

REPLY TO MR. MITCHELL

77. Mr. Mitchell has shown a greater appreciation of micromotion study than have any of the other discussors. He brings out in paragraph 1 its usefulness for comparing and testing methods, a use implied in our emphasis on the importance of deriving the One Best Way.

78. We are not sure what he means in the latter part of the paragraph. If he implies that the micromotion method may be used to evaluate stop-watch data, he is quite right. It has been so used, with startling results. He must surely realize, however, the wastefulness of such a process, since the "standard time," if desired, can be derived from the accurate record of the micromotion method, thus making absolutely unnecessary the "mass of varying readings" of the stop-watches.

79. He has brought out admirably, in paragraph 2, the vital defect of stop-watch time study. As he says, the methods vary, the data are not interchangeable. "They cannot all be best." We have confined ourselves in our paper to Mr. Merrick's method, as we consider Mr. Thompson's in detail in a forthcoming paper, and as we understand our friend Mr. Knoepple no longer emphasizes stop-watch time study.

80. Of course Mr. Mitchell cannot imply that micromotion study should be only a judge of the correctness of conflicting "times."

81. In paragraph 3 he speaks of "different readings for the same element," as being a "common experience." We should say rather, *universal* experience. He emphasizes well the variety and number of possible, no, practically unavoidable, errors. As he says in the first part of paragraph 4, these errors are "concealed" from the stop-watch observer. He does not overlook them, he cannot see them, while attempting to take accurate times with the "running watch." He states our views absolutely when he advocates taking records simultaneously with all the available devices, and comparing the data. The H. H. Williams time study machine is practically the same as one we invented and discarded in 1907.

82. We have micromotioned not only the observed man at work but also highly expert advocates of the stop-watch, timing the said worker simultaneously on many operations, and demonstrated that in the matter of times alone—a small part of the micromotion record, but all that compete the stop-watch records—the resulting records have invariably made all of the stop-watch data ridiculous and pathetic.

83. If any other stop-watch experts feel that they have anything further to offer, we ask nothing better than for some member of our organization to have a chance to complete with the master of each stop-watch method.

84. As Mr. Mitchell suggests, in paragraph 5, the micromotion method is ideal for recording "before and after,"—a real measure of both behavior and results.

85. We agree with him in paragraph 6, where he says "there are comparatively few classes of work elements." In fact, we believe that there are but sixteen sub-divisions of a cycle of motions. They are called therbligs. They are as follows:¹

1. Search, 2. Find, 3. Select, 4. Grasp, 5. Transport loaded, 6. Position, 7. Assemble, 8. Use, 9. Disassemble, 10. Inspect, 11. Pre-position for next operation, 12. Release load, 13. Transport, empty, 14. Rest for overcoming fatigue, 15. Other forms of unavoidable delay, 16. Avoidable delay.

86. Mr. Mitchell seems to be remotely groping for these in his "pick up," "put down," "drop," etc. He is quite right in saying that "these cannot be timed directly by the running decimal watch." Also he is right beyond the slightest doubt in believing that the study of them will lead to really scientific job analysis, instruction cards, times and standards.

87. We had the honor of explaining this to Prof. Mitchell at our house more than four years ago, and we regret that he still emphasizes the value of the feature of errorless timing more than the possibilities of recording the method with such perfection that it can be used for any purpose of re-examination that may come up later, including, of course, synthesizing the One Best Way to do Work.

REPLY TO PROFESSOR SPAETH

88. Professor Spaeth's discussion stands in a very different class from the others. He has none of the advantages or the disadvantages of knowledge of the history and theory of Scientific Management. He has no experience in the practice of Scientific Management. His discussion is, therefore, of importance not as an opinion as to the values of the stop-watch method and the micromotion method, but as reflecting the "state of information" or lack of information today of the highly trained physiologist and psychologist, as to

¹These therbligs were first disclosed in the pioneer paper in any language on reeducation of the crippled soldier. See "Motion Study for the Crippled Soldier," Journal American Society of Mechanical Engineers, 1915.

the problems of modern management and their solution.

89. It must be remembered that Professor Spaeth is an expert in physiological hygiene, but not in time study, motion study, or skill study, therefore, in accordance with the time honored practice for courts of law, his opinion is to be accepted as *testimony* and not as *evidence*, and, as in all cases where one is not an expert in the subject under discussion, he must prove each statement that he makes in order to give it weight.¹ His testimony will not have weight merely because he is a recognized expert in other professions, or even because he has rendered valuable service to industry by contributions to Fatigue Study, thru the Committee of the Society of Industrial Engineers, and otherwise.

90. We must, therefore, consider Professor Spaeth's discussion on its merits as determined by measurement.

91. In paragraph 2 Professor Spaeth states that he believes that we have "lost sight of the fact that the problem of time study is not one involving extraordinary accuracy in measuring time." To which we reply that "time study" is but a small portion of the subject of our paper. Until it is realized that time study is one thing and motion study another and entirely different, it will not be appreciated that what we are discussing is a much greater problem than mere time recording. We have stated repeatedly and emphatically that *deriving the One Best Way is the chief aim of our methods*. We have stated that this One Best Way known is offered as an ideal of achievement to the learner, and used as a base line from which the improvements suggested by the workers may be measured and rewarded. We are obliged to assume that Professor Spaeth is completely unaware of the existence and uses of our Simultaneous Motion Cycle

¹The normal function of a witness is merely to state facts within his personal knowledge. An expert witness who can prove his qualification as such by special training and experience in a particular line is permitted to state an opinion or inference drawn by him based on an assumption of the truth of facts proven by other evidence. "In all cases in which opinion evidence is admitted in a court of law it is essential that the witness should be possessed of adequate special experience and knowledge of the (precise) subject matter to which his testimony relates.

"Chateaugay Etc. v. Blake 144 U. S. 476.
American Car etc. Co. v. Thornton 183 Fed 114.
Parsons v. Syracuse etc. R. R. 133 N. Y. App. Div. 461.
Boroughs v. N. J. Gas Co. 88 N. J. L. 634,
and that the witness is specially qualified to draw a correct inference.

Feuchtwaenger v. Manitoc Co. 187 Fed. 713.
Samuels v. U. S. 232 Fed. 536."

Charts,² which are made from data on the film, or he would not think for a moment that we place much emphasis on time records as compared with motion records.

92. Nevertheless, in such problems as that of determining in advance which of many will be eventually the One Best Way To Do Work, we must have accurate times, otherwise it is impossible to distinguish between *merit of method and, state of dexterity and automaticity* of the observed demonstrator of the proposed method, or method under consideration.

93. To illustrate, let us consider a proposed method for doing a piece of work at which the demonstrator has little or almost no practice, as compared with an existing method at which he has had much practice. The former may and often does take three to ten times as long to perform as the latter, when the proposed method is first demonstrated. A proposed method must be analyzed by the micromotion process into its therbligs.

94. In no other way can the ultimate achievable times of a new method be accurately prophesied, and the method undertaken and carried with confidence thru the learning period, until skill is achieved.

95. For definite and simple examples of this one should try writing one's name; 1—upside down; 2—backwards; 3—mirrorwise; 4—various combinations of 1—2—3. To do this simple experiment will require approximately from three to ten times the length of time which one requires to write it in the customary manner, yet the only change is the effect upon one's automaticity, due merely to the simple change of the variable, *direction of motions*.³ A study of the times of the worker under the same condition of automaticity at work at which he is skilled, will give information as to his ability at similar and at dissimilar work. Therbligs must be synthesized from their fatigue standpoint, not their time standpoint unless under similar conditions of automaticity for all methods being tried. Therefore the stop-watch is out of the question on such work.

96. Our standards of times for individual and combinations of therbligs can then be used to furnish the times. If this were not possible we could not select the method that would eventually be the One Best Way until automaticity had been actually achieved in all methods considered. Obviously, a

²See "Applied Motion Study" Pages 138-9. "Motion Study for the Handicapped" Pages 30-31.

³For list of variables of motions see "Motion Study," Pages 6 and 7.