

THE argument of the proponents of the stop-watch technique, which presents such strength as to justify this demand for facts, may be summed up as follows:

1. Granted that the micromotion observations are more accurate, it does not necessarily follow that the unit average of these is more accurate. It is not the whole truth that a final average can be no more accurate than the accuracy of the individual data from which they are derived. The law of compensating error may make absolutely accurate the average of a series of observations practically all of which are inaccurate, especially in the case of repeated observations of the same object. Astronomers and geodesists know that their observations with instruments of precision are inaccurate and compute what they call the "most probably correct" measurement mathematically; it is this computed "true" measurement (which may not coincide with a single observation) which permits the remarkable accuracy in their subsequent calculations. Therefore the computed micromotion net operation time is not necessarily more accurate than the computed stop-watch net operation time.

2. The film is superior in recording data for motion studies, and for determining in *minute detail* the one best way to teach a new generation of skilled workers without fixed psycho-manual habits, but only in exceptional operations is it superior in determining new psycho-manual methods for workers with fixed habits, and it is not necessarily at all superior in determining applicable standard times for current use by workers of fixed habits.

3. Furthermore, the micromotion final standard time, like the stop-watch final standard time, includes allowances for rest for overcoming fatigue and for other forms of unavoidable delay and avoidable delay (*Closure*, paragraph 85). Now this additional delay time to be added to arrive at a final standard time is a matter of calculation and judgment and places both methods on practically the same basis with respect to the final standard time. These allowances are considerable and at this point the value of the original micromotion accuracy in observation may disappear.

4. Finally, the micromotion technique introduces a special necessary allowance not introduced by the stop-watch technique with respect to the computation of a standard time for immediate use in a particular plant, in that a time computed on the basis of observations of the exceptional best man

must be adjusted for application to men as they average in a plant (*Closure*, paragraph III, "due allowance must be made accordingly"). At this point the value of the original micromotion accuracy in observation entirely disappears.

5. Therefore, in accordance with the statistical principle cited by the Gilbreths, that "the total can be no more accurate than its most faulty item" (King, p. 76), the accuracy of the micromotion technique for purposes of determining standard times for current use can be no greater than the accuracy of the allowances and adjustments no matter how accurate the original measurements may have been. The Gilbreths are not unaware of this point, for they say; "if 'time data' is all that is wanted, a stop-watch probably is close enough. It certainly is close enough for those who are interested in their work only temporarily" (*Closure*, paragraph 46).

FROM the Gilbreths, therefore, we should like to have more data,—descriptions of cases, and figures contrasting micromotion and stop-watch results in determining currently usable standard times and rates. We should like to see the proponents of the stop-watch join with the Gilbreths in making these comparative studies comprehensive and convincing. We should like to have these data for all types of operations, such as the operations of road construction or mining, lathe or boring operations on large and small parts, and machine type-setting or sewing operations. We should like to have also comparative costs, for if the micromotion results should prove to be superior in having a smaller coefficient of error, we should like to know the additional cost, if any, of securing the lesser error. From the proponents of the stop-watch technique we should like to have, not merely acknowledgement of the motion-study value of the micromotion technique, but an appraisal of its social value, in general and particularly in education for the crafts; and an argument for its adoption by research organizations, associated employers, trade associations, trade unions, trade schools and other organizations capable of bearing the cost, if it is greater, of such refined methods as a step towards future improvement of the crafts.

It is a principle of scientific management that no principle or mechanism should be considered permanent; but the burden of proof rests on the advocates of the new.

H. S. PERSON

SYMPOSIUM

STOP-WATCH TIME STUDY

AN INDICTMENT AND A DEFENSE

FOREWORD

AT a meeting of the New York Section of the Taylor Society, December 16, 1920, Frank B. Gilbreth presented a paper prepared by himself and Mrs. Gilbreth on "Time Study and Motion Study as Fundamental Factors in Planning and Control: An Indictment of Stop-Watch Time Study." This paper was printed for private distribution by Mr. and Mrs. Gilbreth.

Mr. and Mrs. Gilbreth's argument against the stop watch and in favor of micro-motion study seemed so significant to the members of the Taylor Society that the first opportunity was seized for a general discussion of the subject. This general discussion was held at a meeting of the Philadelphia Section of the Taylor Society, April 11, 1921.

The original paper presented by Mr. Gilbreth at the meeting of the New York Section is here reprinted as the first contribution to the symposium; the remaining contributions, including Mr. Gilbreth's concluding statement (revised and expanded), represent the discussion at the meeting of the Philadelphia Section.

For the benefit of those readers who are not familiar with the stop watch and the Gilbreth micro-motion apparatus, the following simple explanation of each is added.

The stop watch used is identical in principle with that employed in timing athletic events except that the dial is decimal, i.e., is graduated in hundredths, and the watch is calibrated so that the hand makes one revolution in exactly a minute. Therefore hundredths of a minute can be read. In addition the observer uses an "observation sheet" on which is written the sequence of elements of the operation to be observed in accordance with a preliminary analysis of the operation and data concerning the surrounding conditions. Stationing himself so that the watch and the observation sheet are held in the direct line of ob-

serva-tion of the worker, the observer watches the worker and makes notes of the time of beginning and completion of each element of the operation. From these recorded times the lapsed time of each element is afterwards computed. A dozen or more such observations are made, the lapsed times for each element compared, and by consideration of the arithmetic average, mode and median of these a standard time for each element is determined. The sum of these standard times of the elements of the operation plus an estimated allowance for "delays" (fatigue, etc.) becomes the standard time for the operation.

The micro-motion apparatus consists of moving-picture camera, a clock of which the dial is graduated into hundredths and the hand makes a complete revolution in exactly one minute, slates with recorded data and a background (wall) ruled into squares of known dimension. A film is then made of the operation, including clock, slates and background squares. A study of this film, the negatives of which are taken at the rate of sixteen or more to the second, enables one to determine with precision the sequence, direction and duration of elements of the operation, for the camera catches and registers the time of the beginning and conclusion of an elementary motion with an exactness not possible by an observer with the stop watch. By these films the worker can be taught "the one best way" and a standard time can be computed for each elementary motion, a "delay" allowance computed, and a standard time for the complete operation determined.

We hope that a continuation of this discussion will take the form of the presentation of accumulated data. As it now stands it is a record of opinions. When opinions of experienced technicians do not agree the Taylor Society, and the public which it serves, have a right to request the submission of the data on which the several opinions are based. (Editor)