cent which is paid for doing the piece of work in the time set.

The Chairman. Assuming an employer having a thousand employees, and conditions being imposed upon a workman requiring him to do more work than he believes he ought to do, and his refusal to do the work because he believed it to be too much, and the other 999 men continue on at work: upon what basis of equality would the employer and employee be under a condition of that kind?

Mr. Taylor. There is no earthly reason, if it is desired by the workmen, why there should not be a joint commission of workmen and employers to set these tasks, not the slightest earthly reason. And, as I think I have told you before, Mr. Chairman, the tasks which are set

in our establishment are universally set or almost universally set by men who have themselves been workmen, and in most cases those who set the daily tasks have come quite recently from doing work at their trades. They have within the last six months or a year or two years perhaps worked right at those trades. They are chosen because they are fair-minded men, competent men, and because they have the confidence both of the management and the workmen. You must remember, Mr. Chairman, in the first place, that under scientific management the workmen and the management are the best of friends, and, in the second place, that one of the greatest characteristics of scientific management—the one element that distinguishes it from the older type of management—is that all any employee working under scientific management has to do is to bring to the attention of the management the fact that he thinks that he is receiving an injustice, and an impartial and careful investigation will be made. And unless this condition of seeking to do absolute justice to the workman exists, scientific management does not exist. It is the very essence of scientific management.

The Chairman. As I understand, then, very frequently those tasks are set by men who have come fresh from the ranks?

Mr. Taylor. Yes, sir.

The Chairman. Over on the side of the management?

Mr. Taylor. Yes, sir.

The Chairman. Now, is it not true that when a man is selected by the management, as a rule, he is selected because they believe in his ability to take care of the interests of the management?

Mr. Taylor. Under scientific management because they believe in his impartiality, his straightforwardness, his truthfulness, and they believe he will have both the confidence of the management and the men, and equally forward the best interests of both sides which are mutual.

The Chairman. Then, to get back to the original point stated by you—that scientific management cannot exist unless there is a complete change of mind—

Mr. Taylor. Yes, sir.

The Chairman. Now, do you conceive that

it is possible to have a complete change of mind when a man is engaged in business for profit?

Mr. Taylor. I do. I say that any set of men who want to earn a big profit in any industry must have that change of mind. If they want to get a big profit, in addition to the fact that any decent man would have that view for good business, if for no other reason, they must have that view. You cannot keep men working hard on one side and not have them work equally hard on the other side. If you want a profitable business you cannot have meanness and injustice on one side or the other; you have got to eliminate meanness and injustice from both sides.

The Chairman. I believe you stated that after all the other things had been paid for, if there was a certain surplus that was left, you included in that surplus a profit for the workmen and a profit for the employer?

Mr. Taylor. Yes, sir.

The Chairman. Taking that as a basis, would there not immediately arise a contention between the employee and the employer as to what portion each should receive?

Mr. Taylor. I will say that in my experience under scientific management no such contention has arisen, because the workmen who have come under my observation, and who came under scientific management, looked upon 30 to 100 per cent increase in wages, which they were paid for performing their share of the contract, as full recompense for the work which they were doing; and I do not remember that personally I have ever had a workman seriously question the justice of that percentage. I can very well imagine that in the future, with the growth of the industrial world, with the betterment of the whole world, that those percentages may become wrong and that the workman ought to have a larger share. And, if he ought to have it, he will get it under scientific management.

The Chairman. Is it not true that the very essence of scientific management is that there must be one directing head in an establishment, and that no association of workmen can be permitted to interfere with the directions and with the policy of that directing head?

Mr. Taylor. Interfere, yes; cooperate, no.

The cooperation of the workmen is asked for in every possible way in which you can get it; interference is never tolerated.

When you once get a correct standard established, when, by way of illustration, you have got your train schedule made out, and the trains are going to move, no one is allowed to interfere with the movements of those trains; but if any set of men think the schedule is wrong, that there is a better schedule, all that they have to do is to call the attention of the management to a defect in the schedule and they will correct it. And, let me tell you, Mr. Chairman, that nine-tenths of the improvements that have come under scientific management have come from this friendly cooperation on the part of the workmen with the management. Almost all of the best suggestions for improvements come from intelligent workmen who are cooperating in the kindest way with the management to accomplish the joint result of producing a big surplus which can be divided between the two sides equitably.

The Chairman. And must not that cooperation be entirely in accordance with the judgment and direction and policy of the directing head under scientific management?

Mr. Taylor. No, sir; most emphatically no. Scientific management has developed over a period of 30 years a series of standards which are recognized by both workmen and management as being just and fair. I have tried to point out in my testimony examples of those standards, and I can point out if you wish it a thousand more—standards which are accepted as the just and fair laws of that establishment by both sides. And the president of one of these companies would no more think of interfering with those laws than the workman would.

The Chairman. In what percentage, if any, of those establishments that have come under your observation where scientific management has been introduced has collective bargaining been introduced, by which the workmen collectively become a party in determining the wages, the task, and the conditions under which they shall work?

Mr. Taylor. Under the old sense of collective bargaining, I know of no single instance in which that has been used under scientific

management. That is in the old sense of collective bargaining.

In the new sense of collective bargaining it is done in every establishment in which scientific management exists. During my first day's testimony I tried to make it clear that under the old system of management a very large part of the time and thought of both those on the management side and of the workmen was devoted to securing each for its own side what it looked upon as its proper share of the surplus. I use this word "surplus" as defined by me in my first day's testimony.

Now, a manufacturer who is an unjust man (and that frequently is the case—no more frequently is the manufacturer unjust, however, than is the workman unjust) when the manufacturer is unjust toward his men, without collective bargaining under the old system of management he has the power to secure more than his fair share of this surplus. Therefore, in many establishments under the ordinary system collective bargaining has become and is in my judgment an absolute necessity.

Under the old system of management (not scientific management) the attitude assumed in nine cases out of ten by the leaders of the workmen on the one hand and by the management on the other, is that of semihostility. It is an attitude the existence of which prevents the full measure of cooperation which should exist between both sides in order to produce the largest and best results, and whenever this attitude exists collective bargaining is a necessity.

Now, the moment this attitude of hostility or semihostility between the two sides is abandoned, and the moment it becomes the object of both sides jointly to arrive at what is an equitable and just series of standards by which they will both be governed; the moment they realize that under this new type of cooperation—by joining together and pushing in the same direction instead of pulling apart—they can so enormously increase this surplus that there will be ample for both sides to divide; then collective bargaining instead of becoming a necessity becomes of trifling importance. In all establishments working under scientific management it is always understood that any single workman or any four or five or six workmen can at any time

call to the attention of the management the fact that any element in the management is wrong and should be corrected, and this protest will receive immediate and proper attention. And what I want to emphasize is that the kind of attention which any protest from the men receives under scientific management is not that which is subject to the personal prejudice or to the personal judgment of the employer, but it is the type of attention which immediately starts a careful scientific investigation as to all of the facts in the case, and this investigation is pursued until results have been obtained which satisfy both sides of the justice of the conclusion. Under these circumstances, then, collective bargaining becomes a matter of trifling importance. But there is no reason on earth why there should not be a collective bargaining under scientific management just as under the older type, if the men want it:

The Chairman. If collective bargaining is satisfactory under the conditions first described by you in order to get a proper division of the surplus, because the division of that surplus affects both the employer and the employees, would it not also be just as essential that there should be collective bargaining relative to conditions under which the workmen should work, because those conditions affect both the employer and the employee.

Mr. Taylor. I should make the same answer to this question as I did to the last: that all that is necessary under true scientific management is for the attention of the management to be called to the fact that a bad condition exists to have a scientific investigation started, the results of which should be satisfactory to both sides.

The Chairman. If the satisfactory handling of scientific management depends on the ideal condition of mind whereby the employer is willing to concede to the workmen that which each workman is entitled to, how, under the other phases of scientific management, is the workman going to be able to protect himself against imposition by any other process than that of collective bargaining?

Mr. Taylor. I think I have already stated, Mr. Chairman, that the workman has it in his power at any minute, under scientific manage-

ment, to correct any injustice that may be done him in relation to his ordinary every day work by simply choosing his own pace and doing the work as he sees fit. That remedy lies open to him at any minute, and the workman will do it every time he is treated unjustly under scientific management, just as he would under any other management. In other words, injustice on the part of the employer would kill the goose that lays the golden egg.

The Chairman. Would not your suggestion of cooperation on the part of the workman with the management (the management being the sole and arbitrary judge of the issue) be very much like the lion and the lamb lying down together with the lamb inside?

Mr. Taylor. Just the opposite. The lion is proverbial of everything that is bad. The lion is proverbial of strife, arrogance—of everything that is vicious. Scientific management cannot exist in establishments with lions at the head of them. It ceases to exist when injustice knowingly exists. Injustice is typical of some other management, not of scientific management.

The Chairman. Mr. Taylor, do you believe that any system of scientific management induced by a desire for greater profit would revolutionize the minds of the employers to such an extent that they would immediately, voluntarily, and generally enforce the golden rule?

Mr. Taylor. If they had sense they would. And let me tell you, Mr. Chairman, that that is the best answer. Not immediately. I have never said that. You cannot persuade any set of men, employers or employees, to adopt the principles of scientific management immediately. I have always said that it takes a period of from two to five years to get both sides completely imbued with the principles of scientific management. And I have further said, which I wish to repeat and emphasize, that nine-tenths of the trouble comes from those on the management side in taking up and operating a new device, and only one-tenth on the workmen's side. Our difficulties are almost entirely with the management.

The Chairman. Is it not true that scientific management has been developed with a desire to cheapen the production in order that there might be greater profits?

Mr. Taylor. Mr. Chairman, in one of the

books which I have written on scientific management, in paragraph 21, page 1343, in the paper-covered pamphlet entitled "Shop Management," and which is in the possession of the Chair, in large print—and I believe this is perhaps the only paragraph in that whole book written in this very large print—is emphasized this fact:

This paper is written mainly with the object of advocating high wages and a low labor cost as a foundation of the best management and of pointing out the general principles which render it possible to maintain these conditions, even under the most trying circumstances, and of indicating the various steps which the writer thinks should be taken in making a change from a poor system to the better types of management.

The Chairman. In the same book, Mr. Taylor, do you not undertake to show that high wages are brought about by taking a workman who has been employed at a lower-priced class of work and putting him at work on a portion of the work formerly performed by the high-class workman and then giving him a higher rate of wage than he had before in the lower class of work, and yet a lower rate than was actually paid to the skilled workman who performed that work prior to that time?

Mr. Taylor. I have pointed out that under the principles of scientific management, with the teaching and kindly guidance which the workmen receive from the teachers who are over them; who are helping them in the management—with the high standards which are placed before them and taught to them; with the better methods of doing work (which are gradually developed through the joint efforts of hundreds of men) I have pointed out that when any workman of any caliber receives this unusual training and is given these unusual opportunities, that he is thereby enabled to do a higher and a better and a more interesting and finally a more remunerative class of work than he would be able to do under the old system of management, and that when he did this higher class of work he was paid a higher day-work

wage. That is, his wages were first advanced beyond the price he had received in the past, and that, in addition to this advance, he received daily a premium of from 30 to 100 per cent for carrying out the instructions which are daily given to him.

And this applies not only to those workmen who do the cheaper kinds of work, but to all workmen high and low. For example, a man who under the old system of management has only sufficient brains to sweep the floor, under scientific management is taught and trained and helped so that he finally learns how to use, say, a grinding machine or to do some of the more elementary kinds of machine work. He is taught to do a class of work which is far more interesting and requires more brains than the sweeping to which he was formerly limited. And he is then given the higher wages and the interesting conditions and surroundings which accompany this higher class of work. At the same time the man who was under the old system on the grinder is taught to do some of the simpler kinds of "high-class machine work." Of course you understand I am speaking now of types of men who under the old system were limited by their mental capacity to simple work such as running a grinder; I am not speaking of the exceptional man who was born with plenty of brains to do high-class work, but who did not have the good fortune to learn a trade when he was young; but I am speaking of the man whose mental caliber would naturally limit him to sweeping the floor or running a grinder. Now, to continue the illustration, the drill-press hand, for instance, by this same teaching and training, is enabled to do the work of the lathe hand, and the lathe hand is enabled to do the work of the high-priced tool maker or a man of that mental caliber.

You understand I am not speaking literally; I am speaking by way of example. And finally the tool maker becomes one of the teachers to show the men lower down all along the line how to do their work—to show them and teach them and guide them in their work. Now, this upward movement of all the men is not confined to any one class; it applies to all types of workmen. They all rise to a better class of work and to higher pay under scientific management.

The Chairman. Take the illustration, for instance, of a man of the mental caliber of a common laborer and who is employed as a common laborer. What were the rates paid, say, at Midvale, under scientific management to the common laborer as compared with the wages paid to the common laborer under the ordinary management by the United States Steel Corporation at Pittsburgh?

Mr. Taylor. The wages of common laborers when I was at the Midvale Steel Works (and I left there in 1889) ranged from \$1.20 per day to \$2.70 per day, with piecework added.

The Chairman. From \$1.20 to \$2.70 per day?

Mr. Taylor. Yes. In other words, under scientific management there is no standard or uniform rate of pay for laborers, nor for any other group or class of men. And I want to emphasize this fact, Mr. Chairman, which does not seem to be at all recognized by the world at large, that workmen differ just as much as horses differ. Now, we all know that there is a vast difference in horses. I do not mean anything degrading to the workman by this comparison, but I dare say some one will say that I am comparing workmen to beasts. We all know that horses differ, and yet very few people seem to recognize that there is an even greater difference between different members of the human species. There is just as much difference between laborers as there is between horses. I think I can say with truthfulness that the laborers to whom we paid \$2.75 a day at the Midvale Steel Works quite as fully earned their high wages as did the cheaper men who were only paid \$1.20 per day.

The Chairman. This man at \$2.70 a day, how many hours does he have to work?

Mr. Taylor. Ten hours.

The Chairman. Is that the usual time of work?

Mr. Taylor. Yes, sir; 10 hours per day, with the exception of certain departments of the plant, in which it is impossible to shut the apparatus down. For instance, the open-hearth furnace department. As we all know, it is as impossible to shut down an open-hearth furnace as it is to stop the sun from setting. It takes a week to shut down an open-hearth

furnace. So that particular department in our works (and if I remember rightly it was the only department in the Midvale Steel Works that ran right straight through the year) the open-hearth furnace, ran and always will have to run, right straight through, night and day, although the work was so arranged that it was rarely necessary to pour a heat on Sundays, so that the smallest possible number of men were kept at work in the department on Sunday. Now, in this department there were two 12-hour shifts at work. I say 12 hours because there were practically two shifts of 12 hours each to run these furnaces. And I can say, that for the whole time that I was at the steel works, it was a matter of the very gravest concern to all of the managers that there seemed to be no way of doing away with the 12-hour shifts under scientific management. But it was made easier in this way—that is, this practice was made justifiable to a certain extent in this way—that the task of the men running that—that the tasks which were given to the men who worked on 12-hour shifts were made lighter than the tasks given to the men running on 10-hour shifts. But that does not make the necessity for these long hours of work any the less unfortunate. And I used to regret this necessity the whole time I was at this works; it was a matter of great concern. Time and again we consulted as to the possibility of introducing 8-hour shifts in the place of 12 hour shifts, and since I left there I understand that this has been tried, and that the workmen themselves seriously objected to it, and preferred to go back to the old 12-hour shift. This is merely hearsay, however, what other people have told me, and therefore is not given as of my own knowledge. But I understand the workmen themselves said that when they boarded in houses with other people and had to have different mealtimes and sleeping hours, working partly in the daytime and partly at night, so that they had to have their meals in the middle of the afternoon or middle of the night (when no one else took their meals), they looked upon it as a hardship, and my impression is that the eight-hour shift, after being tried, was abandoned. On that point I am not sure, however, Mr. Chairman.

The Chairman. How do those conditions compare with the conditions existing at the same time at the United States Steel plant?

Mr. Taylor. The conditions in many of the plants of the United States Steel Co. are and always have been deplorable—deplorable to the greatest extent. Now, I do not wish to be understood as criticizing the managers of these steel works. I think a great many of the men in that business recognize the very deplorable state of things that exists there; and certainly there are now deplorable, if not shameful, conditions existing in the steel business. I say this most heartily. As far as possible, that sort of conditions would not be tolerated under the principles of scientific management. I have heard of many cases where year in and year out men have worked with almost no vacation and very little lay off, and that is inhuman; it is impossible.

The Chairman. You consider it to be one of the essential features of scientific management that a time study must be made with a time-piece, such as a stop watch, in order to determine the length of time that a piece of work can be done in, to hereby give a knowledge of it.

Mr. Taylor. I know of no other way of determining how fast work ought to be done than by timing the workman, Mr. Chairman. As long as time remains one of the most important elements (and in the past most of the disputes between employer and employee have been connected with the question of how long it should take to do the work), I fail to see how you are to know anything about time without timing. I know of no way of getting any accurate knowledge in this field except by watching a man who is doing the work at the proper speed and recording his time. The old way of guessing as to how fast a man ought to do a thing (and that is the way I did, as I explained to you, when I was a foreman under the old system of management) is most unsatisfactory as to both sides. This old-fashioned guesswork is quite as unsatisfactory to the workmen as to those on the management's side.

The Chairman. Under your system, when you have made a time study with a stop watch, do you then take the exact time that you have

found by the stop watch and say that is the time in which the work must be done?

Mr. Taylor. No, sir; never. We first take a good man, not a poor man—we always try to take a man well suited to his work. We then assure ourselves that that man is working at a proper rate of speed; that is, that he is not soldiering on the one hand, and that on the other hand, he is not going at a speed which he cannot keep up year in and year out without undue exertion. We then determine as accurately as we know how the proper speed for doing the work, by timing the man with a watch, and having determined that, then we add a marginal percentage of time to cover unavoidable delays and accidents, and, in many cases, we make an extra allowance when the workman who is called upon to do this particular job is not especially skilled at it.

For illustration, Mr. Chairman, to show you what I mean by this marginal allowance, suppose you were asked in a shop to turn axles for a standard railway car. This is a piece of work which as you know is done by the thousand, and done year in and year out; and now that the railway master mechanics of the country have established a standard car axle, the conditions have become uniform for doing this piece of work. We will assume that a company is going into the manufacture of these axles as a regular business, and that they propose having men working on these axles year in and year out. The time study would be made first to determine the quickest time in which the axle ought to be machined. By the quickest time—I do not mean any improper time—but the quickest proper time in which that work could be done by the workmen if they did not have the slightest interruption or delay or anything of that sort. And after having determined this time, then 20 to 27 per cent of that time is added to cover unavoidable delays and all such accidents as may happen to a workman. That 20 to 27 per cent has been found, from long experience, to give the workman plenty of time to overcome those little unavoidable delays and interruptions which interfere with his work. This allowance has been generally accepted by the workmen as correct, and I have never heard this allowance disputed as incorrect.

If you were to take that same axle, for instance, where only 10 or even 100 axles were to be turned in a shop, you would in this case have to allow as much as 70 per cent additional time to the man. This is because you cannot expect a workman to go right at a job which is new to him and do everything just right and at the same speed which he could readily maintain after having more practice.

In some other classes of work it has been my habit to add as much as 225 per cent to the time in cases similar to the one I have described. I think that is the highest per cent that we have been accustomed to add to the “quickest reasonable time” in which the work might be done.

The Chairman. By what scientific formula or mathematical calculation did you arrive at an addition of 20 to 27 per cent to the time which you have determined by that stop watch?

Mr. Taylor. We have done that through a very careful study—and this study has been repeated over and over and over again—of workmen well suited to their particular jobs. They were told, “Now, men, we want to arrive at a proper allowance for unavoidable accidents and delays, and I want you to cooperate with me.” This is the way we talk to the workmen when we propose to make a time study in ninety-nine cases out of a hundred—“I want you to cooperate with me in arriving at the truth regarding this fact. Now, go right ahead and do the work as it ought to be done. I want to know what time it will take, first, to turn the axle, and then I want to see what is the proper allowance to make for unavoidable accidents and delays.” We would then watch and time that man, not for one axle alone, but frequently for days at a time, until finally we would both agree as to what was the proper time. During this time we would watch, of course, carefully to see whether he had not perhaps forgotten something—had not slipped off the track and was making some unnecessary motions, and then as a result of this careful joint study between the workman and the management the proper percentage allowances are accurately determined. You see that it is joint, because both sides cooperate; we have one man who is watching and records the time, and the other man who works,

and both are in entire accord and working for the same object, so that it is a joint affair. That is typical of the way we arrive at all percentages.

The Chairman. Is not that 20 to 27 per cent arbitrarily arrived at by the judgment of a person watching the operation, of the time that should be added?

Mr. Taylor. No, sir; not the arbitrary judgment of anyone. An arbitrary judgment would be something that a man guessed at. But this is a scientific investigation, a careful, thorough scientific investigation of the facts. It is based on the fact that in perhaps as many as 20 cases, with different men on this general type of work, this figure has been proved to be correct. This is not founded on any one judgment; it is based on facts.

The Chairman. Is it not true that under the old system, in determining the length of time that it would take to produce a certain piece of work, that it was based upon the observations of some man relative to that work over a long period of time, and would not that be just as scientific and just as arbitrary as the method employed in securing this 20 to 27 per cent?

Mr. Taylor. No, sir. I suppose, as I walk along the street, for example, I could in a general way look at a trolley car and say it is going at the rate of 8 miles an hour, or 10 miles an hour; but that kind of arbitrary judgment would not compare in accuracy with timing the car with a watch. Watching horses when they are trotting by and guessing at their speed would not be anything like as trustworthy as that kind of observation which comes from the use of a stop watch. The one is guesswork, while the other is a careful scientific experiment.

For instance, when I was a foreman, as I told you, the workmen knew ten times as much as I did about how long it took to do work. Their knowledge was exact, because they looked at the time when they started a job and at the time when they stopped and knew exactly how long it had taken them. My knowledge was casual; I had in a general, hazy way, an idea that a job ought to take such and such a time; but I have seen myself judge from 300 to 400

per cent wrong, and I think that is true of all foremen.

The Chairman. Isn't it part of the scientific management, or the Taylor system, to bring all of the power of the management to bear on the individual in order to compel the individual to carry out the policy of the management?

Mr. Taylor. With the first man whom you tackle in a shop and want to teach and bring from the old method of doing the work to the new method, as a rule, I think you can say that you do bring heavy pressure to bear on the man. You are very apt to put three or four teachers around him at once to see that he does not skip out from under anywhere. You understand, of course, that is true of the first man. Under scientific management our procedure is to get one man working under the new conditions and at the proper pace, and then let him go right on earning his premium of 30 per cent to 100 per cent until he wants the new system badly. And invariably some friend of his—generally not one friend only, but a dozen of them—will come and ask for the same thing. When the men see a friend of theirs, right alongside of them, working practically no harder than they are working, but merely obeying certain instructions and directions given him and thereby becoming more efficient and doing the work quicker—when they see that man getting 30 to 100 per cent higher wages than they are getting, they want some of that velvet. The other men throughout the shop themselves come and ask for the new system. When scientific management is properly introduced, almost invariably we wait for the men to come and ask to work under the new plan.

The Chairman. When the power of the management is brought to bear on the individual workman, while time study is being made, would not the time study itself be inaccurate because of the abnormal conditions created by that power being brought to bear on the individual workman?

Mr. Taylor. Mr. Chairman, I have said before that in nine hundred and ninety-nine cases out of a thousand it has been our practice to have the workman cooperate with us in the most friendly manner in making this time study. The workman is just as much a part of this

time study, and a voluntary part of this time study, as we are a part of the time study. I say "we," meaning those of us who are on the management side. An effort is first made to get a workman to realize that this is the road toward high wages. And when he realizes that and knows that we must have a time study as a just and substantial foundation for both sides he is not opposed to time study, but consents to it with the greatest alacrity. We have had hundreds of men come and ask us to make a time study of their particular jobs.

The Chairman. Is it not true, under those circumstances, that a failure to cooperate means that his ability to earn a livelihood has been completely destroyed, or cut off to the extent of 100 per cent, while he realizes at the same time that his employer's earning ability is not altered; that a disagreement might continue as far as the employer is concerned, while it would mean starvation to him?

Mr. Taylor. I must say, Mr. Chairman, that I do not exactly catch your meaning; I do not think I understand you.

The Chairman. I will give you an illustration. Suppose, as I suggested to you some time ago, that there is an employer with 1,000 employees, and he deals with them individually, as this method proposes. The conditions are not satisfactory to the workmen. They are to the employer. The conditions made by the employer are satisfactory to him, but if the workman refuses to accept the unsatisfactory conditions his power to provide for himself and his family has been destroyed to the extent of 100 per cent; but the 999 of the employees continuing at work, the power of the employer to earn a profit has practically not been reduced at all. Now, you have on the one side the employee with no employment to earn a livelihood to live upon and starvation staring him in the face thereby, and on the other hand the employer continuing to produce the same profit that he formerly produced. Now, would not the disagreement under those circumstances simply result in the necessities of the workman ultimately compelling him to accept the terms of the employer?

Mr. Taylor. Mr. Chairman, my observation is that in very dull times, when there is a lack

of employment for good men in trades—those times come occasionally—at that time an unscrupulous employer might have an advantage. The unscrupulous employer, under those conditions, might have a very distinct advantage over the workmen. My observation, however, of the ordinary normal times in the United States is that a good workman need never be out of employment for five days. There is an immense demand for competent workmen in this country, in all normal times. I cannot recall in normal times a single instance of a good workman having to come anywhere near starvation because of lack of employment. There is always an immense demand for good workmen, so that the condition does not exist which you have outlined.

The Chairman. Is it not true that a man who is not a good workman and who may not be responsible for the fact that he is not a good workman, has to live as well as the man who is a good workman?

Mr. Taylor. Not as well as the other workman; otherwise, that would imply that all those in the world were entitled to live equally well whether they worked or whether they were idle, and that certainly is not the case. Not as well.

The Chairman. Under scientific management, then, you propose that because a man is not in the first class as a workman that there is no place in the world for him—if he is not in the first class in some particular line that he must be destroyed and removed?

Mr. Taylor. Mr. Chairman, would it not be well for me to describe what I mean by a "first-class" workman. I have written a good deal about "first-class" workmen in my books, and I find there is quite a general misapprehension as to the use of that term "first-class."

The Chairman. Before you come to a definition of what you consider a first-class workman I would like to have your concept of how you are going to take care, under your scientific management, of a man who is not a first-class workman in some particular line?

Mr. Taylor. I cannot answer that question until I define what I mean by "first-class." You and I may have a totally different idea as to the meaning of these words, and therefore I suggest that you allow me to state what I mean.

The Chairman. The very fact that you specify "first-class" would indicate that in your mind you would have some other class than "first class."

Mr. Taylor. If you will allow me to define it I think I can make it clear.

The Chairman. You said a "first-class" workman can be taken care of under normal conditions. That is what you have already said. Now, the other class that is in your mind, other than "first class," how does your system propose to take care of them?

Mr. Taylor. Mr. Chairman, I cannot answer that question. I cannot answer any question relating to "first-class" workmen until you know my definition of that term, because I have used these words technically throughout my paper, and I am not willing to answer a question you put about "first-class" workmen with the assumption that my answer applies to all I have said in my book.

The Chairman. You yourself injected the term "first-class" by saying that you did not know of a condition in normal times when a "first-class" workman could not find employment.

Mr. Taylor. I do not think I used that term "first-class."

Mr. Redfield. Mr. Chairman, the witness has now four times, I think, said that until he is allowed to define what he means by "first-class" no answer can be given, because he means one thing by the words "first-class" and he thinks that you mean another thing.

The Chairman. My question has nothing whatever to do with the definition of the words "first-class." It has to do with the other class than "first-class," not with "first-class." A definition of "first-class" will in no manner contribute to a proper reply to my question, because I am not asking about "first-class," but the other than "first-class" workmen.

Mr. Taylor. I cannot describe the others until I have described what I mean by "first class."

Mr. Redfield. As I was saying when I was interrupted, the witness has stated that he cannot answer the question for the reason that the language that the chairman uses, namely, the words "first-class" do not mean the same

thing in the chairman's mind that they mean in the witness's mind, and he asks the privilege of defining what they do mean, so that the language shall be mutually intelligible. Now, it seems to me, and I think it is good law and entirely proper, that the witness ought to be permitted to define his meaning and then if, after his definition is made, there is any misunderstanding, we can proceed.

The Chairman. It seems to me, Mr. Redfield, that having said a "first-class" workman could be taken care of under normal conditions, it was perfectly proper for me to ask the question of how to take care of those who are not "first-class" workmen under scientific management, and that a reply to a question of that kind does not involve the necessity of defining what is "first-class."

Mr. Tilson. It seems to me, Mr. Chairman, that you are entirely in error, because the very term you are asking him to describe is described by negative words, including the words "first class;" that is, not a "first-class" workman, but workmen other than "first-class." Therefore, in order to get at the other class, it seems to me not only improper, but if he means something else by the words "first-class" than you mean, it seems to me it would be very necessary for him to describe what "first class" is, so that you could get at the negative of that and know what to subtract from the sum total. If you want to know what is not "first-class," you ought to know what is "first-class" so that you would know what to subtract.

Mr. Taylor. Mr. Chairman, I want to assure you that I am not quibbling. Not for an instant am I quibbling; and if you will allow me to proceed with the definition, I think you will see that it is a matter of great importance, because I have used the words "first-class" throughout my book.

And I wish to say, Mr. Chairman, that both of these books were written to be presented to the American Society of Mechanical Engineers. I had that in view, both in writing the book on Shop Management and the Principles of Scientific Management.

Now, the American Society of Mechanical Engineers is perhaps the most rigid society in this country in insisting on conciseness in writ-

ing—in insisting on having what is to be presented to them placed in the fewest possible words, and this book on Shop Management has received no end of criticism from the members of the Society of Mechanical Engineers, because from their standpoint it was too verbose; yet in the original form in which I wrote this book it was three times as voluminous as it now is, and in my endeavor to make it sufficiently concise for acceptance by the society, I was compelled to omit definitions of words and of expressions which were important to a proper understanding of the book. And among the expressions which for this reason have not been properly defined are the words “first-class men.” My other book, which is in the hands of your committee, “The Principles of Scientific Management,” much more nearly expresses my exact views, because in this book I absolutely refused to make it so concise as to emasculate its meaning, and for this reason, although the society held this manuscript for a year and asked me again and again to condense it, they finally refused to publish it.

I have found that an illustration often furnishes the most convincing form of definition. I want therefore to define what I mean by the words “first class” through an illustration. To do so I am going to again use “horses” as an illustration, because every one of us knows a good deal about the capacity of horses, while there are very few people who have made a sufficient study of men to have the same kind of knowledge about men that we all have about horses. Now, if you have a stable, say, in the city of Washington, containing 300 or 400 horses, you will have in that stable a certain number of horses which are intended especially for hauling coal wagons. You will have a certain number of other horses intended especially to haul grocery wagons; you will have a certain number of trotting horses; a certain number of saddle horses—of pleasure horses, and of ponies in that stable.

Now, what I mean by a “first-class” horse to haul a coal wagon is something very simple and plain. We will all agree that a good, big dray horse is a “first-class” horse to haul a coal wagon (a horse, for instance, of the type of a Percheron). If, however, you live in a small town

and have a small stable of horses, in many cases you may not have enough dray horses in your stable to haul your coal wagons, and you will have to use grocery-wagon horses and grocery wagons to haul your coal in; and yet we all know that a grocery-wagon horse is not a “first-class” horse for hauling coal, and we all know that a grocery wagon is not a first-class wagon to carry coal in; but times come when we have to use a second-class horse and wagon, although we know that there is something better. It may be necessary even at times to haul coal with a trotting horse, and you may have to put your coal in a buggy under certain circumstances. But we all know that a trotting horse or a grocery horse is not a “first-class” horse for hauling coal. In the same way we know that a great big dray horse is not a “first-class” horse for hauling a grocery wagon, nor is a grocery-wagon horse first class for hauling a buggy, and so on, right down the line.

Now, what I mean by “first-class” men is set before you by what I mean by “first-class” horses. I mean that there are big powerful men suited to heavy work, just as dray horses are suited to the coal wagon, and I would not use a man who would be “first-class” for this heavy work to do light work for which he would be second-class, and which could be just as well done by a boy who is first class for this work, and vice versa.

What I want to make clear is that each type of man is “first-class” at some kind of work, and if you will hunt far enough you will find some kind of work that is especially suited to him. But if you insist, as some people in the community are insisting (to use the illustration of horses again), that a task—say, a load of coal—shall be made so light that a pony can haul it, then you are doing a fool thing, for you are substituting a second-class animal (or man) to do work which manifestly should be done by a “first-class” animal (or man). And that is what I mean by the term “first-class man.”

Now, there is another kind of “second-class” horse. We all know him. Among the “first-class” big dray horses that are hauling coal wagons you will find a few of them that will balk, a few of them that can haul, but won’t haul. You will find a few of these dray horses

that are so absolutely lazy that they won't haul a coal wagon. And in the same way among every class of workmen we have some balky workmen—I do not mean men who are unable to do the work, but men who, physically well able to work, are simply lazy, and who through no amount of teaching and instructing and through no amount of kindly treatment, can be brought into the “first-class.” That is the man whom I call “second-class.” They have the physical possibility of being “first-class,” but they obstinately refuse to do so.

Now, Mr. Chairman, I am ready to answer your question, having clearly in mind that I have these two types of “second-class” men in view; the one which is physically able to do the work, but who refuses to do it—and the other who is not physically or mentally fitted to do that particular kind of work, or who has not the mental caliber for this particular job. These are the two types of “second-class men.”

The Chairman. Then, how does scientific management propose to take care of men who are not “first-class” men in any particular line of work?

Mr. Taylor. I give it up.

The Chairman. Scientific management has no place for such men?

Mr. Taylor. Scientific management has no place for a bird that can sing and won't sing.

The Chairman. I am not speaking about birds at all.

Mr. Taylor. No man who can work and won't work has any place under scientific management.

The Chairman. It is not a question of a man who can work and won't work; it is a question of a man who is not a “first-class” man in any one particular line, according to your own definition.

Mr. Taylor. I do not know of any such line of work. For each man some line can be found in which he is first class. There is work for each type of man, just, as for instance, there is work for the dray horse and work for the trotting horse, and each of these types is “first-class” for his particular kind of work. There is no one kind of work, however, that suits all types of men.

The Chairman. We are not in this particu-

lar investigation dealing with horses nor singing birds, but we are dealing with men who are a part of society and for whose benefit society is organized; and what I wanted to get at is whether or not your scientific management had any place whatever for a man who was not able to meet your own definition of what constitutes a “first-class” workman.

Mr. Taylor. Exactly. There is no place for a man who can work and won't work.

The Chairman. It is not a question of a man who can work and won't work; it is a question of a man who doesn't meet your definition of “first-class” workmen. What place have you for such men?

Mr. Taylor. I believe the only man who does not come under “first-class” as I have defined it, is the man who can work and won't work. I have tried to make it clear that for each type of workman some job can be found at which he is “first-class,” with the exception of those men who are perfectly well able to do the job, but won't do it.

The Chairman. Do you mean to tell the committee that society is so well balanced that it just provides the proper number of individuals who are well fitted to a particular line of work to furnish society with the products of that line of work?

Mr. Taylor. Certainly not, Mr. Chairman. There is not a fine balance in society. It is sometimes difficult to find jobs right near home for which men are well suited, that is, for which they are “first-class.” There is an immense shortage of men, however, who are needed to do the higher classes of work. There always has been and always will be, an immense shortage near the top. It is not so great down below, but at the top there is an immense shortage of “first-class” men, so that there is plenty of room for men to move up.

The Chairman. If society does not produce an equal balance in all the lines of production of “first-class” men, must there not of necessity be some men who are not “first-class” in any particular line of work where they can secure employment?

Mr. Taylor. I do not think there is any man, as far as I know, who is physically fitted for work, who in this country has to go without

work in ordinary times. I do not know of this case except in very dull times.

The Chairman. Is it not true and generally recognized by statisticians, that there are at all times from 1,000,000 to 4,000,000 workmen in the United States who are willing to work but unable to secure it?

Mr. Taylor. I do not believe that is true in busy times at all. There are many times, however, in which men cannot secure the exact work which they want right close to where they live.

The Chairman. Is it not true in times generally?

Mr. Taylor. I am not familiar with the statistics; it is merely an impression on my part, and from the difficulty I have had personally in getting men I should say that it was not true. I can point to a company right now, in Connecticut, the owner of which told me that all through these dull times he had had employment for 25 per cent more people than he could get.

The Chairman. This 25 per cent would be people well suited to that particular line of work, I take it?

Mr. Taylor. It is the American Pin Company. I only went through there once, and I do not know the type of the men that he wanted well enough to judge what was in his mind, but that was his difficulty.

The Chairman. Is it not true that today there is a shortage of men, and that there frequently is a shortage of men for the higher skilled trades, while at the same time men who have not acquired that skill are unable to find employment?

Mr. Taylor. I think there is a shortage of men for the very high classes of work in the dullest of dull times, but not that same shortage of men in the very elementary kinds of work, in dull times. I think that is right, Mr. Chairman. I think that I catch your point, Mr. Chairman—that working people frequently suffer because they are unable to find the particular kind of work that they want and I agree with you in this. We who are engaged in creative industries—the industries in which you and I have worked during our lives—fail to realize the fact that those men who are in creative in-

dustries are a small minority of the whole community. Perhaps 17 per cent (I think I am right) of the people of the country are in what may be called creative industries.

Now, there is a very large outside field of work for people to go into, and in this outside field it is an undoubted fact that the selection of workmen and that the training of workmen is not nearly as accurate as it is in the industrial field. You will realize that in domestic employment and in the farm work, and in the ordinary work of sweeping the streets of the cities, for instance, the ordinary work that goes on largely in an isolated way all over the country—that the same careful selection of workmen is not made as occurs in the industrial field. The same study of workmen is not made in those occupations as in the trades at which you and I have worked.

Now, when dull times come, in some one or more of the creative industries, and men who have learned a trade are thereby temporarily thrown out of work, there is no doubt that these men suffer hardship. They are very loathe to work at anything else than their trade and many of them will suffer a good deal before they turn to employment in the great field that I have spoken of, which is outside of the creative industries. In some part of this field, there is practically at all times a demand for men which is not supplied, but this demand is often at a distance from the man who is out of work, and the man out of a job does not know of its existence. In making this readjustment there is undoubtedly suffering.

There is the other class of men whom I have spoken of who suffers (and I think properly suffers), namely, the man who can work but refuses to do a proper day's work.

If I gather rightly you have in mind both of these classes of men. Sooner or later this second class of man who can work but deliberately refuses to do what the world recognizes as a fair day's work (the man of the type of the great big dray horse who refuses to haul anything heavier than a grocery wagon, for illustration), that type of man sooner or later drifts out into that class of work in which his daily task is not accurately measured by the men around him; in which the difference between

the "first-class" and "second-class" man is not accurately defined.

The Chairman. You have a wrong concept of what is running in my mind, and I want to set you right. What is in my mind is this, that neither an employer nor any other man has a right to determine arbitrarily how much physical exertion shall constitute a day's work for a workman. That that is a matter that if determined at all by anyone else than the workman involved, shall be determined between all his associates collectively and the employer for whom he works, and that it should not be arbitrarily determined by his employer, notwithstanding the great change of mind that the employer undergoes by virtue of having introduced scientific management.

Mr. Taylor. My understanding is then, Mr. Chairman, that you believe that even under scientific management collective bargaining or the principles of collective bargaining should apply. I am not at all prepared to say that you are not right, I have not the slightest objection, and never have had to collective bargaining, but I merely say that under the principles of scientific management that necessity has never come before me. The workmen have the same sort of freedom and they have just the same opportunity, to enter into every experiment which is made in establishing what constitutes a fair day's work, that the management have. The making of joint experiments (the workmen and management cooperating together) has been universal in scientific management, or practically universal, and the results have been satisfactory to both sides. I wish to emphasize the fact that until results of these experiments are satisfactory to both sides, scientific management does not exist. This is indispensable—that the results of this accurate study (and this accurate study to replace the old rule-of-thumb judgment is one of the essential features of scientific management), whether this study be made by one man or twenty—that the results must be satisfactory to both sides is absolutely indispensable.

Mr. Tilson. Do you believe generally with Gen. Crozier that you would not be in favor of attempting to apply scientific management to any shop without the cooperation of the employers and the employees?

Mr. Taylor. I certainly do. Never would I believe in applying scientific management unless it was thoroughly agreeable to both sides.

Mr. Tilson. And unless it worked satisfactorily to both sides, you would be in favor of abolishing it?

Mr. Taylor. I certainly would be every time. The principles of scientific management must rest upon justice to both sides, and it is not scientific management until both sides are satisfied and happy.

The Chairman. Would that satisfaction be expressed by the men collectively, or would it be individual after all the power of the management has been brought to bear on the individual?

Mr. Taylor. I do not care which way it is expressed. I have tried to explain that up to now that matter of collective bargaining has never come before me; that we have always been ready to consider any protest, whether made by one man, five men, or twenty men. If any man or any set of men, under scientific management, come with a protest, it is always received and would be accorded just as much attention and as much consideration as if 400 men came.

Mr. Tilson. That is, you would receive one man in an establishment if he came, or you would receive all en masse—if all the men interested in the establishment should come to you?

Mr. Taylor. Absolutely.

Mr. Tilson. Or a committee representing all came to you?

Mr. Taylor. Why, certainly.

The Chairman. Is that principle used now under scientific management?

Mr. Taylor. So far as I know. I never heard of anything else. Mind you, if you refer to having a committee from a union coming to bargain, or present a kick, I have never had that thing happen under scientific management, because the men are perfectly free to come themselves at any time. I think that is the reason for it. I have never had any objection to any one presenting any protest against what seemed an injustice or making any suggestion for an improvement.

Do not understand for a minute, Mr. Chairman, that I am opposed to trade unions. You

have never heard me say that, and no one has heard me say it. I am in favor of them. They have done a great amount of good in this country and in England; I am heartily in favor of those elements of trade unions which are good, and I am equally opposed to those elements of trade unions which are bad; and they have had elements just as they have good. Now, the things that constitute the bad elements in trade unions I tried to point out in my direct testimony. I believe that the unions are controlled and misguided in a few respects by leaders who simply lack education; they lack a knowledge of some of the vital facts. One of the worst principles of the trade unions, as they are taught by the leaders of the unions (I believe that the leaders are misguided; I do not think they are dishonest) is that it is to their interest to deliberately, purposely work slow instead of working fast with the object of restricting output. It is this deliberate restriction of output that has already done the great harm in England and that is doing most of the harm that the unions are doing in this country. High wages are not doing any harm; I favor even higher wages than the unions do. Short hours are not a bad thing; I believe in short hours. I believe in almost all the things the trade unions do; but restriction of output, never! That is the thing fatal to their own best interests that they are now doing.

The Chairman. What trade unionist, prominent or otherwise, have you ever heard express an opinion in opposition to increased production if the increased production was not brought about by increased energy expended on the part of the workmen?

Mr. Taylor. Now, Mr. Chairman, I do not know of a single labor leader that is not advocating restricted output among his men; not a single one.

The Chairman. Can you name one who has advocated restriction of output or who is opposing increased output except where the increased output is brought about by an increased expenditure of energy on the part of the workmen?

Mr. Taylor. Well, I should say that it would take a little more energy for a plumber to make three wiped joints or four wiped joints a day

than for him to make two, surely. The plumbers' union restricts a plumber to three wiped joints a day. I am not a plumber, but I'll be damned if I can't wipe five joints a day, and no trouble at all. Of course, it takes more trouble to do four than three wiped joints. But what I mean to say is that when the plumbers' union restricts a plumber to three wiped joints a day and insists that one or two helpers shall always go along, whether they are needed or not, that union is restricting the output per man. If you quibble about it (I am not talking about you personally, Mr. Chairman; I am using the word impersonally; I would not for the world say that you quibble).

The Chairman. That is all right; I presume I can stand it as well as the other fellow it was intended for.

Mr. Taylor. I do not mean to say that you have quibbled for a moment, and, on the contrary, I want to thank you for the most considerate treatment I have had from you ever since these hearings began.

The Chairman. I am going to ask you at this time again, Mr. Taylor, what special necessity or economic necessity is there to increase production by virtue of the expenditure of increased energy on the part of the workmen from that which existed prior to the introduction of this system?

Mr. Taylor. There is the economic necessity that the whole world is now, just as it always has been, suffering from underproduction. Underproduction is responsible mainly for low wages; it is responsible for the fact that the poorer people of this world have just so much fewer things to live on (that they have poorer food to eat; pay higher prices for their rents; can buy fewer clothes to wear than they ought to have; in other words, that they lack what I have defined in my direct testimony as true riches); the fact that the poorer people lack in many cases the necessities, and in all cases the luxuries of life which they ought to have, is a justification for the fact that an increase of output is needed now just as much as it always has been, because absolutely the only way that these necessities and luxuries can be brought into the world is through an increase in output. Now, as I pointed out in my direct testimony,

and as an analysis of the testimony presented to this committee will show, a great part of the industrial world is deliberately soldiering. And until we have reached the point where deliberate soldiering has been stopped; and until the normal and proper output per man has been reached, no workman will be asked to work materially harder than he is now working. And, as you know, scientific management is a scheme for greatly increasing the output of the man without materially increasing his effort.

The Chairman. Is it not true, Mr. Taylor, that the great bulk of the poverty of workmen at the present time is due not to the fact that we have not solved the problem of production, but to the fact that we have not solved the problem of distribution of that which is produced?

Mr. Taylor. Mr. Chairman, I agree with you that there is an immense reform needed in the distribution; I agree heartily in that; and I am also firmly of the opinion that in the next hundred years the wealth of the world is going to grow per capita (the real wealth of the world, as I have already defined it, not money nor useless extravagances, but those things which are really useful to men) to such an extent that the workman of that day will live as well, almost, as the high-class business man lives now, as far as the necessities of life and most of the luxuries of life are concerned. If you will look into the past you will see that our laborers of today have made fully as great progress as this with relation to the laborers of the past. A most striking illustration of the way in which the workman has progressed is presented by the following fact, Mr. Chairman. I do not think that it is a fact of very common knowledge, and it therefore may be a proper fact to get into this record, the standard by which we ordinarily measure the relation of men living in one period to those living in another period is the money standard.

It is a most unreliable and unsatisfactory standard, that 50 years ago such and such wages were paid, and now such and such wages are paid. This fact alone is almost meaningless. But there is one standard by which you can go back for a long term of years and by which you can compare the condition of workmen at that time with

their present condition. I think it was 250 years ago (the exact number of years I do not know; it makes very little difference—it was from 150 to 300 years ago) the farm laborer of England sold his week's work for half a bushel of wheat. We eat wheat; that is, we eat bread now, just as they did 250 years ago, not much more nor much less per man, and a measure in wheat of what a man got then and gets now for his day's work is therefore a standard measure of the living condition of 250 years ago and now. Think of it! A half bushel of wheat for a week's work was the pay of a man then!

The Chairman. Would that be an accurate measure of comparison in view of the conditions of the cost of production—the labor cost of producing wheat now as compared with then?

Mr. Taylor. It is not what the labor cost. It is a question of how much riches were coming into the world and available for use then, and how much now; and the riches then coming into the world were measured then by the amount that the land produced per man and the productivity of the average man, just as riches are now measured, and the fact that the average man is 20 times as rich now as then—he is turning out 20 times the output of a man of 250 years ago. And the average man of 100 years from now will, I firmly believe, turn out at least three times as much work as now.

The Chairman. Notwithstanding the fact that scientific management is only 30 years old, the productivity has been increased twenty-fold during that period of time?

Mr. Taylor. No. I am taking the period of time 250 years ago (not of 30 years ago) when a man sold his week's labor for half a bushel of wheat, as the measure of a man's productivity.

The Chairman. The measure is 20 times greater now than it was 250 years ago?

Mr. Taylor. I think in that measure. I should say that in round numbers it would be nearly that.

The Chairman. And having increased productivity 20 times (we are producing twenty-fold now) would it not naturally follow that if poverty exists now, with twenty times more productivity, it is due, not to the fact that we have

not solved the problem of production, but to the fact that you have not solved the problem of distribution?

Mr. Taylor. It is due to both of these facts, Mr. Chairman, but due mainly to the fact that what is now ranked as extreme poverty were the normal conditions of nine out of ten men 250 years ago. The standard of living has changed fortunately, so that what was then affluence is now poverty.

The Chairman. The other day, Mr. Taylor, you made the statement that the mechanism of scientific management was a power for good and a power for bad.

Mr. Taylor. Yes, sir.

The Chairman. Now, if scientific management is power for good and a power for bad, and scientific management requires that there shall be only one directing head, with no interference with the law of that directing head, how is the workman going to protect himself against the power for bad that is in that system?

Mr. Taylor. Why, that is not scientific management, Mr. Chairman. I have tried to point out that the old-fashioned dictator does not exist under scientific management. The man at the head of the business under scientific management is governed by rules and laws which have been developed through hundreds of experiments just as much as the workman is, and the standards which have been developed are equitable; it is an equitable code of laws that has been developed under scientific management, and those questions which are under other systems subject to arbitrary judgment and are therefore open to disagreement have under scientific management, been the subject of the most minute and careful study in which both the workman and the management have taken part, and they have been settled to the satisfaction of both sides.

Mr. Tilson. Wherein is the power for bad then in scientific management?

Mr. Taylor. The mechanism of scientific management is a big engine, Mr. Tilson. If you have a locomotive and train of cars which, when running on a track and doing all right, is a great power for good, it is equally as great a power for bad when it gets off of the track. Now, if

the mechanism—I am speaking now of the mechanism of scientific management, Mr. Chairman—if that same mechanism is used by unscrupulous people, it is not then used under scientific management, it may do a durned lot of harm. That is not scientific management. It is just as if you were to turn a locomotive loose on the streets and say "Let her go." You can use it either for good or for bad.

The Chairman. If that mechanism is once introduced, is it not possible that it could be utilized to more value in the hands of an unscrupulous man who would use it for bad?

Mr. Taylor. That is conceivable for a short time, but only for a very short time. For instance, this is a beautiful building that we are in here, and it has been erected and doing magnificent service for a good many years. It is conceivable that some fool party might get into power and order one wing of the Capitol blown up with dynamite. Such a thing is conceivable; but I can tell you that party would regret it if it ever did such a foolish thing, and it would be promptly voted out of power. Just so with any one attempting to use the mechanism of scientific management in a wrong way. He would regret it. It might do an immense amount of harm for a short time but its abuse would bring its own remedy promptly. Even with the finest laws that have ever been made, you cannot absolutely insure their enforcement at all times; but that does not prove that it is not good to have laws, that it is not good to have standards.

The Chairman. If the enforcement of a law, however, is dependent upon the will of a man who has the power to violate it, there is not much likelihood of the law being enforced against him, is there?

Mr. Taylor. Mr. Chairman, I believe that the very great bulk of mankind wants to work under and wants to live under laws. They believe in laws. It is only the rare exception in this country, whether it be the workmen or whether it be the employer, who does not believe in laws and see the desirability of living up to them.

The Chairman. Apparently, Mr. Taylor, you have lost sight of the thing I was illustrating, and you have used again the laws as illustrating a certain point. Now, to get back to the

original proposition: If the whole proposition of whether scientific management shall be used for good or shall be used for bad depends upon the single directing head of the establishment, there is not much likelihood, is there, of any penalty being attached to the exercise of that power for bad?

Mr. Taylor. I have never said that scientific management could be used for bad. It is possible to use the mechanism of scientific management, but not scientific management itself. It ceases to be scientific management the moment it is used for bad.

The Chairman. That might be true. But scientific management cannot be developed, as I understand it, unless you have the thing with the mechanism of it?

Mr. Taylor. Yes.

The Chairman. And according to your statement that the mechanism can be used for bad, and according to another statement that in scientific management there must be a directing intelligence and that the directing intelligence must not be interfered with by anyone. You may cooperate in accordance with the desires of that intelligence, but it must not be interfered with; otherwise it is not scientific management.

Now, under those circumstances, how is the workman going to be able to protect himself against the employer using that mechanism that has been established to oppress him for the gain of the employer?

Mr. Taylor. If a man in the management tries to use the mechanism of scientific management to oppress the workman or in any other way that it should not be used, the workman simply reverts to his old ways and goes right back and does what he did before under the old management, he soldiers, and cooperation at once ceases. This is a mutual affair and both sides must work together; then, and only then, do you have scientific management. The moment one side starts to jump the fence and bulldoze the other, or to do any acts which are outside of the principles of scientific management it ends. Without harmony you cannot have scientific management, and you go right back to the old fighting scheme, in which each side

is watching the other carefully and trying to get an advantage over the other.

We are, both sides, trying to get the largest possible amount of work out; there is no time for fights. Fights and quarrels are not characteristic of scientific management. The old type of management is full of demands on one hand and refusals on the other. The terms "demand and refuse" are never heard in scientific management. These are not words which one friend uses to another.

The Chairman. I think you stated the other day, Mr. Taylor, that up until last year you did not know of any strikes where scientific management had been introduced, during the time since it has been introduced.

Mr. Taylor. Yes, for 30 years.

The Chairman. Isn't it also true that peaceful relations almost invariably exist between master and slave, that no strikes occur?

Mr. Taylor. Well, if you call peaceful relations one fellow lashing the other with a whip, I do not call that peaceful relations. I call that very far from peaceful relations, the conditions that existed under slavery.

The Chairman. Did the master always lash with the whip?

Mr. Taylor. No, he did not.

The Chairman. Were there not some considered good masters, and some considered hard masters?

Mr. Taylor. There were. But, Mr. Chairman, I do not think you and I for one instant can disagree on the subject of slave institutions; there is no question about that whatever; there can be no two views between us as to slavery.

The Chairman. My only purpose in referring to it at this time was to demonstrate the idea I have always had, that the fact that no strikes have occurred does not prove anything as to the private relationship between employer and employee. I think you will admit, Mr. Taylor, will you not, that there are comparatively few strikes in India and China.

Mr. Taylor. Mr. Chairman, coming back to India, there was the terrible Sepoy mutiny which we always have in mind. We know that there exists even now the elements of dissension in India, and we know also there now exists an absolute state of revolution in China.

The Chairman. Is not that political revolution, rather than industrial rebellion?

Mr. Taylor. I admit I know very little about industrial conditions in India and China.

Mr. Tilson. In this country where a man is free and he has a perfect right to apply to public opinion in general (he thinks that is a proper sovereign court sometimes if he is not properly treated), would not you take it as evidence that his relations were rather friendly, where this free-sovereign man has been working for years and there has been no evidence of discontent?

Mr. Taylor. I should say that was evidence. I have heard it said, however, Mr. Tilson, that those men who are working under scientific management are weaklings; are men of little or no character, and yet our factories are more than holding their own with their competitors.

Mr. Tilson. That may be, but the kind of men that work in factories are not weaklings; the great mass of workmen in this country are not weaklings and not slaves, and are not enduring any oppression of an unendurable character, without making it known.

Mr. Taylor. No, sir. I know that we make errors and we make plenty of them on the management side, naturally, but the moment an error is made, a good big howl goes up from the workmen right off, and I can assure you that the complaint is not the kind made by weaklings or slaves.

Mr. Tilson. Because the workman knows what is right and knows how to get it.

Mr. Taylor. Certainly. In nine out of ten times, the trouble is on the management side, and I assure you that if we make a mistake it is promptly corrected by us, and if you like, I can bring you thousands of workmen right here to tell you that they do not have to go to anyone to have a mistake rectified beyond the man who has made the mistake. People do not become perfect under scientific management; they make mistakes; but when we do make them, the workmen tell us about them right off and we correct them, or the whole scheme would fall to smash.

The Chairman. Some time ago you gave as four fundamental principles of scientific management about the following definitions:

First. The gathering together of the tradi-

tional knowledge and recording, tabulating, and reducing this knowledge to laws.

Second. Scientific selection and then the development of the workmen.

Third. The bringing of the science and scientifically trained workmen together.

Fourth. The almost equal division of work of the establishment between the workmen and the management.

Now, under the third of those, the bringing of the science and the scientifically trained workman together, isn't it the purpose of scientific management that the workman must follow absolutely the directions that are given to him when this science and scientific workman are brought together—that he must follow the directions that are given to him as to how he shall perform the work?

Mr. Taylor. It is the rule under scientific management that the workman works in accordance with the laws that have been developed, and that they shall at least (when they get a new job, we will say, that they have not done before)—that they shall at least practice the method that has been set before them once before raising any objection or any kick about it. If after having tried the new method once any workman has a better suggestion to make, of any kind, sort or description, that suggestion is most welcome to the management. And it is through those suggestions from the workmen that nine-tenths of our progress is made. The following kinds of suggestions are received from workmen, after having faithfully tried the method outlined to them, they see something wrong about our method and suggest a new or a better way of doing the work, or suggest a more efficient series of movements or some better process than we have outlined. And in that way we get most of our knowledge and make our improvements in methods and implements.

The Chairman. If the workman has to obey instructions implicitly as to how the work should be done, would he not thereby simply become an automaton, and would not that ultimately reduce the skill and value of the skill of the workman?

Mr. Taylor. Mr. Chairman, I want to give an illustration in answer to that question, be-

cause I think my answer can be made very much clearer through an illustration than through a single sentence.

The workmen—those men who come under scientific management—are trained and taught just as the very finest mechanic in the world trains and teaches his pupils or apprentices. Now, I think you will agree with me as to who this finest and highest-class mechanic in the world is. So far as I know there will be no question about him, for we will all agree that the highest-class mechanic in the world is the modern surgeon. He is the man who combines the greatest manual dexterity and skill with the largest amount of intellectual attainment of any trade that I know of—the modern surgeon.

Now, the modern surgeon applied the principles of scientific management to his profession and to the training of the younger surgeons long before I was born—long before the principles of scientific management were ever dreamed of in the ordinary mechanical arts. Let us see how this man trains the young men who come under him. I do not believe that anyone would have an idea that the modern surgeon would say to young doctors who come into the hospital or who come under him to learn the trade of surgeon—I do not think the surgeon would say anything of this kind: “Now, boys, what I want of all things, is your initiative; what I want, of all things, is your individuality and your personal inventiveness.”

I do not think anyone for an instant would dream that a surgeon would say to his young men, for instance, “Now young man, when we are amputating a leg, for instance, and we come down to the bone, we older surgeons are in the habit of using a saw, and for that purpose we take this particular saw that I am holding before you. We hold it in just this way and we use it in just that way. But, young men, what we want, of all things, is your initiative. Don’t be hampered by any of the prejudices of the older surgeons. What we want is your initiative, your individuality. If you prefer a hatchet or an ax to cut off the bone, why chop away, chop away!” Would this be what the modern surgeon would tell his apprentices? Not on your life! But he says, “Now, young men, we want your initiative; yes. But we want your initiative,

your inventive faculty to work upward and not downward, and until you have learned how to use the best implements that have been developed in the surgical art during the past hundred years and which are the evolution of the minds of trained men all over the world; until you have learned how to use every instrument that has been developed through years of evolution and which is now recognized as the best of its kind in the surgical art, we won’t allow you to use an iota of ingenuity, an iota of initiative. First learn to use the instruments which have been shown by experience to be the best in the surgical art and to use them in the exact way which we will show you, and then when you have risen up to the highest knowledge in the surgical art, then invent, but, for God’s sake, invent upward, not downward. Do not reinvent implements and methods abandoned many years ago.”

That is precisely what we say to the workmen who come under scientific management. No set of men under scientific management claims that the evolution has gone on enough years to be in the same high position as is occupied by the surgeon, but they do claim that the 30 years of scientific investigation and study (which goes on under scientific management) of the instruments that are in use in any trade, whatever it may be, have enabled those engaged in this study to collect at least good instruments and good methods, and we ask our workman before he starts kicking; “Try the methods and implements which we give you; we know at least what we believe to be a good method for you to follow; and then after you have tried our way if you think of an implement or method better than ours, for God’s sake come and tell us about it and then we will make an experiment to prove whether your method or ours is the best, and you, as a workman, will be allowed to participate in that experiment. It is not a question of your judgment or my judgment or anyone’s judgement; it is a question of actual experiment and time study to see whether this suggestion is better than the standard we have had in the past.” And if it proves to be better, what I advocate every time is, not only that the new method shall be adopted, but that the man who made the suggestion be paid a big

price for having improved on the old standard.

And it is just in this way that we make progress under scientific management.

The Chairman. Taking your own system of illustration and own basis of illustration, is not the workshop and the management of the workshop more in the position of the surgeon in chief of the hospital than it is of the head of a medical college, and would it be expected that a surgeon in chief would say to the surgeons in the hospital: "Now, when a case comes in here for you to operate upon you must not make a diagnosis of the case; you must not decide upon how you are going to operate on this case; you must not determine anything at all about how the operation should take place or what tools should be used for this operation until after you have got a specific written order from the surgeon in chief, and then when you have received that written order, if you vary from that, no matter what the case may be—if you vary from that you must expect to be held responsible for your having done so."

Would not that be a better illustration of the relative positions of the two than the one which you have given. And who would expect that a surgeon, under these circumstances, would undertake to do any operating in a hospital.

Mr. Taylor. Mr. Chairman, I have among my acquaintances quite a number of the great eastern surgeons—the noted surgeons of New York and Philadelphia especially. Without any exception they all point to the establishment of Mayo Bros., in Rochester, Minn., as the finest example of surgery in the world; they say that so far as they know the finest surgical establishment in the world is under the management of Mayo Bros. in Rochester, Minn.

Last evening I met one of the surgeons from Mayo Bros., and earlier in the fall I met Mr. Mayo himself. He came East from his work, as he told me, largely to see me and talk about the principles of scientific management. He made the statement that his establishment (and it was corroborated by the doctor I met yesterday) is run, so far as possible, along the principles of scientific management.

For example, when a patient arrives in the establishment the first thing that is done is a brief questioning and diagnosis which would

indicate what general branch of surgery was likely to be called for. It is just a preliminary investigation. And then the man best fitted to perform that particular type of diagnosis is assigned to that patient. He diagnoses, and if he finds in the course of his diagnosis that he is not the proper man, then another expert is sent for and makes the diagnosis.

This diagnosis is then written up carefully by the specialist who has plenty of time to accurately describe the case.

After this man follows one of the four great assistants of the two Mayo brothers (four other noted surgeons), and the one of those four who is best fitted to this type of surgery again diagnoses the case with the written information before him of the first diagnostician, and he finally (being a man of riper experience or judgment than the first one) corroborates or makes additional notes, and finally the diagnosis is brought to the one of the two Mayo brothers who is going to perform the operation. (The two brothers have their two somewhat separate departments in surgery.) He finally makes his own diagnosis, but he makes it with all this preliminary information and data before him.

And then when he performs his operation, instead of performing it alone, he performs it with from eight to ten assistants, each one having his special work, just as is the case under the principles of scientific management.

And Mr. Mayo came East to get further information right along the lines upon which he has been working (we not knowing anything about his proposed visit), to see if he could not add more to the principles which he was already using.

Instead of having an operation performed by a single surgeon as they used to, the modern operation is performed by 8 to 10 men combined, and each one performing that particular part of the operation for which he is best fitted. And my informant told me they would sometimes go through an operation of two hours without one word spoken. So well are they trained, that they perform the functions they are called upon to do by a simple nod of the head, the reason for not speaking being that the germs from the breath from speaking might

get out and get into the wound, and contaminate the air, as you know.

I think that represents the best practice today in modern surgery, and I think it is very analogous to what is done in our industrial establishments under scientific management.

The Chairman. Would not that be the same as if a job came into a shop, and you would select a molder to do the molding part, a machinist to do the machining part, and so divide that into the various lines that the men had to do? Is not that practically the same thing?

Mr. Taylor. I think not. I think this operation performed by eight or ten men, all cooperating, working as a team is very different from giving the molder one thing to do in one department by himself and the machinist another thing in another department.

The Chairman. Is not one of the elements of scientific management this possibility to divide it up so that the workmen will have the same operation to perform over and over again?

Mr. Taylor. That is just the same under scientific management as it is under the other types of management; neither more nor less. Under scientific management precisely the same principles of work are used in that respect as under the other types of management.

Naturally, for manufacturing shoes, under the modern way, under scientific management or any other management, the manufacture of shoes is divided into very, very many minute parts. I have a very high regard for Mr. Tobin, the leader of the shoemakers' unions of New England, and the other day he told me that in making an "upper" there were over 450 operations—in making the upper of a shoe, each one performed by a different man in a well-run shop.

Well, this is what now takes place under the older types of management, and that undoubtedly would continue under scientific management; and I do not think in that respect there is any difference between scientific management and the other, except this. And I want to emphasize this, Mr. Chairman—that under scientific management it becomes both the habit and pleasure of those people who are on the management side to try and help their men rise to the highest class of work for which they

are fitted. I say that deliberately. In our working right alongside of men who are friends, and warm friends, we can't help having the kindest feeling toward them, and wanting to develop them to do the highest class of work they are fitted for, and to finally get the highest practicable day's pay. This is characteristic of scientific management and is not the characteristic of the old type of management.

The Chairman. Does not scientific management undertake to show that a change from one part of the work to another part of the work, if they involve different operations, is a loss of time and consequently it is better, if possible, to have one man perform each of the operations?

Mr. Taylor. Mr Chairman, what is true under scientific management in this respect is also true under all types of management. I think this tendency to training toward specializing the work is true of all managements, for the reason that a man becomes more productive when working at his specialty, and while it is deplorable in certain ways (there is no question about it, there are various elements in this specialization that are deplorable), still the prosperity of the world and the development of the world—the fact that the average workman in this day lives as well as kings lived 250 years ago—that fact is due to a certain extent to just this very specialization.

The Chairman. Is not the result of specializing that the workman does not secure a general knowledge of his trade, and consequently the number of men from which the best managers are recruited is limited—is not the result of that that there is a shortage of first-class managers?

Mr. Taylor. It is quite the reverse, Mr. Chairman. Under scientific management we are making 10 managers every day to one that is being made under the old type, and in order to prove this fact I am very glad that you brought up that matter, because I wish to ask your committee, Mr. Chairman, if I may be allowed, to present at least two witnesses before your committee who will testify to the fact that they first started in under scientific management at low wages and in unimportant positions; that they were gradually promoted under

the principles of scientific management until in each case each man rose to the highest position in the particular establishment in which he was and for which his abilities fitted him; and that while he was rising in this way his wages were increased—not in a small way, but to a large extent—and that after those men reached in the companies in which they were working the highest positions which it was possible for those companies to offer them, that the managers and owners of those companies then deliberately set out to find for these men better positions in which they could get better wages and still have a chance to progress in a larger field outside their own companies. I want to bring those men to tell you that themselves, because it illustrates just what I was trying to demonstrate, that the kindest relations exist between the management and the workmen. And that promotion is the rule, not the exception.

The Chairman. You do not mean to convey to the committee the impression that a kindly feeling has not existed between the same men and some other men—that it did not exist and could not exist until the advent of scientific management?

Mr. Taylor. Certainly not, but I wish to point out that that is a characteristic of scientific management and not a characteristic of the other, as you know. It is not a characteristic of the old type of employer to develop a very fine foreman and deliberately find employment for that foreman on the outside. It is quite the reverse. They are very anxious to keep those men to themselves, even though they keep them at lower wages than these men could get outside.

The Chairman. Would not the introduction of witnesses to show that under your system they had been promoted from low positions up to the higher and best and transferred at the suggestion and consultation of the employers to some other establishment—would that show that it was characteristic of that system?

Mr. Taylor. I beg your pardon?

The Chairman. I say if two men were brought here, for instance, to testify before this committee that they had under your system risen from the very lowest positions to the highest positions in the gift of their employer, and

then their employer had deliberately sought higher positions for them in some other concern—would that demonstrate that that is characteristic of your system?

Mr. Taylor. Mr. Chairman, if you could produce from a small company employing only a few men four similar instances of that kind of promotion in one year, and bring those people before this committee to testify to this fact, I say it would tend to show that this is characteristic of scientific management. In a small company working under our system and employing only about 100 workmen as many as four foremen in one year were found better positions on the outside, because they had reached the highest salary which that company was able to pay them, and because that company, wishing them well, found them something better on the outside.

The Chairman. Would not that show that it was characteristic of that particular employer, or would it show it was characteristic of the system?

Mr. Taylor. I say, Mr. Chairman, that so far as I know it is not characteristic of the older type of management and that it is characteristic of the newer type of management.

Thereupon, at 5 o'clock p. m., the committee adjourned until 8 o'clock p. m.

Evening Session

The committee met at 8 o'clock p. m., Hon. William B. Wilson, (chairman) presiding.

The Chairman. The committee will come to order, and Mr. Taylor will proceed with his statement.

Mr. Taylor. At the end of an answer which I made near the end of the last session today, I desire to have the following added: I may add that in the Tabor Manufacturing Company, which is the company to which I referred, before the introduction of scientific management, not a single foreman or leading man was ever promoted to a better position outside of the employ of the company, whereas in that company during the present year alone four of the leading men have been provided with outside positions because they had reached the apparent present limit of their promotion in the Tabor

Company, and a better opportunity with higher wages was sought for them outside.

The Chairman. Mr. Taylor, is it not true that the American workman is a more productive workman than any other on earth, taken in the aggregate?

Mr. Taylor. I am inclined to think that is true, Mr. Chairman, but my knowledge is not sufficiently definite upon the subject to be certain of it. I should say that the fact that our men are more productive is that the workmen of our country have more of the good things of life, more of the things that are of real value in life, than the workmen of other countries. If the workmen of our country have arrived at a condition of feeling perfectly satisfied with their present state of material prosperity, as well as with their mental and esthetic opportunities of various kinds, then possibly one might question the desirability of a further increase in the output of the individual. But, in my judgment, the best possible measure of the height in the scale of civilization to which any people has arisen is its productivity; and, for my part, I am looking forward to the day when the working people of our country will live as well and have the same luxuries, the same opportunities for leisure, for culture, and for education as are now possessed by the average business man of this country, and this condition can only come through a great increase in the average productivity for the individual of this country. That is the road we shall have to travel.

The Chairman. If the American workman is already more productive than any other workman, and by systematizing the work you can still further increase his productivity, then what necessity is there for adding to the discomfort of the workman by requiring the expenditure of more energy on his part?

Mr. Taylor. My impression is that that is correct.

The Chairman. It has been stated on various occasions, and the figures alleged to be taken from official figures, that the average productivity of the American workman is \$2,400 per year, as against an average of the British workman of \$565 per year. If that be true, what necessity is there for crowding the American workman to greater productivity by

reason of the expenditure of greater energy?

Mr. Taylor. In the first place, Mr. Chairman, I have not the slightest idea that that ratio is the correct one for the productivity of the two countries. In the second place, as I tried to point out before, the money standard is no fit standard by which to measure the relative productivity of two peoples. You must be familiar with the relative purchasing power of money in the various countries before you can come to any correct conclusion by means of the money standard for comparison. And even if that ratio were correct, the reason why the American workman, the principal reason why the American workman is a happier and more contented and more prosperous workman on the whole than those of other countries—and I believe that to be the fact—the principal reason for this condition of affairs is that the workmen of this country are more productive than those of other countries.

Scientific management does not demand an unnecessary expenditure of energy. If it did it would be wrong. Scientific management only asks that soldiering be stopped, and that each man while he is working shall work at a proper normal pace and shall use efficient instead of inefficient movements.

The Chairman. I am not speaking about the expenditure of unnecessary energy. What I am endeavoring to get at is what necessity there is under those circumstances for the expenditure of any additional energy in order to increase productivity.

Mr. Taylor. I do not look upon the fact that the man who works under scientific management, and who throughout his working day is usefully employed—is expending his energy in a useful way—as a misfortune in any way. I look upon it as a great gain for the workman that he is not obliged, in order to defend his own interest, as he was under the old system, to soldier a great part of the day, that is, to pretend to work hard or to go through motions which are unproductive and yet which are tiresome.

The Chairman. Is it not the purpose of all production to add to the comfort and well-being of mankind?

Mr. Taylor. It is.

The Chairman. If by any system of production you increase the discomfort of mankind, have you not thereby destroyed the very purposes of your production?

Mr. Taylor. That depends entirely upon the amount of discomfort which the workman had before. If a man had not been working faithfully, if he had spent one-half of his time in idleness, I do not look upon it as anything of a misfortune to that man that he is brought to spend his working time in useful effort instead of in useless exertion.

The Chairman. Do you think that the comparatively small number of employers should have the power to determine absolutely for the comparatively large number of employees what constitutes comfort for them?

Mr. Taylor. I certainly do not think it ought to be in the power of any outside man to say what shall constitute the comfort of his fellow men. Every person should be free to decide what is for his own comfort, and I think in this country, so far as I know, that is true.

The Chairman. Would not the fact that industry is to be directed by scientific management—by one central intelligence—and that the question of whether the workmen are comfortable or uncomfortable is to be determined by that central intelligence, place in the hands of the employers the power to determine what constitutes comfort for the employees?

Mr. Taylor. Mr. Chairman, I must again state that under scientific management those men who are in the management, such as, for instance, the superintendent, the foremen, the president of the company, have far, far less arbitrary power than is now possessed by the corresponding men who are occupying those positions in the older types of management. I must again state that under scientific management the officers of the company, those on the management side, are quite as much subject to the same laws as are the workmen. As I have again and again stated, our great difficulty in the introduction of scientific management has been to get those on the management side to obey these laws and to do the share which it becomes their duty to do in the actual work of the establishment in cooperating with the workmen, so that I hope that I may be able to make

myself clear that under scientific management arbitrary power, arbitrary dictation, ceases; and that every single subject, large and small, becomes the question for scientific investigation, for reduction to law, and that the workmen have quite as large a share in the development of these laws and in subsequently carrying them out as the management have.

The Chairman. Is not the management the final arbiter in the determining of those questions under scientific management?

Mr. Taylor. In most cases the laws and the formulas and the facts of scientific management, which are vital both to the workmen and the management, have been developed during years preceding the one on which the work is going on. And that being the case, neither the management nor the workmen have any final arbitrary dictum as to those laws. The laws of scientific management are somewhat analogous to the laws of this country. We are all working under certain laws that were not enacted by the present Congress or the present President of the United States, and which have not been interpreted by the present courts, and yet the President of the United States and all the citizens of the United States are alike working under those laws. Now, under scientific management there have gradually grown up a code of laws which are accepted by both as just and fair. What I want to make clear is that the old arbitrary way of having a dictator, who was at the head of the company, decide everything with his dictum, and having his word final, has ceased to exist.

The Chairman. Under our laws no judge would be permitted to sit in a case in which he had a personal interest. Now, under scientific management, with the power centered in the head of the establishment, would not the final judge in the case be a man who was interested in the outcome?

Mr. Taylor. A final decision must be reached in all disputed cases by some one.

The Chairman. Yes.

Mr. Taylor. And if the decision were finally appealed it would probably go to the board of directors of the company, as the final appeal. That would probably be the final appeal, and the decision of that board of directors, as far

as this particular case is concerned, would be final.

But, Mr. Chairman, you must remember that if any injustice is done to a workman under this system he always has the recourse of leaving, and he has further the much more powerful remedy of sitting down and soldiering just as he did under the old system, and he will still get the same wages if he soldiers. He gets the full wages that he is employed for, even when he soldiers. So that if an injustice is done to him it comes to a question of whether the workman has the power to force an unjust management to do what is right, or if he fails in this, to virtually return to the old system of management with all its antagonisms and sad conditions.

The Chairman. But if the workman leaves, quits his employment, would he not be placed to a greater disadvantage by virtue of his quitting his employment than the employer would be by virtue of the workman quitting?

Mr. Taylor. That depends entirely on—

The Chairman. It would, as a general rule, be true, would it not? There might be special cases where it would not be true, but would not that, as a general rule, be true?

Mr. Taylor. I think it is almost impossible to generalize on that. My experience is that, for instance, in the machinery business, employers are always looking for good men. It has been so all my life. They are always looking for good men, and one of the most humane employers under the old system of management, a man who stands very high and who is looked up to as a very humane man, told me with the greatest sadness that during the last three or four years about 40 per cent of his men had left him every year. Forty per cent each year had left him and new men came. Now, that could not happen under scientific management. Our men are too prosperous, too happy and contented for that.

The Chairman. Would you not permit them to leave?

Mr. Taylor. They do not want to leave. Permit them? Of course they are permitted. This is a free country. But they are so well off, and so well treated, that they do not want to

leave. It is not a question of permitting; it is altogether a voluntary matter.

The Chairman. When your scientific management has gathered together its information, its formulas, and formulated its rules and regulations, systematized its work, etc., giving its direction to the workman, and the workman fails to obey these formulas that are laid down for him, is there any method in scientific management to discipline the workman?

Mr. Taylor. There certainly is, Mr. Chairman; and any system of whatever nature under which there is no such thing as discipline is, I think I can say, pretty nearly worthless. Under scientific management the discipline is at the very minimum, but out of kindness to the workman, out of personal kindness to him, in my judgment, it is the duty of those who are in the management to use all the arts of persuasion first to get the workman to conform to the rules, and after that has been done, then to gradually increase the severity of the language until, practically, before you are thru, the powers of the English language have been exhausted in an effort to make the man do what he ought to do. And if that fails, then in the interest of the workman some more severe type of discipline should be resorted to.

The Chairman. Having gathered together all your information and built up your formulas and introduced your scientific management, if the management violates its formulas, what method is there in scientific management to discipline the management for its violation of its principles?

Mr. Taylor. I am very glad that you asked that question. Just the moment that any of our men in the planning room does not attend to his end of the business, just the moment one of the teachers or one of the functional foremen does not attend to his duties, or do whatever he ought to do in the way of serving the workmen—I say serving advisedly, because if there is anything that is characteristic of scientific management it is the fact that the men who were formerly called bosses under the old type of management, under scientific management become the servants of the workmen. It is their duty to wait on the workmen and help them in all kinds of ways, and just let a boss fall down

in any one thing and not do his duty, and a howl goes right straight up. The workman comes to the planning room and raises a great big howl because the foreman has not done his duty. I tell you that those in the management are disciplined quite as severely as the workmen are. Scientific management is a true democracy.

The Chairman. Suppose that it is the man higher up that violates these formulas? As I understand your testimony before this committee no scientific management can exist until there has been an entire change of mind on the part of the management as well as on the part of the workmen?

Mr. Taylor. Yes, sir.

The Chairman. And that this change must take place in the point of view, in the mind of the employer and the employee.

Mr. Taylor. Yes, sir.

The Chairman. And that the condition of "Do unto others as you would have them do unto you" must exist, and that spirit must exist. Suppose having that as a part of your formula, as part of your rules, that the workman is dependent upon the generous spirit on the part of the employer to say that he is treated well, suppose that the head of the house, the man higher up, violates that formula, what power is there in scientific management to discipline him for that violation?

Mr. Taylor. The losing of the men who are under him, their quitting, and going to some other place where they are treated better.

The Chairman. There is no scale of language set to the strongest scale of language that can be used for him, is there?

Mr. Taylor. I recall a particular instance in which one of the men who is here in this room was systematizing a company, and in which the president of that company, who was at the same time one-half owner of the company, refused in small matters to get into line and do his share of the duties, and I remember distinctly the volley of oaths that were thrown at the president of that company by the man who was systematizing the company for him, and he wound up by saying, "Um, um, um, if you do not do your share now and get right into line, we will get right out of this place and

leave you where you are." And he got right into line.

The Chairman. Is it part of scientific management that the workman shall cuss the man higher up when the man higher up violates his own formulas?

Mr. Taylor. It is part of the democratic feeling that exists between all hands that under scientific management they should talk to each other very freely and very frankly. And I think it is safe to say, that if I, for instance, were to swear at one of these fellows here (pointing to some of the workmen who were present at the hearing) he would swear right back at me without the slightest hesitation. I do not think there would be any difference between us if I happened to be a little higher up and he were a little lower down. I have not seen any great distinction between the two when it comes to swearing.

Mr. Redfield. Does not scientific management take the third commandment into account?

Mr. Taylor. I am sorry to say it does not take it into account as it ought to. I was brought up wrong—

The Chairman. In your direct testimony, Mr. Taylor, you referred to baseball playing as being an ideal type of scientific management, the manner in which the players were handled and the manner in which they responded to the management being pointed out as an indication of what scientific management can do. Are you aware of the fact that in baseball playing, in the professional baseball playing that you have reference to, the players are bought and sold like cattle on the market?

Mr. Taylor. I have heard of that fact, and I have often wondered why it was. I do not know. I am not intimately acquainted with that phase of the management of baseball to be able to say whether this is fair and just. I rather suppose, although I do not know, however, that no sale can be made without the consent of the player, that it is a mutual affair, and I rather imagine that the player always insists upon getting his share of the booty. But that I do not know; I am entirely unacquainted with it. My friend Mr. Reagan (points to Mr. Reagan, who is present) who is the ex-manager of a baseball

team, can probably enlighten you on that point.

The Chairman. I did not know but what you might have some information on the point since you were holding it up as an example.

Mr. Taylor. No; I do not know that feature. I was never bought or sold when I played. I was the pitcher of the Phillips-Exeter nine when I was a boy. They never bought or sold me. That is all I can say.

The Chairman. Are you aware of the fact that once a player has been signed by any team in the league in which he is playing that he cannot go to any other team in the league, no matter what wages are offered to him, without the consent of the team with which he had signed?

Mr. Taylor. I have an impression that that is true, but I really do not know.

At the end of my answer will you allow me to state that in citing the management of the players on the baseball team as an excellent example of the scientific management I do not have in view in the slightest degree any such management as that. I do not wish it to be understood that I approve of any such thing as that. I know nothing about that feature of the management of a ball team, and I did not have that in mind when I spoke of baseball as a fine example of scientific management. I had the careful training and coaching and teaching of the baseball players in mind. And then their coordination and the cooperation which is so conspicuous in the management of a baseball team while it is playing a game. It was that that I had in mind and not the form of contract which they sign when they join their team, or the form of agreement.

The Chairman. You spoke of the science of shoveling and the introduction of different size shovels for different weights of material, that being based upon observation. Was it not to be expected, and would it not be expected under any system of shop management, that where the workman was required to furnish his own shovel that he would furnish a shovel of a size necessary for handling the heaviest kind of material, and that consequently his shovel would be too small for the lighter kinds of material?

Mr. Taylor. I have not really considered what would be the probability in that case, Mr.

Chairman. My impression is that the workman would probably take a shovel that would insure his not overworking himself when he was shoveling heavy material, and that therefore he would incline toward taking a shovel, as you say, which would be entirely too small for the lighter materials.

The Chairman. Is it not the case for hundreds of years that men have used different sized shovels for different weights of material; where they had light material to handle continuously, using light shovels, and where they had heavy material using heavy shovels, so as to get nearer the proper weight a man can handle?

Mr. Taylor. I have not the slightest doubt that different size shovels and implements for handling dirt have been in existence for hundreds of years. I do not know it, but I have not the slightest doubt of it. What I was trying to indicate in my testimony was that it became the duty of the management to supply the man with exactly the right implement to do each kind of work, and that the proper implement was only supplied to the men, and could be only supplied to the men, after the science of shoveling had been carefully studied, and that this was one of the results of the study of the science of shoveling.

The Chairman. I simply say, Mr Taylor, that more than 40 years ago I worked for a large coal company that required men to do shoveling, sometimes shoveling slates and shales, which are heavy, and sometimes shoveling coals, which are light. They maintained different sizes of shovels for use in shoveling the different kinds of material, an old-style No. 2 shovel being the style for handling the heavy materials and an old-style No. 5 or No. 6 for handling the lighter material or coal, the 5 and 6 being simply used for the different capacities of men, and that was before any furore had arisen with regard to shop management.

Mr. Taylor. It seems to me, Mr. Chairman, that you came very close to working under scientific management about 40 years ago yourself.

Mr. Tilson. I desire to ask a question. In regard to the 21½-pound load for shoveling,

does that apply regardless of the bulk to 21½ pounds? Is that the most economical load, regardless of the bulk?

Mr. Taylor. Yes, sir; regardless of the bulk.

Mr. Tilson. Do you take into account any difference in effect on the man, as the load varies?

Mr. Taylor. I think the load remains the same; whether the bulk is large or small the load remains the same.

Mr. Tilson. My question is just this: You found, as I understand it, that at 38 pounds to the shovel that was not an economical load?

Mr. Taylor. Not an economical one if it was too heavy a shovel load and prevented the man from doing a proper day's work.

Mr. Tilson. That is, your dirt pile grew as the size of your shovel went down?

Mr. Taylor. The pile of dirt shoveled in a day grew larger and larger as the shovel load starting with 38 pounds per shovel went down until we reached a 21½-pounds shovel load, at which load the men did their largest day's work, and then again the dirt pile grew smaller and smaller as the shovel load became lighter and lighter than 21½ pounds.

Mr. Tilson. What I was trying to get is this: You have told us the effect on the pile. What about the effect on the man? Was the man as well off when he was shoveling the 21½-pound load?

Mr. Taylor. Yes; he took his natural gait all day long in each of those kinds of shoveling. The workman regulated his own pace. No one regulated it for him. The fact was that when he was shoveling with a heavy load of 38 pounds it tired him to such an extent that he went much slower, naturally. He took fewer shovel loads, and he had to rest more between shovel loads.

Mr. Tilson. Then take it on the other side, if it was very light, not more than 10 or 15 pounds?

Mr. Taylor. In order to shovel the same amount with a light load of 10 to 15 pounds that he shoveled with a 21½-pound load, he would have to work so quick—to make his motions so quick—that they then became tiresome.

Mr. Tilson. So you figure it out that regardless of bulk the easiest load for a man to handle is 21½ pounds with a shovel?

Mr. Taylor. Yes, sir.

The Chairman. Would that be true irrespective of the distance that the dirt had to be thrown?

Mr. Taylor. No, sir. I am very glad that you asked that question. That again opens another large element of the science of shoveling, and I did not wish to burden you unnecessarily with the science of shoveling. Now, that holds true up to about 4 feet in length and 5 in height; that 21 pounds is the best load. When you rise above 5 feet in height, say, the combination of 5 feet in height and 4 feet in length, and go higher than that, then you must have a lighter load. The load again falls off. You understand, Mr. Chairman, that in my direct testimony, in speaking of the science of shoveling, I only spoke (broadly speaking) of the effect of that one element of the science. I want to assure you, gentlemen, again that the true science of shoveling is quite a large affair, but I will be glad to go into it if you care to go further, and tell you more about it. It is quite a large affair.

The Chairman. There is one feature about it that I am interested in, because I am quite convinced that it was scientific, and that was your description of the forearm to thigh, when you had to use force other than the arm force to get entrance of the shovel.

Mr. Taylor. Yes, sir.

The Chairman. I wondered at that time whether you had given any consideration in your scientific investigation to the direct application of force by the thigh or knee to the back of the hand.

Mr. Taylor. Mr. Chairman, I think if you get down as low as that, that it then demands quite an exertion of force by the right leg, a pulling of the leg, which is much more tiresome than if you put the right forearm (indicating a position two-thirds way up from the knee) and throw the whole body forward. The one motion is merely a throwing of the body forward like this (indicating), while the other is a motion of the right leg requiring considerable exertion when you push in the shovel. You must also have a specially made shovel to shovel at the knee.

The Chairman. That may be true as to the man who is trained to shovel out doors, but to

the man who is trained to shovel in the mines it is not true.

Mr. Taylor. I rather fancy that, as you say, it is not true. Again, Mr. Chairman, it appears that the science of shoveling is even broader than we know anything about, and that a further investigation (I haven't a doubt) would prove that what you claim is true.

The Chairman. You say that one of the methods by which the employer can be disciplined if he fails to live up to his own methods of rules and regulations is that the workmen can drop back to the old method which you call soldiering. Would it not be part of scientific management to let out of employment entirely the man who drops back to the old conditions?

Mr. Taylor. If he were let out of employment, and another man took his place, and that man were treated unjustly, that man would do the same. It would be simply getting a second man who would do the same thing. You cannot get a fresh man who will submit to injustice any more than your old employee will.

The Chairman. The only method, then, of disciplining the employer for failure to comply with his own formulas is that the individual workmen might leave him?

Mr. Taylor. I fail to see why just exactly the same treatment could not be accorded to the employer under the scientific management who misbehaves himself as could be employed under any other type of management.

The Chairman. Would it be possible under your scientific management for the workmen to act collectively for their own protection, when it is stated that collective arrangements or collective bargaining relative to the conditions under which the workmen are to be employed cannot be permitted under scientific management?

Mr. Taylor. Mr. Chairman, I have never made any such statement as that. I dare say that some one else has made it. I never have made any such statement as that. I stated in my testimony just a little while ago that I have never seen the necessity for collective bargaining. I have never found the time when those who were engaged in scientific management needed the stress of collective bargaining to be

brought upon them in order to make them right any wrong. It is sufficient under scientific management for a single workman to step up and say, "I have been wronged" and he will have his wrong righted; to say that these conditions are wrong, and he will have an investigation made to find whether they are or are not wrong conditions, and in investigations, as I have stated, the workman always has his share.

The Chairman. If I understood your testimony correctly, Mr. Taylor, you said there was no objection—in fact that you courted the co-operation on the part of the employees relative to the conditions of employment, and yet under scientific management you would permit no interference on the part of the employees relative to the conditions under which they should be employed?

Mr. Taylor. If I made that statement then I made a statement which I did not intend to make. I think you have in mind, Mr. Chairman, that I stated that when a workman is given an instruction card asking him to do work in a particular way that until he has attempted to do that work in that way, until he has followed his instructions as they are written, that no protest on his part will be received. In other words, that you do not want to furnish a man with an instruction card which represents the careful result of years of standardization and of definite laws that have been developed and then without any trial of the method on his part have him start a debating society. That is, we want him first to do one piece the way his instruction card says, and then only after he has the personal experience of trying this method, let him come and protest in any way he sees fit, but not start a debating society every time a piece of work is given to a man. That is what I have said, and that, I think is the limit in the direction to which you refer.

The Chairman. Do you speak of Mr. Gilbreth having developed a method by which he increased the productivity of bricklayers from 120 bricks per hour to 350 bricks per hour, which would be equivalent to increasing from 960 per day of eight hours to 2,800 bricks per day of eight hours, and that the wages of the workmen in doing that had been increased approximately \$5 per day to \$6.50 per day? Do

you think that that kind of division for increased productivity shows a change of mind has taken place on the part of Mr. Gilbreth relative to the Golden Rule? Do you contend or state that \$6.50 for laying 2,800 bricks is a proper division, as against \$5 for laying 960 bricks?

Mr. Taylor. Mr. Chairman, if you will remember my detailed description of the way in which Mr. Gilbreth taught his workmen when he succeeded in laying 2,800 bricks, Mr. Gilbreth's method of working was less tiresome than when the same workmen worked under the old unscientific conditions and were laying only 900 bricks. Under Mr. Gilbreth's method he is working less hard and using fewer motions to lay 2,800 bricks than he formerly did to lay 900 bricks. He avoids entirely stooping over to the brick pile on the ground and raising his entire body up again every time he lays a brick. He reduces his motions from 18 movements per brick to 5 per brick, so that the workman himself was working less hard than he formerly did. The workman voluntarily chose his own pace. Mr. Gilbreth did not tell him how fast he must work. He did not have to lay 2,800 bricks. The workmen, of their own accord, laid 2,800. There was no limit whatever put upon them. They were merely told by Mr. Gilbreth, "Use my methods and the moment you use my method I will pay you \$6.50. That is all I ask of you, to use my methods."

The Chairman. Assuming that the workmen voluntarily laid these 2,800 bricks, did that, of their own volition, the spirit having got into their mind, some change of spirit having reached there and they did this voluntarily, laying 2,800 bricks as against 960, do you want this committee to believe that the same spirit has got into the mind of Mr. Gilbreth when he only paid them \$6.50 for those 2,800 bricks as against \$5 for 960?

Mr. Taylor. In the first place, I am not sure that \$5 and \$6.50 were the exact figures; I merely stated them as relative figures as I recollected them.

The Chairman. Well, assuming them to be that.

Mr. Taylor. Under scientific management

we have been accustomed to increase the wages of our workmen so that they receive from 30 to 50 per cent higher wages than they had before whenever they follow our instructions. That is about our raise in wages for that class of work, from 30 to 50 per cent. And I believe that the workmen all over the country who have come under scientific management are satisfied and contented and feel that they are well paid for this change in their method of working.

Mr. Redfield. Right in the same point, put down these figures and see if they are correct as to this laying of bricks. By the old method at 120 an hour, multiplied by 18 motions, equals 2,160 motions per hour. By the new method 350 bricks per hour, multiplied by 5 motions, equals 1,750 motions per hour. The product of 960 bricks per diem, therefore, was on the basis of 2,160 motions per hour, and the product of 2,800 bricks per diem was on the basis of 1,750 motions per hour, or a diminution of 410 motions per hour for the larger product, or per day of 3,280 motions less for the new method than the old with a product of 2,800 as against 960. Is that correct?

Mr. Taylor. That is correct, and, Mr. Chairman, I would add that among the eliminated motions was this terribly tiresome one of lowering the body from its full upright position all the way down to the ground and picking up a brick, and then raising the body up again before turning around and placing it on the wall. The elimination of that one motion alone is an enormous saving in effort, so that without question the workmen are working far less hard under Mr. Gilbreth's new system than they were under the old system.

Mr. Redfield. So far, Mr. Taylor, let us assume that the result may be called scientific. Now, I want to renew the question which the chairman asked in a little different form. Now, he has, though concededly at a less effort, a product of 2,800 as against 960, or in other words, our output has been multiplied by nearly three. The rule of the scientific management system is that one-half of the gain, or approximately that, should be given to the workman. If that were done his wages would rise to \$10 per day, and the employer would

still be a large profiler by paying his men \$10 a day, would he not?

Mr. Taylor. In that particular case I think he would, Mr. Redfield.

Mr. Tilson. May I ask a question there; what about the conditions under which the men work? Did you not tell us something about the additional appliances that were used?

Mr. Taylor. Yes. The scaffold was so arranged that the workmen were kept at the same relative height to the wall all the time. The scaffold was raised alongside the building as the wall went up.

Mr. Tilson. That was probably somewhat more expensive for maintenance than the old way?

Mr. Taylor. Very much more expensive. They had to have helpers to coordinate the bricks for them.

Mr. Tilson. Placed in the proper position?

Mr. Taylor. Yes; then they had to have men place it just right in the proper position. The labor cost more to temper the mortar than it did before. They had to have paid teachers to go around and show these men how to make their new motions. That was an additional expense. I just wanted to bring out the different and the improved conditions under which the men work now, and show that these improved conditions were paid for by the management.

Mr. Redfield. What about the chain blocks to carry the scaffold?

Mr. Taylor. The scaffold is a patented one of Mr. Gilbreth's which does not work with the chain blocks. It works by jacking up—

Mr. Redfield. Then it is your desire to have us understand that this increase of nearly three times did not represent a net profit—the whole of it?

Mr. Taylor. Certainly not.

Mr. Redfield. But was largely absorbed by additional outlay to produce this higher efficiency?

Mr. Taylor. Well, I should hardly say "largely absorbed." Partly absorbed, not largely absorbed. But in this connection I want to be perfectly frank. I will put it in this way so as to show an extreme case, that if, we will say, in a machine shop, a workman were today

using any series of movements on a machine which would turn out 5 pieces a day of a certain kind, and if any individual, a foreman, or another workman, or the management, or a group of men in the management were to devise a new series of motions, which causes the workman to exert no greater effort than he had before exerted, and if the workman could turn out 500 pieces instead of 5 in a day with the new method, that man would do his work tomorrow for his 30 per cent premium just the same as he had yesterday. I want to show this entirely new mental attitude. If, owing to no extra exertion on the part of the men, no new invention on the part of the man, a new and superior device has been adopted for doing the work—we will say, a new machine has been introduced that never was used before, and if that machine can turn out five or ten times the number of pieces the old machine turned out, the man is paid just the same 30 per cent increase in his wages as he was yesterday. I want to make the fact perfectly clear that there is no implied bargain under scientific management that the pay of the man shall be proportional to the number of pieces turned out. There is no bargain of that sort. There is a new type of bargain, however, and that is this: Under scientific management we propose at all times to give the workman a perfectly fair and just task, a task which we would not on our side hesitate to do ourselves, one which will never overwork a competent man. But that the moment we find a new and improved or a better way of doing the work everyone will fall into line and work at once according to the new method. It is not a question of how much work the man turned out before with another method. Mr. Barth here has perhaps been the most efficient man of all the men who have been connected with scientific management in devising new methods for turning work out fast. I can remember a number of—one or two—instances in which almost overnight he devised a method for turning out almost twenty times as much as had been turned out before with no greater effort to the workman. In that case you could not pay the workman twenty times the wage. It would be absurd, would it not?

The Chairman. I understand from your de-

scription now of the bricklaying system of Mr. Gilbreth that part of the increased productivity was due to a patented device which Mr. Gilbreth had invented, or that someone had gotten out?

Mr. Taylor. I think it is patented. I am not sure.

The Chairman. Whether patented or otherwise, it is an improved device, is it not?

Mr. Taylor. Yes. That scaffold that I told you about had a table on it, where on the old scaffold they had no table. The table is put in the middle of the scaffold.

The Chairman. You do not for a moment want the committee to believe, do you, that there could be no improvement in machinery were it not for scientific management?

Mr. Taylor. Of course not, Mr. Chairman.

The Chairman. Is not that also true with regard to your art of cutting metal, that that also is an improved device for cutting metal?

Mr. Taylor. No, sir.

The Chairman. And no improvement?

Mr. Taylor. No, sir; that is the study of an art. That represents the evolution of a science which took years to develop, and is in no sense analogous to the invention of a new machine.

The Chairman. Is it any part or parcel of the management, or is it the study of the art itself separate and apart from the management?

Mr. Taylor. The moment that scientific management was introduced in a machine shop, that moment it became certain that the art or science of cutting metals was sure to come. When it became the duty of the management to answer the two questions: What speed shall the machine run at and what feed shall be used, it was inevitable that they should seek for exact knowledge wherewith to answer these questions instead of guessing at the answer as the workmen have done in the past, and this would start the series of experiments which lead to the development of the science of cutting metals. It is the new mental attitude of the management that it is "up to us" to know and direct every element of the work instead of "up to the workman," which inevitably leads to the development of a science. When it becomes the duty of the management to make a

careful study of any group of facts, then the results of that study naturally formulate themselves into laws, into rules, into the development of a science. I want to make it clear, Mr. Chairman, that work of this kind undertaken by the management leads to the development of a science, while it is next to impossible for the workman to develop a science. There are many workmen who are intellectually just as capable of developing a science, who have plenty of brains, and are just as capable of developing a science as those on the managing side. But the science of doing work of any kind cannot be developed by the workman. Why? Because he has neither the time nor the money to do it. The development of the science of doing any kind of work always required the work of two men, one man who actually does the work which is to be studied and another man who observes closely the first man while he works and studies the time problems and the motion problems connected with this work. No workman has either the time or the money to burn in making experiments of this sort. If he is working for himself no one will pay him while he studies the motions of some one else. The management must and ought to pay for all such work. So that for the workman, the development of a science becomes impossible, not because the workman is not intellectually capable of developing it, but he has neither the time nor the money to do it and he realizes that this is a question for the management to handle. Furthermore, if any workman were to find a new and quicker way of doing work, or if he were to develop a new method, you can see at once it becomes to his interest to keep that development to himself, not to teach the other workmen the quicker method. It is to his interest to do what workmen have done in all times, to keep their trade secrets for themselves and their friends. That is the old idea of trade secrets. The workman kept his knowledge to himself instead of developing a science and teaching it to others and making it public property.

So that many of the similiar improvements in methods which doubtless have occurred to workingmen in the past, instead of being formulated into a science as they are under scien-

tific management have either died with the workingman or have been handed over by him to one or two of his friends, and then have gradually gone out of existence. Whereas, when the management make an accurate study of processes and methods, it is not only their duty but their profit to see that this science is disseminated and is spread out before all of the workmen who are under them. For instance, when we developed the science of cutting metals, after it was developed we published it broadcast to the world. This science was published as a part of the proceedings of the American Society of Mechanical Engineers which is not a copyright publication and is free to the entire public to publish. It went all over the world at once. It was not kept as a trade secret but was made public property.

Mr. Tilson. Does everybody use it now?

Mr. Taylor. Everyone uses it all over the world. It is open to everyone.

Mr. Tilson. How extensively is your system of cutting metals being used?

Mr. Taylor. I can say that it has been translated into Russian, into German, into French, into Danish, and into Dutch; it was also published in England.

Mr. Tilson. That is all right about the books, but how about the use, the actual application of it?

Mr. Taylor. I assume that the people would not have translated it into German if they had not proposed using it. This much I can say, Mr. Tilson, that one of the great results of this careful scientific investigation—one of the direct products of it—was the discovery of high-speed steel and the moment that this discovery was published to the world every machine shop grabbed it from one end of the world to the other. It is used all over the world. It has increased the average cutting speed of machine shops at least three times over their former speed. High-speed steel went all over the world right off. There is no question about that.

Mr. Tilson. Were you the first to use it?

Mr. Taylor. Mr. White and I are the joint inventors. We have patents for it all over the world. And we were fortunate in selling many of them. We got \$100,000 for the patent rights

in England, but the fellows over there did not get anything out of the patent rights in the way of royalty, I understand they far more than got their money back through being first in England to equip all of their shops with high-speed steel.

The Chairman. Might not those books be bought simply for the purpose of investigation to determine from them whether or not they did want to use your art of cutting metals, and the fact that they bought the books or that they were translated into those various languages would not in itself be evidence that they had adopted the system after having had investigated it through your books, would it?

Mr. Taylor. I am quite sure that a great part of that art has not yet come into use because in order to properly use it you must have a slide rule such as I have shown you here.

The machine shops in this country have not taken the pains to use those slide rules as they should. They are not used to the extent that they ought to be. I may state, however, that I had a recent visit from the owner of the Renaud Automobile Works, the largest automobile works in France, together with Monsieur de Ram, the young French engineer who personally became interested in the art of cutting metals some years ago, and in our system of management, and who put this system into one of Renaud's departments. These two men came over to this country especially to study our system (scientific management) and the art of cutting metals, and assured me that in those departments in which they had introduced the art of cutting metals and our system of management that they had much more than doubled their former output. They said that they were going back to France to spend any amount of money and any amount of effort to get it in as fast as possible in their entire works. The warning I gave them before they left was this: I said, "You have been at it three years. Do not expect to get through with it for five years, because you will not. It will take you more than five years before you will get through the entire process of putting our system in."

The Chairman. You spoke of laboratories in connection with scientific management. Is

it not true that nearly all the large firms in the country, irrespective of what system of management they have, maintain laboratories?

Mr. Taylor. I do not remember to have spoken about laboratories. Was it chemical laboratories you referred to?

The Chairman. Yes; chemical laboratories.

Mr. Taylor. Every steel works that amounts to anything has chemical laboratories, but I was not aware that I had spoken of chemical laboratories in my testimony. I may have.

The Chairman. My recollection is that you did speak of laboratories in connection with your testimony, and that recollection is reinforced by the fact that I have a note in connection with it.

Mr. Taylor. More than likely I did, then, Mr. Chairman. But I have forgotten. At any rate, I shall be glad to answer whatever questions you may ask.

The Chairman. I wanted to know if it was not a fact that nearly all of the large manufacturing establishments in the country maintain laboratories, irrespective of what management they may have?

Mr. Taylor. All the large steel works do, but I do not think the large machine shops have the chemical laboratories.

The Chairman. There are a great many industries where laboratories are maintained, are there not?

Mr. Taylor. Yes, indeed.

The Chairman. Irrespective of what system is used?

Mr. Taylor. In the cement mills, in some pulp mills, in the chemical works of the country, in the steel mills of the country, in the rubber establishments of the country there are laboratories.

The Chairman. So that a laboratory would not for the purposes of investigation in connection with the particular industry, would not in itself be peculiar to scientific management?

Mr. Taylor. Certainly not.

The Chairman. Would it not be more peculiar to scientific research? Would it not be more peculiar to scientific research than scientific management?

Mr. Taylor. I think that these laboratories that are established in connection with indus-

trial works are not often research laboratories in the sense in which that word is used in university parlance. I think they are very rarely research laboratories. I think they are practical laboratories needed for the everyday analysis of the products that are being made or the materials being bought.

The Chairman. Mr. Taylor, if men are induced to a greater productivity by virtue of a bonus system, and consequently an expenditure of greater energy on their part to secure this bonus, would there be any possibility of their securing a positive guarantee that would be binding for all time that the bonus would not be taken away, and thereby leaving them with the expenditure of energy at the old rate of pay?

Mr. Taylor. Most certainly no permanent guarantee could ever be given for anything that I know of in this world. But the workman would always have his remedy open to him. If he were badly treated he could soldier just as he is now doing under the present system. This is his cardinal remedy. This is the final word. The workman always has that resource. All the workmen have to do is to sit down and soldier, and the injustice comes to an end.

Mr. Redfield. Does he not have the interest of his employers always at heart?

Mr. Taylor. Yes, indeed. I am assuming that a fool employer, and there are a good many of them—

The Chairman. Are there not differences of opinion as to what constitutes a fool employer?

Mr. Taylor. Yes, sir; and a great many of the old-style employers are pointing to those who are introducing scientific management as being fool employers, inasmuch as they pay this unnecessary increase in wages to their workmen, as they call it. I do not share that view, of course, but a great many of the old-style employers do.

Mr. Redfield. Have you dealt with the question as to what happened to those laborers in the yards of the Bethlehem Steel Co. who were laid off from shoveling, so to speak, when the force was reduced, as you have testified, from between 400 and 600 to about 150?

Mr. Taylor. Mr. Redfield, I am very glad, indeed, that you asked that question. The gen-

eral impression which I find in the minds of people who hear the story told of the reduction of the men from, say, 500 to 150 (and this impression is particularly strong with those ladies who have heard of that story), is that all of the men who were thrown out of work went right out and drowned themselves in the river which flows by the works because they could never get any more work to do, and would therefore have to starve to death. That is the usual impression. I find a vast sympathy on the part of all classes of the community for those poor fellows who were thrown out of work, and who could never do anything else as long as they lived, but mighty little sympathy for the 150 who remained with the company and who received 60 per cent higher wages than they had ever earned before, or that the same men could get if they stepped out of that establishment and went to any other works around that part of the country. Now, I find that is the universal frame of mind, and I am very glad of the opportunity of saying just what happened.

The Chairman. You do not think those men who remained in there need sympathy, do you?

Mr. Taylor. No; I do not. I think they were all subjects for hearty congratulation. And I feel that the management who gave them 60 per cent higher wages than anyone else would pay them ought to have some sympathy and some regard. They ought to be looked upon as kindly and nice employers instead of being looked upon as brutes because the other fellows were discharged.

Mr. Redfield. What happened to the other fellows?

Mr. Taylor. What happened to the other fellows? That is the proper question. In every one of our establishments we have men employed whose business it is to make a careful study of the laborers as they come to work, that is, of all of the ordinary day laborers, as they come into the employ of the company. Those men are selected because they know how to get next to the average workman as he comes in, get acquainted with him, and find out what he is thinking about, to ask him what kind of work he has done before, and watch and study the new men when they do not know that they are being watched. They will come right on him

while he is at work and see if he is really an industrious man. In other words, their business is to get thoroughly acquainted with the newcomers. There are any number of fine fellows who come into the steel works, or into any other establishment, as laborers who never in their youth had the opportunity of serving an apprenticeship, and yet who with the proper instruction and the proper opening were intelligent enough and energetic enough to have learned a trade.

This man or these men who are employed especially for the purpose of making a study of these laborers are constantly sent for by the foremen of the various departments who are in search of good workmen. The foreman of the blacksmith shop, the foreman of the foundry, the foreman of the machine shop, the foreman of the rolling mill, of all the various departments of a steel works, are constantly after these men. They say, "Haven't you got any good raw material for me to try out in my department?" Whenever a fellow shows himself to be an energetic, a good, hard-working fellow—and if, in the judgment of this man he has sufficient intelligence to become something more than a shoveler, something more than a pig-iron handler—he is deliberately taken out of the labor gang and put, say, into the smith shop, first as a laborer, then finally taught to be a helper, to learn to strike at a forge; or he is taken into the foundry as a laborer, and then gradually taught to be a helper to the molder and given the higher wages that go with these higher types of work. Or he is taken into the machine shop, if he is an especially intelligent man. And later on he has the opportunity of learning to be a helper to the machinist who is running a big machine which calls for the work of two or three men. Now, to show the extent to which the men were promoted from the laboring gang in the yard of the Bethlehem Steel Co.—that is the gang we spoke of where the reduction had been made from 500 men to 150—to show the extent to which promotion took place from this gang: In the big shop of the Bethlehem Steel Works, which is about one-third of a mile long, also one of the widest machine shops in the country, there are a great many powerful roughing machines—machines

used for removing the outside rough material from forgings or from castings, merely to take off the heavy rough stuff, not to finish to size. These machines are called upon to do work in which a limit of accuracy of a quarter of an inch in diameter or half an inch in diameter is sufficient.

In running a machine of that sort nothing like the same amount of skill is required which is demanded of a first-class mechanic who has to finish work to exact size and put a true, fine finish on it. There are any number of those heavy roughing machines in the big shop of the Bethlehem that do not demand a high-class mechanic to run them. Before we left the Bethlehem Steel Co.—just as a matter of interest to ourselves—we had an investigation made to find out the origin of all the men who were then running the roughing machines in that shop, and 95 per cent of the men who were running these machines had been promoted from laborers, had been taken into the shop, taught their trades, and had risen to the position of roughing machinists, and then had been given the higher wages which goes with this class of work, as well as having the higher and more agreeable work to do. That is what happened with those 500 yard laborers who have been pitied so for the hard treatment they received.

Mr. Redfield. What happened to the men at the roughing machines?

Mr. Taylor. If they were good men, if they were able to learn to do finer work, they were promoted from there onto the finishing machines.

Mr. Redfield. Then do you mean that under the system as it was applied there was a general upward movement throughout all grades in the shops?

Mr. Taylor. That is exactly what takes place under scientific management. The management look upon it as their duty to raise every man in the place to the highest grade of work for which he is suited and then to pay him the higher rate of pay which goes with the more skilled work.

The Chairman. When it had reached the point that you were about to elevate the second highest grade to the highest grade in this gen-

eral movement upward, what became of the men in the highest grade?

Mr. Taylor. They became the teachers. They became the functional foremen. They were promoted to the planning room. They were placed in exactly the same position that these gentlemen have reached whom I have brought here to testify before you and to tell you how they were promoted. They started as workmen and finally graduated as bosses.

The Chairman. Had you reached that stage in the introduction of scientific management at the Bethlehem Steel Works where you had these functional foremen supplied from the men from the highest grades?

Mr. Taylor. We had to a very great extent. I suppose we had 40 or 50 promoted in that way, but nothing like as many as we ought to have had if the works had been finally systematized as it ought to have been. There ought to have been three times as many men who had graduated from machinists to teachers, etc. and there would have been if we had remained there.

Mr. Redfield. Excuse me, Mr. Taylor, but what has been your experience as to the effect of the helping and the teaching and the definite instruction card which workmen receive under the scientific management in its effect upon making them mere machines and injuring their initiative?

Mr. Taylor. Mr. Redfield, I answered that question already, did I not, Mr. Chairman?

The Chairman. I believe you did in your own way.

Mr. Taylor. If you wish me to answer it again I will do so. I think that question is on the record.

Mr. Redfield. Then it is not necessary to answer it.

The Chairman. I made an inquiry in practically the same language.

Mr. Redfield. I understand. We will let that rest then.

Mr. Taylor. Not that I object to answering if you wish me to.

Mr. Redfield. Mr. Taylor, how far is it recommended or is it customary in connection with the installation of the system of scientific management to require or to utilize incidental ap-

paratus in which you have an interest as a manufacturer?

Mr. Taylor. I hardly understand that, Mr. Redfield. I do not quite understand your question. If you will give me an illustration perhaps I can answer it.

Mr. Redfield. The suggestion has been made at various points in the testimony that while it must be understood that you are not actually engaged professionally and personally in the business of introducing scientific management that you would have a marked financial interest in its introduction arising from the necessary sale, it is suggested, as an incident, as a portion of the installation of the product of certain businesses in which you are a part proprietor.

Mr. Taylor. Mr. Redfield, if anyone wants the profits I am making annually they can have them for the asking from any incidental apparatus that is sold. These slide rules, the use of which I explained to you, for instance, I have never known one of them being sold to anyone. They are given away if anyone will show us that he can use them. Mr. Barth and Mr. Gantt and I, myself, are the joint patentees of those slide rules. If any man can come from any part of the world and show us he can use that slide rule, he may have it for the asking, but he has got to show us that he can use it.

We used to let them have slide rules like these, whether they could use them or not, until we found that they were being used as an object lesson to display the folly of scientific management. Men whom we had given these slide rules to would say, "Why, here, just see what damn fools these fellows are. They use a thing like this to run a machine shop with." When I found that this was the use to which they were being put, we got a little bit wiser. We said, "You cannot have these appliances to make fools of us with. You cannot have them until you can show us that you know how to use them." And in further answer to your question, Mr. Redfield, far from making money out of scientific management, since retiring from money-making business I have each year, for the past ten years, spent more than one-third of my income in trying to further the cause of scientific management, besides giving

my whole personal time and work to the cause without pay.

The Chairman. Is the slide rule an essential part of scientific management?

Mr. Taylor. No, sir. It is not an essential part, but it is a highly desirable instrument; if a man wants to run a modern machine shop as it really ought to be run under scientific management, he must use it. The Midvale Steel Works, my old establishment, are still using the tables which Mr. Gantt and I developed there for running their machines instead of the more modern and far more efficient slide rules developed after we left there. These tables were the limit of the mathematical solution of that problem when we left Midvale in 1889. The same tables are still used by the Midvale Steel Works.

The Chairman. Is it not only applicable where machines are used?

Mr. Taylor. Certainly; this rule is only applicable to the solution of problems connected with the art of cutting metals.

The Chairman. As a matter of fact, is not the so-called scientific management consigned almost exclusively to machine shops, and to the metal trades particularly?

Mr. Taylor. It is in use in flour mills, in paper mills, in cotton mills, in bleacheries, dye works, in printing establishments, lithographing, and the Lord knows what. Mr. Chairman, you can go right along, into the steelworks and ironworks and machine shops of all kinds and sorts, and find it in use in pulp mills, optical works, electrical works, and even a button factory. One of the shops was a bicycle-ball factory. They made some 300,000,000 bicycle balls in a year. There is variety for you.

I may say, as an interesting and new use for scientific management, that the director of public works at Philadelphia was appointed to that position so as to introduce the principles of scientific management in the management of the city of Philadelphia. He is doing it mighty fast. He is making a mighty good start at it. I should like very much to have the director of public works at Philadelphia to appear before the committee if you care to hear him, and have him give you his experience with scientific management, because he was chosen for his present

position on account of his experience in scientific management.

Mr. Redfield. Is not scientific management largely a state of mind?

Mr. Taylor. The essence of it is this new state of mind. The very essence of it involves this new and complete mental revolution as to the duty of both sides, one toward the other; the substitution of the attitude of peace for the attitude of war. There is no question about that.

Mr. Redfield. Was scientific management ever introduced in whole or in part in the factories of the American Locomotive Co.?

Mr. Taylor. I am very glad to state, not what I know, but what I believe to be the truth about the American Locomotive Co. I have never been in their works since they started to try to introduce scientific management; but if such knowledge as I have, and it has been obtained by talking to perhaps 20 or 30 different reliable men connected with the American Locomotive Works, will be of any value to you, I shall be very glad to give it.

In the first place, Mr. Van Alstine, whom I know intimately, and who I have every reason to believe is one of the most upright and straightforward and honorable men in this country, and who is a high-class man, became interested in the principles of scientific management when he was master mechanic of the Chicago & Great Western road; but he met with little sympathy in his attempt to introduce these principles in the shops of that road. He then went to the Northern Pacific as master mechanic, and had very much greater success there. But he found that after all people there had no great sympathy with him. They did not understand what he was driving at. He produced economies which were very notable, and which led them to want him to remain there, however, in the most urgent way. Then he finally went to the American Locomotive Works, with the object of introducing the principles of scientific management into that works. About the time he went there he came to see me, because I had been in consultation with him for several years. He came to see me about the introduction of scientific management in the American Locomo-

tive Works, and the most urgent advice which I gave him (and I gave it in a most emphatic way) was that he should not start in the locomotive works to introduce scientific management until he had the complete backing of the board of directors of that institution, until every man on that board, as well as the president of the company, was with him—until every man on that board wanted scientific management and wanted it badly.

It has been my experience that if a man starts to introduce the principles of scientific management into any company, unless the owners of that company, the directors, the people who have the final power—unless they want it and want it badly, and understand the price that has to be paid for it (and that price is one of long time and patience), my advice to him was that you let that thing alone. Mr. Van Alstine thought he could carry it over, as he said, without bothering the whole board to get a thorough knowledge of the whole matter and everything connected with it, and he started to introduce scientific management, and started in the right way to introduce it—that is, rather slowly. But if I understand the conditions—and I think I do—the board and the president began to put such pressure on him for immediate results, that, contrary to his best judgement, he was tempted to shove the thing too fast.

He attempted to do what is an utter absurdity in any company. He attempted to do in two years what he ought to have taken five years to do, and in doing so he and Mr. Harrington Emerson, who joined him, abandoned the very essence of scientific management, the one essential thing. They tried to force in a whole lot of mechanism which ought to belong to scientific management; it is all useful and very fine, this mechanism, without waiting to convert the workmen as they went along; that is, to bring about this great mental change on the part of the workmen which is necessary for the success of the system. They went ahead, neglecting the absolute necessity of the mental change both on the part of the workmen and those on the part of the management, which I have referred to so many times in my testimony as the essence of scientific management. They tried to do what is an utter absurdity, and final-

ly wound up by forcing the mechanism of scientific management in many departments of the company, where the proper spirit did not exist among the employees at all, and that led to just what I told them it would lead to when they first came to me. I told them, "If you do not go slow enough; if you do not allow the workmen to see that the new system is a fine thing for them, and get them into the proper frame of mind, so that they will cooperate with you thoroughly, the time will come when the whole thing will fall." As I have said before, the chief trouble with the whole undertaking lay with the board of directors. Their attitude was wrong. It was the owners who finally made the thing go wrong.

Mr. Redfield. Mr. Taylor, how far is scientific management in use by any of the large railway systems of the country?

Mr. Taylor. There is one of the large railways in this country that is using it to a very large extent. I have some of the data here which was given to me in confidence by the man who spent, I should think, some three, four, or five years in introducing the principle of scientific management very largely in one of our great railway systems. The result of his work has been that during the whole time in which he has been working there and up to the present time there has existed almost perfect harmony between the workmen and their employers. The workmen are earning higher wages I understand than corresponding workmen in any other railway system in the United States. If I remember rightly he told me that all the repairs on 20 types of locomotives were made with proper instructions as the result of accurate, careful time studies, and that the men who were making those repairs were all working under piecework. I may be wrong in the figures, but my remembrance is that he said that 70,000 items of repairs had been studied in that way on the locomotives and cars of this section of the line. I regret that I am unable to give the name of the man and the road which is doing this, because it came to me in confidence, and while I should be very glad and delighted to help you in getting a complete knowledge of this work I always feel that I am bound to strictly maintain a confidence of that sort.

Mr. Redfield. In other words, you were his professional adviser?

Mr. Taylor. In a way, yes; he started because he had read what we have written on the subject. He came down to see me at intervals and talked the matter over, but I could not say that I was his professional adviser. I was merely a friend having the interest I have in all earnest endeavors to introduce the principles of scientific management. I should be delighted to show you samples of the piece-work schedules that he gave us. Here are two lists of these piece-work prices.

Mr. Redfield. Did you say that there was 70,000 of them?

Mr. Taylor. They are simply samples of the 70,000. These are two of the various schedules which he left with me. My impression is that there are 70,000. My recollection is that on another branch of the same road there are over 100,000 items of locomotive and car repairs carefully studied and put on piecework in this way. I am sure the number of operations was 100,000 to 130,000 on one of the branches of that line and somewhere near 70,000 on another. In a recent conference the vice president of the road told me, "No set of men on the face of the earth can ever stir up any sort of discord between us and these employees of ours who have come under these new principles. We have become the best of friends under this system." That is the principal reason why I have concluded that in this railway company the principles of scientific management exist. In talking with him lately I asked permission to place this information before your committee. He said, "Yes, as far as I am concerned, but the request ought to go to the board of directors of our company; I have not the authority to do that sort of thing without their permission. I think I can get the authority. As far as I am personally concerned I am delighted to have this knowledge go anywhere, but you understand I am not the whole thing, I am not the railway company, I don't know what our board of directors would say."

The Chairman. Mr. Taylor, without making the name of this particular railroad public, or without any desire to put the name of the railroad company in the record, in view of your

explanation, is it not true that within a year that railroad company had very extensive strikes in its railroad shops?

Mr. Taylor. Certainly in none of the shops where this was introduced. I am absolutely sure of that. As to what occurred in other shops I do not know. There is one large section of that line that has not yet come under these principles, and what occurred there I do not know. My impression is, as you say, that there was a strike in the section, still working under the old system, but nothing of the kind in the two sections where our system of management was in use. That I am sure of.

The Chairman. I think you said, Mr. Taylor, that scientific management was to a great extent a state of mind.

Mr. Taylor. Without a certain state of mind scientific management cannot exist. There must, however, be something more than a state of mind. There must first be a certain state of mind—that is, a certain new outlook on both sides. The idea of peace must replace the old idea of war on both sides. Then in addition to this change in mental attitude both sides must come to look for exact facts and exact information as the foundation of their action. That is, exact science should be the basis for every action instead of the old rule-of-thumb knowledge or guesswork.

The Chairman. Would not a state of mind be a very unstable and changeable thing upon which to base materialistic production?

Mr. Taylor. I think there is nothing more stable in life than our convictions. If there is anything stable in life it is a state of mind. It is principles, and there is nothing more permanent than the principles which have become deep rooted in us. The principles of religion, the principles which govern men's daily actions are the most stable things in us. Our outward acts may change, our knowledge may change, our views may change, but once we have fundamental principles they rarely change materially.

The Chairman. It is a noted fact that the state of mind frequently changes?

Mr. Taylor. Yes, in minor matters they do, but when people are gradually convinced, when men adopt a new mental attitude toward

one another, and toward their duties, and scientific management is a revolution as to their duties toward themselves and their fellowmen—that is, a slow revolution, difficult to bring about, but once it is brought about it is apt to be very stable.

Mr. Tilson. Is there not this further fact that if your contention is true that it is not only a state of mind that is just but it is profitable to both parties?

Mr. Taylor. Exactly; immensely profitable.

Mr. Tilson. So that their particular interest will coincide with this state of mind if your contention is true?

Mr. Taylor. Yes, sir.

Mr. Redfield. How is it possible to study how long the workman should take in that part of the work that is purely mental? For example, how long he should take in making up his mind how work should be done or in reading and grasping a drawing?

Mr. Taylor. The first piece of time study that I ever saw made by anyone was made in the study of just that thing, a study of the mental capacity of boys. When I was at Phillips Exeter Academy, Mr. George W. Wentworth was the professor of mathematics, and he worked off his first geometry while it was in manuscript and his first algebra on my first class, the class of '74. He worked those books off on us for the two years while I was there. I, as a student, wondered how it was possible (that right along steadily, right through from the beginning to the end of the year, as we went on from month to month) that old bull, Wentworth, as he was called, gave us a lesson which it always took me two hours to get. For the two years I was there I always had to spend about two hours getting that lesson, and finally we got onto his method. We were very slow in getting onto it, however.

Mr. Wentworth would sit with his watch always hid behind a ledge on the desk, and while we knew that it was there we did not know what the darn thing was used for. About once a week or sometimes twice a week he went through the same kind of exercise with the class. He would give out a series of problems and insisted that the first boy who had them done should raise his hand and snap his fingers.

Then he would call his name. He went right through the class until just one-half the class had held up their hands. We always noted when he got half-way thru the class and the middle boy would snap his fingers he would say, "That is enough; that will do." What he wanted was to find out just how many minutes it took the average boy in the class to do the example which he gave. Then we found that Wentworth timed himself when he first tackled those problems. He got his own time for doing those five examples, and the ratio between his time to do the examples and the time of the middle boy of the class enabled him to fix the exact stunt for us right along. The speed of the class changed. He did not change. All he had to do was to get this ratio of change, and he could say, for instance, the average of that class will take 2 hours if I can do the examples in 25 minutes, and in this way he was able to give the class its proper stunt right along. That was the first instance of a time study of mental operations which I had ever seen. Under scientific management we are working constantly making mental time studies now. If we want to find how much time it takes for the average machinist to read a new drawing which he has never seen before, the man who is in the planning room and who is especially skilled in reading drawings—that is what he is there for—keeps a close tab on the time it takes himself to read all kinds of drawings, and he knows, for instance, if it takes him 10 minutes it will take the average man in the shop, say, three or four times that long. That, for example, may be the ratio between the skilled man and the average man in the mental operation of reading a drawing. The moment he knows how long it takes him, then by multiplying he knows how long it takes the average man. He has to keep himself constantly in touch with the men in the shop in that way, of course. Mental time study is made by us now, just as it was made by Wentworth in 1872.

Mr. Tilson. How do you first find out how long it takes the man in the shop to do it? How does this man in the planning room first find out how long it takes the other man to do it?

Mr. Taylor. You must realize that a lot of similar information is already known for other drawings. So that the man in the planning

room has a general line on how long it ought to take to read drawings, and this makes it difficult for any workman, if he even is inclined, to fool the planning-room man very much. The planning-room man calls in a reliable workman and says, "John, I want you to study this drawing, and study it right, and let me know when you have got wise on it." Now, in this way he asks several men of about average ability to make this study and finds that it takes them, on the average, 20 minutes to do it; then he will study the drawing himself and see how long it takes him to get onto it. In this way he gets the ratio of his speed to that of the average man in the shop. Once that ratio is determined it becomes a rather simple matter to make this kind of mental time study.

Mr. Tilson. But, after all, that is only approximation?

Mr. Taylor. The whole subject of time study is only an approximation. There is nothing positively accurate about time study from end to end. All that we hope to do through time study is to get a vastly closer approximation as to time than we ever had before. That is one reason why we have to allow this big margin of safety, as I explained to you. A marginal allowance of from 20 per cent to 225 per cent is added to the observed time, so as to cover all kinds of uncertainties.

The Chairman. When you make a time study of a man at physical labor do you not always eliminate in that time study the pauses in that man's work, the time when he is not actually applied at his labor, so as to get at the accurate and actual time in which he performs the labor?

Mr. Taylor. There is a printed page (indicating) that is typical of just what is done in time study illustrating this part of the subject.

The Chairman. That will not put the answer to my question in the record.

Mr. Redfield. Let us put this in the record.

The Chairman. I wish to get a direct answer to my question.

Mr. Taylor. To answer your question, we do both things. We take the gross time, the whole time which the man takes in doing the job, and then we make at the same time another study which includes the productive time alone, the time he is engaged in actual work. On this

printed page there is a study of the gross time, and a study of the productive time as well.

The Chairman. When you make a study of the productive time you eliminate in that study, and are able to do so by virtue of your stop watch, the periods in which the workman is not engaged in productive work?

Mr. Taylor. Yes, sir.

The Chairman. How can you take a mental study of the productive time, the mental time that it takes to work out a problem? Would you be able in your time study to take the time of the mental pauses that occur during the time when the problem was being worked out?

Mr. Taylor. The time during which the man stops to think is part of the time that is not productive.

The Chairman. Can you get a record of it with your stop watch or by any other method of timing?

Mr. Taylor. We can get the time during which the man is thinking with the stop watch in just the way that I described to you in the reading drawings, by telling a man to do some mental act, and then seeing how long it takes him to do it.

The Chairman. Would not that simply be the gross mental time from the time the man starts to work?

Mr. Taylor. Yes.

The Chairman. Would you be able to make a time study showing the amount of time in that gross time that was non-productive mental time?

Mr. Taylor. I would assume, Mr. Chairman, that if you asked a workman in advance, saying, "Now, John, I want to find out how long it will take you to get a complete notion of what you are going to do in this work. Now, play fair with me, John. The moment I tell you what you are to do you start and think and plan it all out and don't start to work until you have your plan all made." I think John would be fair in that. I think he would do his thinking in a fair way, just as he does this work in a fair way. And that he would tell you when he had finished making his mental plan.

The Chairman. Why could you not take his word?

Mr. Taylor. You could not be absolutely sure that he was deceiving you in some way.

But I have found that when you are straightforward with men and when you explain to them what you are trying to do, and when they believe that you are in the main straightforward yourself, and that there is no crookedness back of what you are trying to do, men will generally cooperate with you honestly.

The Chairman. Why do you not take his word for it in the physical work then as well as taking his word in the mental work?

Mr. Taylor. Yes—

The Chairman. Why put the stop watch on him?

Mr. Taylor. Because he cannot use the stop watch on himself. He cannot work and put the stop watch on himself at the same time. As I have told you time and again, Mr. Chairman, the way we do in almost every case is to go to the man in perfect frankness and say, "John, we propose to make a joint study of this kind of work; we want to get at this together because it is for our mutual interest to do so. I am sure that you will work fairly on this." As I told you in the case of those laborers, we paid them double wages when they were being studied in that way. We doubled their wages. They played perfectly fair with us. They did not either overwork or underwork. They worked at a proper pace for a fair man to work at. That is the way we get all our information. It is through co-operation. It is not through any sneaking business. It is not through any underhanded business. I think, Mr. Chairman, you will see that in everything I have written in relation to the time study I have advocated absolute frankness and no underhand work. There is no sneaking about it if time study is properly applied.

Mr. Redfield. Have you explained how you arrived at the percentage of increase in pay necessary to make men desirous to work under scientific management? You have said that it was sometimes 30 per cent and sometimes 50. How are those figures arrived at?

Mr. Taylor. Again, that has been the subject of a scientific investigation. It is not the question of my judgment or of any other man's judgement. I am very glad that you brought this matter up, because the average person thinks that the premiums which we pay of 30 per cent for this kind of work, 50 per cent for

that, and 80 per cent for another kind are all arbitrary figures, arrived at from some one's judgment. These percentages were adopted as the result of a long series of experiments. They represent a most difficult type of experiments to make. Nevertheless they were experiments, carefully and scientifically made experiments.

To make one of these experiments I took, perhaps, eight or nine of my friends who were workmen—it was after we had started scientific management, after we had arrived at this condition of mutual confidence which exists between employer and employee under scientific management—I picked out six or eight of my working friends who were nice chaps and sensible, common-sense fellows, who had confidence in our integrity and believed in what we were doing. We were good friends. I said to this group of six workmen, "I am going to give you the same class of work that you have been doing in the past, but I want you to change from working on plain daywork in which you have done the work according to your own method, and to follow the method which we will lay down for you in an instruction card and also you will be expected to do the work within the specified time. Whenever you do the work right and within the specified time we will give you a premium amounting to 15 per cent increase in your pay. Now, just go at that fairly, you fellows, work in the new way for six or eight months, and then if at the end of that time you do not like it, after you have given it a fair trial, let me know, and you can go right back to the old conditions again if you prefer them."

Another set of men, we will say the same number, were given 20 per cent increase in pay; another set of men were given 25 per cent increase in pay, and another set an increase of 30 per cent in pay, and another 35 per cent, and so forth.

Now, out of the six who were given 15 per cent—I do not say that six was exactly the number, but that it is approximately right—practically almost all of them came at the end of the six months and said, "Now, see here, Fred, I have tried that scheme of yours, and I do not like feeling all the day long that I am tied down to any old pace, or to a new way of doing things. I should prefer going back to the old way." Very well; this experiment showed that an ad-

dition of 15 per cent to the workman's pay was not sufficient to compensate him for the bother of having to change his ways and methods of working and adopt some other man's way of doing things. For it is true, as you know, under scientific management, that the man is not allowed to do work in the old way. He has got to learn a new set of motions and do many new things, and the 15 per cent increase in wages was not enough to make those men feel happy and contented in making this change.

At the 20 per cent increase almost all of the men asked to return to their old conditions and their old pay. At the 25 per cent increase more than half of them stuck to the new conditions and preferred them to the old, the 25 per cent increase was attractive to them. At the 30 per cent increase all but one stuck to the new plan. At 35 per cent my remembrance is that all stuck.

It took some years before that experiment was fully carried out, and we made up our minds that when workmen are paid from 30 to 35 per cent increase in wages, 19 out of 20 good workmen, well suited to their jobs, are happier and more contented under the new system than they were under the old, because you will remember that they had had their free choice between two systems. It was in this way that we got at these percentages. I call that a scientific experiment; that is not some one's guess. And it is typical of scientific management that every element that comes under it sooner or later becomes the subject of careful scientific investigation.

Mr. Redfield. The statement has been made that it is un-American and an indignity for a workman to submit to time study with a stop watch; that it is annoying and makes a man nervous and irritable. To what extent have you any knowledge as to what extent that is true or not true?

Mr. Taylor. Mr. Redfield, I think that the average workman, if any man came to him with a stop watch without any previous explanation or understanding and began timing every motion and writing down what he was doing, would become nervous and would be irritated by it. I think it is perfectly natural that any workman should become irritated at an action

of that sort. I am very sure that I should be nervous to a greater or less extent if anyone were timing every one of my motions. I would feel that it was a darned mean job while the thing was going on. But, Mr. Redfield, I wish to call your attention to one fact, which is not at all appreciated: somehow there has come to be an impression in the minds of people who speak and think of scientific management in its relation to time study, that for every workman who is working in the shop there are probably four or five men standing over him year in and year out with stop watches. Let me tell you that in some of our shops there are many workmen, who in the whole course of their lives, never have had a stop watch held on them. And that probably the average man would not be timed for more than one day in his lifetime. So that probably one day of the workman's life would sum up the total of this terrible nerve-racking strain which several of the men who have testified before your committee have complained of. Therefore, if any man objects to time study, the real objection is not that it makes him nervous. His real objection is that he does not want his employer to know how long it takes him to do his job. Because when his employer has this knowledge soldiering becomes much more difficult.

The Chairman. Would it not be more likely that his real objection was that a time study taken under those circumstances and for a brief period of time with an unaccurate system of stop watch, was not the proper kind of study upon which his wages should be based?

Mr. Taylor. I am very glad you brought that out, Mr. Chairman. You must remember that in any one workman's work, which is now being studied with a stop watch, all that the time student is looking for are perhaps eight or ten motions that the workman makes. The rest of his motions have already been studied on other workmen. The great majority of the movements of machinists have become standardized and require no further analysis or timing. When you study new work nineteen-twentieths of the motions made by the machinist have already been studied. It is the one-twentieth, the one new type of motion that we have not yet had the opportunity to study, which the time student is after. You will understand that

modern time study as it is done in our shops is a study of each elementary motion made by the workman. It is not a roundup of how long it takes a man to do a whole job. That kind of time study is very rare. With each new machine that a man starts to run there may be five or six new motions that have never been studied before, and it is those five or six which we are after. And a day's work will give plenty of opportunity to get those few motions all right. These same motions may be repeated 50 times a day, and that will give you a chance to get a fair average of them. The workman does not know unless you tell him what it is you are studying. You come out to see him and say: "John, I want to find out four or five things about your work. When they come around in the course of your work I am going to note down those four or five motions." We rarely make a time study of a man without taking the man into our confidence, without going to him in advance and saying this is what we come after. We want to find out these facts. It is to your interest, just as it is to ours, to have this time study accurately made.

I can tell you that time and time again the request comes to us from a workman to please come and study his job, so that we can give him a chance to earn a premium. He will say the other fellows are getting paid a premium for their work and I would like to get in on it too.

Mr. Redfield. Mr. Taylor, is soldiering still practiced in the works that are systematized under scientific management?

Mr. Taylor. I think that I may say that to a small extent it is still practiced in every scientifically managed shop. I do not think it has ever been entirely done away with. I can tell you the reason why. In the early stages, when scientific management is being put into a shop, the men who are installing the system are very anxious to have the workmen participate as early as possible in the gain which accompanies the scheme. We are very anxious for them to earn larger wages. We are desirous of proving to them as soon as possible, through an object lesson, that the management is not going to be the only party to benefit by the change, but that the workmen will benefit through an increase in wages quite as much as we do. So there is a very great temptation to fix tasks which are

still partly founded on guesswork. We will go to a workman and say, "Now, John, we have not yet made a complete, accurate time study of this job of yours. You understand you are going to be paid a premium on this job, although the task is based half on guess-work. We will be frank with you and tell you that we do not know enough to fix a proper task, but later on we will make a proper time study of this work, and then the task will be revised and made right." In a company which is just introducing the system there will be a thousand or more jobs put on task work in the course of a year where the time study has not developed sufficient information to fix rates that are absolutely just. While it is the intention of the management to go back and pick up every one of those jobs that have been half time studied and make a thorough time study of them and finally establish rates which are equitable, in many cases these jobs are lost sight of. When a workman strikes one of those snaps in which too large a time allowance was made there is a good deal of temptation for him to soldier. I can hardly blame the workman for not giving away a snap of that sort, altho we constantly have workmen coming to us and pointing out that too much time has been allowed on jobs of this sort. Workmen are just as honorable as the rest of the community.

Mr. Redfield. In your talks with the workmen what did you find was their chief objection to the introduction of scientific management?

Mr. Taylor. I think the chief real genuine objection to scientific management on the part of the employees in our arsenals and navy yards is the fear that if it is introduced it will break up the practice of soldiering and ultimately throw a lot of them out of work. They realize that it will largely increase the output per man, and that therefore a great number of their fellow-workmen will be thrown out of jobs. I think that this is a genuine fear on the part of the workmen in spite of the fact that the whole history of the introduction of scientific management shows that it has rarely resulted in throwing men out of work. I think that is the chief objection. But I think there is another cause for the recent protest from the men in Government employ against our system. I think that the objection on the part of the men in the

Watertown Arsenal, in which scientific management is being introduced, was largely brought about by the utterly unjustifiable and mean misrepresentation of scientific management which was embodied in the circular which was sent out by Mr. O'Connell, the head of the machinists' union, and of which I have a copy here, and which circular is already printed in a record of this hearing. Mr. O'Connell wrote a circular, which was sent to the members of the machinists' union all over this country, utterly misrepresenting every element of scientific management. Misrepresenting is a mild word. I would like to use a stronger one, but I do not care to burden the record with it. But misrepresentation is a mighty mild word for what Mr. O'Connell has written in his circular. Here is the circular printed in the *National Labor Journal*, Washington, D. C., January, 1912, and here are some of the expressions to which I want particularly to call attention, so as to dispose of these misrepresentations right here. The fourth item in Mr. O'Connell's description of scientific management reads as follows:

"Instead of collective bargaining, Mr. Taylor insists upon individual agreement, and any insistence on organized-labor methods will result in discharge. Wherever this system has been tried it has resulted either in labor trouble or failure to install the system, so it has destroyed the labor organization and reduced the men to virtual slavery, low wages, and has engendered such an air of suspicion among the men that each man regards every other man as a possible traitor or spy."

Now, Mr. Redfield, that statement is utterly and completely false, and I wish to refute in the most positive way the main statement there, namely, that it reduces the workman to low wages. In proof of that I want to present as a paper to be placed on this record a statement made on October 24, 1911, in which the names of all the employees of the Tabor Manufacturing Co., of Philadelphia, are recorded, who were working at that time in the shops of that company, and who had been working for one year or more in the employ of that company. This statement gives the name of the man, the original date of his employment, his first occupation, the price

at which he hired himself to that company when he first came, his present occupation, and his average wages earned per hour during the week just preceding the date of the report (the week previous to October 24), and the statement then gives the percentage of increase in the pay which each man has received since he first entered the employ of the company.

The Chairman. May I get this point, Mr. Taylor, if this shows the increase of pay to each workman while working at the same class of work?

Mr. Taylor. In some cases the men are now working at the same class of work as they did at first, but in most cases, as I have told you, the men who come under scientific management are taught how to do a better and higher class of work than they did before, and they are given a finer and higher class of work to do with the accompanying higher pay, and this refutes Mr. O'Connell's statement that wherever scientific management has been introduced it leads to "virtual slavery" and "lowering of wages." This statement shows that far from leading to anything resembling "slavery" and to "low wages," as stated by O'Connell, that the system has led to an average increase in the wages of every man in the shops, including even the colored men who just carry the material from place to place, of 73½ per cent. That is the difference in their wages from the time they came there and their present wages. Is this "virtual slavery" and "lower wages," as stated by O'Connell? I would like to have that table placed in the record.

The Chairman. Without objection, it will be inserted.¹

The Chairman. Would this table show that the wages of the machinists were 73½ per cent higher now than they were before the introduction of this system?

Mr. Taylor. It shows that for the average man in that establishment, if you take the price at which he was hired when he came there and his average earnings per hour during the week preceding October 26, that the average wage for all the men throughout the shops is 73½ per cent higher. For example, the first man on this list the percentage of increase of 158 per cent,

for the second man 50 per cent, the third man 50 per cent, the fourth man 64 per cent, and the fifth man 207 per cent, and so on.

The Chairman. How do the wages of machinists here, for instance, 40 cents per hour and 37 cents per hour, 34 cents per hour, and 32 cents per hour compare with the prices paid for machinists in other establishments?

Mr. Taylor. I think that the wages are very materially higher in all cases. It aims to be at least 35 per cent higher than the same man doing the same work could get in any other establishment right around us.

The Chairman. This is 35 per cent higher than the wages generally paid for machinists in other shops around Philadelphia?

Mr. Taylor. Than that same man could get if he went right out of this shop and into another shop right around there in Philadelphia and worked at similar work. That is what the aim is.

Mr. Redfield. I will read you from this report of Mr. James O'Connell. He says:

"These jobs, namely, the speed boss, the gang boss, the inspector, are given as plums to machinists who are willing to act as pacemakers."

Is that statement correct?

Mr. Taylor. That statement is absolutely false. These men are chosen because they are fit to be teachers of other men, because they are kindly men as well as competent men, and want to help other men, not because they are pacemakers, to make the workmen do something that is disagreeable and that they do not want to do.

The Chairman. Would that not be true only under the ideal conditions of your system? Would it be true in all cases in its practical operations?

Mr. Taylor. There might, of course, be an occasional gang boss or speed boss who would be unjust toward his men, but the moment it was found out, that man would be called down and corrected. That thing would not be tolerated if the management knew it, nor would the workmen themselves tolerate it.

Mr. Redfield. In a factory, Mr. Taylor, who suffers the most from inefficiency?

Mr. Taylor. I should say they were both sufferers, but I should say that the company suf-

¹The table is given on page 192.

STATISTICS OF WAGES OF TABOR MFG. CO.

AT TIME OF EMPLOYMENT				PRESENT DATE		
Name of Employee	Date	Occupation	Rate at which Employed	Occupation	Average Wages Earned	Percent. of Increase
			Per Hour		Per Hour	
Allibone, W.	6/22/05	Tool boy	\$0.12	Machinist	\$0.31	158
Angerman, C.	6/3/04	Machinist	.24	Vise hand	.36	50
Anderson, C.	12/3/09	Machinist	.26	Machinist	.39	50
Bradley, G.	10/17/02	Machinist	.25	Machinist	.41	64
Bierschank, W.	9/10/04	Machinist's helper	.15	Machinist	.46	207
Bryson, D.	10/29/06	Colored laborer	.16	Machinist's helper	.23	44
Blackwell, W.	2/16/05	Colored janitor	.18	Janitor	.22	22
Brogan, P.	6/27/07	Drill press	.18	Milling machine	.31	72
Bruan, S.	10/20/10	Timekeeper	.22	Timekeeper	.24	11
Bardsley, A.	1/5/10	Pattern maker	.28	Pattern maker	.38	36
Boasman, W.	3/3/10	Colored tool boy	.16	Tool boy	.19	19
Carter, J.	1/12/03	Machinist	.25	Gang foreman	.54	118
Clark, H.	3/12/10	Apprentice, lathe	.16	Turret lathe	.18	13
Cox, C.	1/1/1900	Laborer	.15	Machinist	.40	167
Chadwick, B.	1/10/10	Machinist	.28	Machinist	.37	32
Connelly, H.	8/10/03	Blacksmith	.31½	Blacksmith	.47	49
Evans, W.	6/19/05	Machinist	.22½	Machinist	.34	51
Freck, J.	5/31/05	Machinist	.25	Machinist	.40	60
Foreman, E.	3/1/05	Machinist	.25	Machinist	.32	28
Fields, M.	8/29/06	Colored machinist helper	.18	Laborer	.22	22
Goodwin, C.	8/19/09	Milling, under instruction	.16	Machinist	.34	113
Hamilton, J.	5/26/01	Pipe fitting	.18	Pipe fitting	.26	45
Kurz, W.	3/24/02	Tool maker	.25	Inspector	.40	60
Kennedy, P.	9/13/06	Laborer	.20	Chipper	.25	25
Kepner, R.	1/31/02	Miscellaneous	.24	Mill wright	.31	29
Klenk, J.	2/25/02	Drill press hand	.22	Drill press hand	.35	59
Loucks, S.	3/22/07	Miscellaneous	.20	Vise hand	.28	40
Laney, W.	11/30/01	Woodworker	.26½	Woodworker	.37½	42
Marsden, T.	9/23/01	Machinist	.27½	Machinist	.33	20
McCullough, C.	6/1/09	Miscellaneous help	.24	Miscellaneous help	.32½	35
Nolan, J.	8/21/02	Gang boss	.34	Gang boss	.50	47
Paxton, W.	10/17/06	Pattern maker	.28	Pattern maker	.40	43
Pfendner, J.	5/15/05	Metal pattern fitter	.25	Metal pattern fitter	.40	60
Rickerts, J.	7/19/05	Machinist	.20	Machinist	.38½	93
Reiff, E.	6/17/04	Machinist apprentice	.12	Machinist	.36	200
Rommel, C.	10/11/05	Drafting apprentice	.05	Draftsman	.36	620
Reed, H.	8/13/07	Toolmaker	.36	Feed and spend time study in Planning Department	.52	44
Rosi, F.	9/26/10	Grinder	.16	Grinder	.22	38
Shire, P.	6/24/04	Drill press	.20	Machinist	.35	75
Sherman, J.	8/17/04	Machinist	.22	Machinist	.35	59
Ski, J.	4/16/07	Oiling machinist and belt man	.18	Oiling machinist and belt man	.22	22
Snyder, J.	10/5/09	Machine repair man	.28	Machine repair man	.35	25
Tait, J.	7/15/06	Turret lathe	.22	Machinist	.38	72
Warner, J.	3/31/04	Machinist	.25	Gang foreman	.54	116
Shipley, A.	11/5/05	Machinist	.30	Routing clerk	.47	57
Holmes, A.	2/15/06	Gang boss	.46	Gang boss	.56	22
Wells, W.	4/4/10	Tool boy	.10	Turret lathe hand	.19	90
Wald, M.	2/3/10	Grinder	.12	Grinder	.25	108
Wald, H.	12/18/05	Tool boy	.10	Tool-room attendant	.24	140
Wetzel, J.	8/22/06	Machinist's helper	.16	Tool grinder	.28	75
Wilson, J.	3/10/10	Grinder	.20	Grinder	.25	25
Walters, E.	9/1/09	Machinist	.26	Machinist	.34	31

Total, 3811—73.5 per cent individual increase.

ferred vastly more than the man through inefficiency, but both are sufferers from it.

Mr. Redfield. If that is the case is the company the greater gainer from efficiency?

Mr. Taylor. I should say they were both the gainers from efficiency, but it is very hard to say which is the greater. The great gain which the man gets from efficiency, to my mind, the greatest gain which he gets, is permanence of employment. That his company is more apt to have work going along steadily in dull times than the inefficient company, and so the man gains through steadiness of employment, whereas the company gains through having its work well done and cheaply as well as quickly done, and through being able to fill its orders quickly instead of filling them slowly, and so is able to get a much larger business.

Mr. Redfield. The suggestion was made in Boston that you were interested in the Tabor Manufacturing Co., and as a part proprietor, and that it was an understood part in the adoption of the Taylor system of scientific management that apparatus made by the Tabor Manufacturing Co. was recommended or preferred and was, as a matter of fact, bought. To what extent, if at all, is that true?

Mr. Taylor. I own 120 shares in the Tabor Manufacturing Co., all of which I bought absolutely as a matter of trying to help out my friend, Wilfred Lewis (the owner of the Tabor Manufacturing Co.), when he was in dire straits and his company had almost failed. Under the old system of management he was on the verge of failure, and he begged me to buy these shares of him to help him tide over his troubles. I bought those shares, and that is my interest in the Tabor Manufacturing Co.

Mr. Chairman. You have 120 shares out of a total number of how many shares issued by the company?

Mr. Taylor. I really do not know what the capitalization is. My friend Mr. Tabor here says there are 1,500 shares in the company.

Mr. Redfield. You have, then, about a one-fifth interest?

Mr. Taylor. Oh, no.

Mr. Redfield. Then it is not a majority interest?

Mr. Taylor. No; and I never have received a cent from it.

Mr. Redfield. Is it, or is it not, a fact that it is a part of the application of the Taylor system that it will be utilized indirectly for the sale of the products of any company in which you are interested. If it is, we want to know it.

Mr. Taylor. Why, no; what a ridiculous—why, no.

Mr. Redfield. The charge was made in the testimony in Boston.

Mr. Taylor. It is absolutely untrue.

Mr. Redfield. That is what I want to know—if it is true or false.

Mr. Taylor. Why, absolutely false.

Mr. Redfield. We want to know if this is being worked to fill your pockets, directly or indirectly. It was said at Boston that something of that kind was true, and I want to know.

Mr. Taylor. It is absolutely false. I have never had a dollar of dividends from the Tabor Manufacturing Company.

Mr. Tilson. I should like to ask you one general question: How many concerns, to your knowledge, use your system in its entirety?

Mr. Taylor. In its entirety—none; not one.

Mr. Tilson. Then how many concerns use substantially your system?

Mr. Taylor. Oh, a very great many, Mr. Tilson. As to how many in numbers, I cannot say, and I want to tell you why: In the first place, I will have to again define what I mean when I say that a company is using our system of management. After the management of that company have gone through this mental revolution of which I spoke at length in my direct testimony and after the workmen have substantially gone thru a similar mental revolution, and both sides have become friends instead of practical enemies (that is the revolution I refer to, but this alone is not enough to constitute scientific management); when, in addition to this, those on the management side recognize that it is their duty to make a scientific investigation of all the facts, a scientific study of all of the elements of their business—when a company has passed thru those two stages, then I say that company has come under scientific management, and not until then.

Mr. Tilson. There are a great many of that kind, are there?

Mr. Taylor. Yes; and since I have been in these hearings I have heard of one of them. I have, in fact, heard of five or ten new companies during this time; but there is one I have heard of during this time and which interests me especially, and I think I will surprise you when I say that Mr. Redfield's company is practicing scientific management and has been for years.

Mr. Redfield. Which one?

Mr. Taylor. I do not know whether your blower company is or not, but I do know that your forging company (the J. H. Williams Co.) is practicing scientific management. I have heard Mr. Redfield say that the management in that company and their workmen were in thorough harmony, that they were the best of friends, that they have never lowered a piece-work price in that company after a rate has once been set, and that the men responded by stopping soldiering and doing a great big day's work for the company, which indicates that both the management and the workmen have arrived at this new frame of mind of which I have spoken. And I have also heard Mr. Redfield say (and that is why I say that they are under scientific management), I heard him make the statement that the officers of that company had made such a careful and thorough study of their machines and of the apparatus that goes with them, that within eight years almost every machine in that company had been rebuilt and redesigned and reconstructed, so as to work in harmony with the latest and most modern information. That shows me that Mr. Redfield's management is using what I call the scientific method. That is, that they are doing their share of the work in developing the science. Therefore, I say Mr. Redfield's company (much to his disgust, it may be) is practicing scientific management.

Mr. Tilson. In other words, you do not claim a monopoly on scientific management?

Mr. Taylor. I should say not, Mr. Tilson. My gracious, I do not believe there is any man connected with scientific management who has the slightest pride of authorship in connection with it. Every one of us realizes that this has been the work of 100 men or more, and that the

work which any one of us may have done is but a small fraction of the whole. This is a movement of large proportions, and no one man counts for much of anything in it. It is a matter of evolution, of many men, each doing his proper share in the development, and I think any man would be disgusted to have it said that he had invented scientific management, or that he was even very much of a factor in scientific management. Such a statement would be an insult to the whole movement. It is not an affair of one man or of ten or twenty men.

I want to try to make clear to you what I mean, Mr. Tilson, when I say that a great many companies are using it. I will tell you one of many similar instances which goes to prove this. The Economic Club of Portland, Me., asked me to speak before them week before last. After I got through, a young man came up to me and asked me what train I was going to Boston on the next day. He said, "I would like to go down with you." So he rode to Boston with me, and to my surprise he told me that for the last five years he had been the manager of the Burgess Sulphite Pulp Mill away up in the woods of New Hampshire, and that having read what we had written on scientific management some six or eight years ago, when he became manager he at once started to make a scientific study of every element that affects the manufacture of pulp. The same kind of study which is advocated under the principles of scientific management.

He also began at once the change in the treatment of the men which has resulted in his case as he told me, in making the men of that company the warm friends of the management, whereas when he came there they were always on the ragged edge of a strike, and since he came there has not been a single strike. He said that their scientific investigation of one element after another of the art of making chemical sulphite pulp in this company had resulted in placing his company in the lead of all similar companies of the world, whereas before the German and Swedish companies were away ahead of the American companies. Now, this careful scientific study of every element that goes into the manufacture of pulp and the use of the by-products not only cheapens the

cost of manufacture but gives the Burgess Sulphite Fiber Co. the preference in the American market at a higher price over all foreign pulp, so that instead of having salesmen on the road all the time to sell their goods as they used to have, they now never have to solicit any orders, and they always have more orders in advance than they can fill. I consider that this company has come under the principles of scientific management.

Mr. Tilson. Let me assume that after the scientific management has been established in a concern and the adjustment of remuneration and employees has been made, and after that the management changes, and we have a management which is not disposed to be fair, and is disposed to get as much out of a man as they have been giving with increased remuneration, but now to cut them back to the old figure, as we have heard it often expressed in this hearing—

Mr. Taylor. Yes.

Mr. Tilson. Now, what is the situation of an employee as compared with what it formerly was. What disadvantages is he under that he would not be under under any management?

Mr. Taylor. In this case the employee would merely be returned to the same position which he occupies now under the old systems of management everywhere. I will tell you, however, the employee, when that trick is played on him, or any such trick is tried, gets back at the company so darned hard that the man who tried to play the trick is sorry that he ever did it. When I left the Bethlehem Steel Co. and Mr. Schwab came, he thought he could do without paying the premium. He thought that part of the system was a good thing to abandon. He tried that for just one month, and at the end of the month (so the foremen and the men told me), Mr. Schwab was mighty darned glad to put the premium back again, because the product of the shop had dropped to about one half.

Mr. Tilson. Suppose it were applied to Government work. The workmen there have the same remedy and an additional one, have they not?

Mr. Taylor. They have indeed, and let me tell you there has been a whole lot of talk about the Watertown Arsenal, and the great injustice

done to the workmen at the Watertown Arsenal through time study and paying them a premium. If you gentlemen in Congress were to vote to bring it about that those workmen in the Watertown Arsenal have to go back to the old system of management there and do without this 30 or 45 per cent premium they are being paid now, there will be a great big howl go up from the Watertown Arsenal. A bigger howl will go up if you try to throw it out than there has been over putting it in. I am simply making that prediction.

Mr. Godfrey. There are three or four things that I do not think are quite clear, on which I should like to ask Mr. Taylor some questions.

You have not answered yet, Mr. Taylor, what money interest you have in scientific management; that is if you have any money interest in scientific management.

Mr. Taylor. I have not a cent. I have not accepted any employment money under scientific management of any kind since 1901, and everything I have done in that cause has been done for nothing. I have spent all of the surplus of my income in trying to further the cause for many years past, and am spending it now, every cent of it.

Mr. Godfrey. You have received no profit?

Mr. Taylor. None directly or indirectly of any kind.

Mr. Godfrey. Do you find that there is a growing interest in scientific management or not?

Mr. Taylor. The interest in scientific management seems to me to be growing immensely. I can judge by one barometer. I am receiving an average of one invitation a day to speak before audiences on the subject of scientific management all over the country. Last spring I was receiving at the rate of one invitation every week and apparently the interest is rolling up with tremendous rapidity. This interest is widespread, it is all over the country from the Pacific coast to Maine.

Mr. Godfrey. Do you believe that the hours of working for working men should be longer or shorter?

Mr. Taylor. I believe in shorter hours by all means, if it is a possible thing, but there is one word of warning that should come in here. If

you are looking at the real interest of the workmen, and you think it is to his interest to have the hours as short, say, nine hours or eight hours a day, be mighty careful that you do not shorten his hours of work without at the same time seeing that some device is gotten up by which he will turn out more work, or in the end you are robbing him of his wages. I should like to call attention to a lot of cases where the workingman's hours have been shortened to his detriment, because when shortening his hours, no sufficient provision has been made for a proportionate increase in his output. In the interest of the workmen I say this to you, do not shorten his hours unless you provide for increase of output, or you are cutting his wages in the end.

Mr. Godfrey. Can you say in one syllable

what the relation of labor unions should be to scientific management?

Mr. Taylor. Of all the devices in the world they ought to look upon scientific management as the best friend that they have. It is doing in the most efficient way every solitary good thing that the labor unions have tried to do for the workman and it has corrected the one bad thing that the unions are doing—curtailment of output. That is the one bad thing they are doing.

The Chairman. Have you stated to this committee that you do not know of one establishment where scientific management has been introduced where collective bargaining has been introduced?

Mr. Taylor. I do not recall any establishment.

(Concluded from page 94)

astonishing. He insisted that his studies of tasks were analyses of jobs in their relations to men.²⁹ He insisted that there are as great differences in temperaments and capacities among men as anywhere else in nature;³⁰ that every worker can be first class at something;³¹ that special observers should appraise and rate performance;³² that men should not be discharged but should be transferred within the organization, in accordance with their capacities, to jobs at which they can be first class.³³ In Taylor's system foremen became teachers, not drivers.³⁴ Modern personnel work and industrial psychology have fashioned many new tools and discovered many new facts, but they have not advanced principles of selection and adjustment in industry beyond the stage represented by these views.

The testimony throws much light on Taylor's attitude towards organized labor. He believed in unions in principle—in them and everything they do, except advocacy of restriction of output.³⁵ He insisted that scientific management aims to do, and does for the betterment of workers, everything unions aim to do.³⁶ It aims to remove all causes of antagonism,³⁷ to bring to workers the opportunity for more leisure and culture by increase of

social income.³⁸ Taylor in his experience had not had the question of collective bargaining presented to him practically, but he accepted it in principle.³⁹

Then why was there this investigation inspired by organized labor? An examination of the complete record, particularly of the testimony of antagonists, in the light of all attendant circumstances, leads to but one conclusion: the investigation was not an inquiry into one or more specific cases of scientific management, but was an inquiry into a doctrine; a politico-industrial manoeuvre. Years of struggle had made organized labor suspicious of new developments in management in proportion as they appeared to be far-reaching in their effects and were not comprehended. As expounded by Taylor it was instantly recognized that scientific management would be far-reaching in its effects. But also as originally expounded by him it was not comprehended as to either the conditions of the successful operation of its technique or the influence it would have on industrial relations. Had Taylor, in *Shop Management*, *The Principles*, and especially his lectures, emphasized aspects of his system and doctrine brought out in the testimony printed in this issue, the investigation probably would never have been inspired.

²⁹P. 173. ³⁰P. 149. ³¹P. 155. ³²P. 180. ³³Pp. 142, 143. ³⁴Pp. 116, 127. ³⁵P. 159. ³⁶P. 196. ³⁷P. 139.

³⁸P. 167. ³⁹Pp. 146, 158, 174.

Officers of the Taylor Society

President.....PERCY S. BROWN, Corona Typewriter Company, Inc., Groton, N. Y. (1926)
Vice-President.....HOWARD COONLEY, Walworth Company, Boston, Mass. (1927)
Vice-President.....HENRY P. KENDALL, Kendall Mills, Inc., Boston, Mass. (1926)
Treasurer.....EDWARD W. CLARK, 3D, E. W. Clark & Co., Philadelphia, Pa. (1926)
Managing Director.....HARLOW S. PERSON, Taylor Society, 29 W. 39th St., New York.
Ass't Managing Director..RUTH RETICKER, Taylor Society, 29 W. 39th St., New York.

Board of Directors

The President, Vice-Presidents, Treasurer and Managing Director, *ex-officio*, and
C. Leslie Barnum, American Radiator Company, New York. (1926)
Nathaniel G. Burleigh, Amos Tuck School of Dartmouth College, Hanover, N. H. (1926)
Lillian M. Gilbreth, Gilbreth, Inc., Montclair, N. J. (1927)
H. K. Hathaway, Industrial Association, San Francisco, Cal. (1927)

Past Presidents

James Mapes Dodge, Link-Belt Company, Philadelphia (deceased)
Harlow S. Person, Amos Tuck School, Hanover, N. H.
J. E. Otterson, Western Electric Company, New York.
Henry S. Dennison, Dennison Manufacturing Co., Framingham, Mass.
Richard A. Feiss, Dennison Manufacturing Co., Framingham, Mass.

Local Sections and Foreign Branches

Eastern Massachusetts

Secretary-Treasurer: T. A. Smythe, Dennison Manufacturing Co., Framingham, Mass.

Connecticut Valley

Chairman: Edwin A. Krause, The Corporation for Inventory Conversion, Springfield, Mass.

New York Metropolitan

Secretary-Treasurer: B. Eugenia Lies, R. H. Macy & Co., Inc., New York.

Central New York

Secretary-Treasurer: E. F. Papworth, Brown-Lipe Chapin Division of General Motors, Syracuse.

New York Southern Tier Counties

Secretary-Treasurer: Otto Hilbert, Corning Glass Works, Corning, N. Y.

Philadelphia

Secretary-Treasurer: Victor H. Karabasz, Wharton School, University of Pennsylvania.

Western Pennsylvania

Secretary: A. G. Ashcroft, Pittsburgh Diagnostic and Consultation Clinic.

Cleveland

Secretary-Treasurer: H. F. Mueller, The Printz-Biederman Co.

Chicago

Secretary-Treasurer: Edward D. Byrnes, W. G. Lloyd Company.

Japan

Managing Director: Yoiti Ueno, Institute of Industrial Efficiency, Tokyo.

An Open Forum

A meeting of the Taylor Society is an open forum.

The public is invited. There is no "registration" or other admission charge.

All members and all guests are welcome at all sessions, no matter how "particular" the subject. Every subject is considered from the point of view of its bearing on general management.

Publications of the Taylor Society are available by subscription to the public.

"The open mind towards experience requires the open forum for appraisal of experience. For just as the field of determination of facts by scientific method is growing broader, the field of the determination of the significance of the facts is likewise growing broader, this latter determination being a group rather than an individual responsibility."

A Management Engineers' Creed

The sublimest duty of the engineer is to keep the faith:

The faith of the client that he will not undertake what he knows to be beyond his ability; and that with respect to what he undertakes he will give conscientious service to the limit of his ability;

The faith of his fellow engineers that he will remain true to his science and will magnify and not cheapen it; and that he will base his efforts for public recognition upon ability, scientific attainment and actual performance, and not upon ambiguous self-laudation;

The faith of the community that he will undertake no service inconsistent with the public welfare and that in service consistent with the public welfare, but in which the interests of groups appear to come in conflict, he will judge carefully and sympathetically the claims of rival interests, and attempt to establish that unity of purpose which promotes the public welfare.

