

per cent more of his income for food in order to maintain an efficient standard than the individual who is engaged in relatively light work. You are all aware of the fact, however, that the heavy laborer receives the smaller wage. So far as I know these facts are consistently neglected in all attempts to establish a minimum working-man's budget. In England attempts are being made by Dr. Waller to measure the calorie consumption of heavy workers. It will interest you also to know that we find corroboration of the familiar fact that the man on piece work shows a higher carbon dioxide output than the same man on a day wage. In other words, he does more work, he works faster on a piece-work basis than on a day basis.

12. The most complicated phase of the human standardization problem lies in the psychological field. The uncertainty of some portions of the technique makes it peculiarly open to fakirs and charlatans. There is, however, only one recognized method of procedure in psychological standardization in industry. We must select a group of workers of known performance and after a careful analysis of the job, test out any particular tests which we believe to be important on this group of human beings. When we find a test which is done with a high degree of proficiency by workers of known skill, we may reasonably assume that the test has a certain predictive value for use in the employment office. We must, however, pay particular attention to testing the test. Unless this is done the whole problem of psychological standardization is better left alone. We must calculate a coefficient of correlation between our test and the performance of our workers and this coefficient must lie above +.50 before we can accept it as being of practical use. A practical illustration from some experiments that Major Dunham and I have been carrying out with army rifle shoes may perhaps clarify this matter further.

13. We suspect that rifle-shooting ability might depend to a certain extent upon the control of so-called natural tremors in the hands and arms of individuals who were shooting. We tested this question out on a number of individuals by having them hold a small brass stylus in holes of varying size in a brass plate. When the needle came in contact with the wall of the hole an electrical contact registered the touch. It was a simple matter to count the number of contacts and note the size of the hole and in this way we established a basis for

scoring the steadiness of different individuals. Through the co-operation of the officers of the Third Army Corps we were able to test out a large number of men at Camp Meade. We found that there was indeed a correlation between steadiness and rifle-shooting ability and that in general men who shot well likewise were very steady. The tendency for rifle-shooting ability and steadiness to fall together, that is the correlation between rifle shooting and steadiness, we found to have a value of about +.60. We have, therefore, tested the steadiness of men of known rifle-shooting ability. It remains for future workers to show whether men can be taught to shoot in the psychological laboratory by learning to control their natural tremors.

14. In the remaining time at my disposal I should like to call your attention to certain interesting phases of the so-called working capacity idea. We customarily plot human output on a base line which is supposed to represent the working capacity of a particular individual. A simple laboratory experiment, however, will convince you that this so-called working capacity is an extremely elusive and uncertain thing. In my laboratory in Baltimore I have an apparatus with which I can measure the amount of work done by a student, the work consisting of raising a weight with one finger. The apparatus which we call an ergograph has one serious defect, in that it does not really show when a man is completely tired. After I can no longer lift seven pounds I find that when I take one pound off I can still raise six pounds for a considerable period. In the case of certain unsuspecting individuals we have found that when they are told that a pound is about to be removed but a pound is actually added, their work continues nevertheless precisely as though a pound had been removed. In other words, such individuals imagine the load to be lighter and consequently work successfully. An even more striking illustration of the power of suggestion is shown by the experiments of the late Doctor Nicholson which were recently published in the Johns Hopkins Hospital Bulletin. Doctor Nicholson placed his subject in an apparatus similar to my own and hypnotized him when he could no longer work. The suggestion of work made the subject continue lifting the weight quite as if he had never been fatigued. I do not wish to be understood as advocating general hypnosis for industrial workers in order to increase production! There is, however, a certain fundamental psychological significance which you will all recognize in these

somewhat crude illustrations. Men and women will work if they feel like working, and if they do not feel like working they simply sabotage whether consciously or unconsciously. The most complicated time-study technique and the finest rate setting in the world will not make human beings work unless they co-operate. The removal of the normal inhibition which keeps human beings from giving their best in industry, in other words, the release of the will to work represents, it seems to me, the most hopeful, untouched field in the whole production problem. The man who can release the complete co-operation of his employees will get production. Mutual suspicion between management and men, however, can never lead to anything but complications. Just how far the attitude of suspicion and mistrust and social unrest is dependent upon certain broad health and happiness factors is shown clearly to my mind by figures recently published by Dr. E. J. Collis. (Table I). These figures show

TABLE I  
The Relation between Mortality and Industrial Unrest  
in Certain English Coalfields.

Coalfields	Deaths from all causes. (1910-12)	Percentage of Miners Favoring Strike. (August, 1920)
(Yorkshire)	(758)	(51) A
Nottingham	570	55
Derbyshire	591	71.9 B
Durham and Northumberland	635	77.9
South Wales	777 C	77.9
Lancashire	941	89.7

A—A strike, affecting this coalfield alone, took place in August, 1919; and the effect of the rest then taken is generally supposed to have influenced the voting.

B—Includes South Derbyshire.

C—Includes Monmouthshire.  
The above figures were compiled from Collis and Greenwood, *The Health of the Industrial Worker*, pp. 75-76.

that in the British coal fields there is a general correlation between the number of coal-miners who voted for a strike in August 1920 and the morbidity and mortality rate in the different coal fields. Nottingham had the smallest strike vote and the lowest accident and death rate, whereas Lancashire had the highest vote and the highest death rate.

15. I hope I have made it clear to you that the management engineer must look for a new ally in the physiologist. In my opinion time study will be improved by greater attention to the standardization of the human machine rather than by a further refinement of the technique of time measurement. It is sounder scientific procedure to get after the big errors first. At present these large errors lie along the lines

of human standardization and not in the method of time measurement.

## VIII. CLOSURE

BY FRANK B. GILBRETH AND L. M. GILBRETH

1. It is not surprising that some management men who have commented unfavorably on our "Indictment of Stop Watch Time Study" should have defended the old practice, because

a. It is associated with the old days of struggle and victory over the "rule of thumb" manager;

b. Dr. Taylor himself used it and advocated its use;

c. They are, many of them, adept in its use compared with beginners, and thus feel that they already have the advantage of years of experience over others in the practice of management;

d. It is their livelihood.

e. A few of them are directly interested in profits from the sale of stop watches, time study devices or books describing stop watch time study methods.

f. They are apprehensive that if the validity of stop-watch time study data is assailed, the tasks and rates based on them are threatened also.

2. As many of these discussions are by men justly prominent in the field of management, they merit the most careful consideration. We shall, therefore, discuss them paragraph by paragraph, reviewing their meaning and answering the criticism in detail.

## REPLY TO MR. BARTH

3. We consider first Mr. Barth's "A Defense of Time Study," as he calls it.

4. Mr. Barth is perfectly justified in strengthening his qualifications as a discussor of our paper by calling himself a "direct disciple" of Dr. Taylor, in paragraph 1. It is perhaps permissible to state, if Dr. Taylor's approval is to be used as a standard of measurement of qualifications and the right to define terms officially for the Taylor System, that on the three most important occasions<sup>1</sup> presented for dis-

<sup>1</sup> Meeting on "The New Conceptions of Business and Industrial Efficiency" held under the auspices of "The Civic Forum," Carnegie Hall, April 28, 1911.

<sup>2</sup> Answering the questions that were sent to the "American Magazine" for further information on Scientific Management after Dr. Taylor's articles in the March, April and May, 1911, issues. The answers appear in "Primer of Scientific Management," 1912.

<sup>3</sup> Western Economic Society's Conference on Scientific Management, March 14, 1913.