also computed the average deviation of the study. When this average deviation had been obtained the calculated minimum was computed by dividing the average elemental time by the average deviation factor. This placed a value on each element of the study, using the same deviation and that of the whole study.

The studies then came back to the observer who first checked back the elements that had a very high deviation factor, in much the same manner as that already described. We found three studies which were not acceptable and they were retaken. The second studies proved satisfactory and the three were rechecked and discarded. We then had a set of studies from which it was easy to make standards.

To draw all of the studies together into one picture, it is possible to lay out a sheet sufficiently large so that all the elements under their proper classifications can be entered on horizontal lines. Vertical columns can then be drawn to record the calculated minimums, with a number at the top of each column to indicate the study from which it came. The lines can then be subjected to the same analysis that was given any of the studies or, as has been our practice, the lines can be averaged and the closest even number selected as standard. No further consideration need be given elements that are constant, but in the case of elements that are variable we have just one point established for a curve on the range of limits of the variations of the elements.

By very careful analysis of the time taken in each study, element by element, when the elements are properly classified and compared with ten or more studies on the same class of work, we can get a time value that represents an actual performance and remove all doubt as to whether it can be done again under similar conditions. We can eliminate the daily use of judgment by time study men in trying to guess the speed at which an operator is working. We set a time which is fair to management and to first class workmen and the value always remains the same.

When this practice is general, time study men will have an opportunity to study machines and men and to devise different or better ways of doing work. The time study men of the future will have less clerical work and more engineering problems to solve.

Computation of Allowances

By NEELE E. STEARNS
Wilson-Western Sporting Goods Company, Chicago, Ill.

THE subject to which I have been assigned, that of the computation of allowances, will be recognized by a great number in my audience as one of the most vexing problems encountered in modern time study practice.

The basis for the now highly developed elementary time study must be credited to Frederick W. Taylor's first distinctive contribution to the science of management. Mr. Taylor, endeavoring to determine "a fair day's work," observed that the chief reason why the employer failed to get it was that no one really understood the term. Industrial history, from what I am able to discern, records but two inconsequential attempts, prior to those made by Mr. Taylor, to determine maximum machine capacities or discover and register limits of human endurance when engaged in productive activity.

In his desire to set up tasks representative of "a fair day's work" Mr. Taylor separated his subject's task into its component elements, the timing of which became the basis for the preparation of the standard task time.

Up to this point time study practice seemed to present no serious problem; however, much remains to bridge the gap between measured productive effort over a short period of time and the result of cumulative productive effort for the entire working day. Several variable factors, usually occurring once or oftener in each operation, must be considered in determining the standard time for the given task. It is these variables, which make up the problem of the computation of allowances, which we are to discuss now.

In my opinion the use of the term allowance as a feature apart from the other constituent elements in the scientific development of the production schedule, tasks, piecework prices, etc., means very little. However, the term allowance gains significance when it becomes associated at installation with the particular plan of the commercial engineer or the individual policy of the specific plant; that is, when it is "tied in" with the other component features of the scheme.

Results in contented personnel and rock bottom production economies determine the satisfaction

gained from the work of the commercial or resident engineer and reveal the accuracy of the scheme upon which the allowance calculation was based. Obviously, this is the commercial aspect of the development of time study practice.

The engineering or technical aspect, however, is a problem which presents various complications demanding constant attention in effecting valuable solutions. Untold quantities of material have been prepared by innumerable authorities on the loss of productive power in the worker because of fatigue, the value of rest periods to offset this evil, and the effect of incorrect lighting, unsanitary working conditions, etc., in slowing down production. It takes no stretch of the imagination to conclude that failure to minimize, and if possible eliminate, these defective conditions must materially affect the allowance factor. Therefore, I am presuming in my discussion that we are starting with fair normal working conditions.

These questions immediately arise. First, what are allowances as we understand them in time study work? What are their functions and of what value are they? In answer to the first question, let us consider an allowance as extra time which is added to the calculated base time to care for the several variable items which require an operator's time and which are not a regular part of any one task.

In proceeding let me stress the importance of striving for accuracy in this matter of allowance determination. Many engineers feel that the careful consideration of allowances is too technical and theoretical, or that the aim is too much toward the ideal, to be practical. However, the establishment of allowances, like the other exact phases of time study work, should be carried on with unerring determination toward accuracy. Clearly, a well calculated base time will be useless if the separate factors are not given due consideration. On the one hand, an incorrect resultant will lose for one the confidence and co-operation of the workers, while on the other, it will create an attitude of doubt on the part of the managerial staff as to the correctness of the incentive principle.

No job, regardless of its seeming ease of accomplishment, can be handled without at least considering the factors of personal care and fatigue; and almost all tasks, because of their various complexities, demand an investigation and solution of all the factors of allowance computation. Plainly, allowance reckoning is necessary in order to convert a theoretic base time into a workable standard in which the additional time is used by the operator as intended—to compensate for cumulative fatigue, personal care, profit and flexibility, as well as incidental irregularities.

To facilitate the collection of material related to time study methods now in use in industry, our Chicago Time Study Standardization Committee prepared and submitted to various industrial organizations, a questionnaire. One of the questions read, "What is your method of operation allowance calculation?" Answers to this question varied greatly, and I wish you would observe the total lack of time study engineering principles in some of the statements received.

To quote from the statistics gathered by our secretary, W. B. Lincoln, we found firms giving no allowance at all and others giving as high as a sixty-five per cent allowance. There were variations all the way between these limits.

The average figure considered sufficient for the total allowance to be given seems to be about twenty per cent. Eight firms made the statement that their allowances varied, no numerical values being assigned to them. To cap the climax, eight firms gave absolutely no allowance at all. I presume that these companies are super-efficient.

Further analysis of the returned questionnaires revealed 35.4 per cent of the companies replying allowed nothing for fatigue; sixty-seven per cent gave no consideration to delays of any kind; forty-seven per cent gave no personal allowance; 88.5 per cent ignored the profit factor; 92.5 per cent disregarded variations on the job; 10.1 per cent, as before mentioned, made no allowance of any kind.

These statistics, illustrating a widely varied practice in methods and reasons for allowance determination, reveal a neglect of a standard and scientific procedure for calculation. Of course, only indifferent results, of limited application, can be obtained under these circumstances.

To be basically correct, allowances should fulfill a dual purpose. First, when expressed as percentages of the standard time, they constitute factors to be used in compensating for certain delays encountered during the working day, and inherent in the operation performed, and for time consumed