development of production control and cost control methods.

2. *Personnel.* A time study man must be competent to develop time standards and to utilize these in rate setting, production control and cost computations. He must be a man of infinite patience, keen judgment, tact and experience in business. He must have a good head for figures and be able to analyze conditions and methods of operating, suggest changes in equipment, work up the data and constructively utilize it.

3. *Implements.* A watch is required—not like a foot-ball timer, which operates entirely from the stem, but constructed so that the stem pressure simply throws the hand back to zero, while a slide on the side of the case starts and stops the hand. The dial, preferably, is divided into tenths and hundredths of minutes.[1] This decimal system is convenient in working out results to avoid converting seconds to minutes.

Printed time sheets eight and one-half by eleven inches in size should be used. These sheets are mounted on a thin board having a projection at the upper right hand corner to hold the watch, which should be in plain view.

4. *Making Ready for Time Study.* The period at which time study should be made is governed by the character of the work. This may fall into several distinct categories: (1) operations such as machining, where the standardization of speeds, feeds and tools may be begun in advance of time study; (2) operations wherein quality, or non-uniformity of material from the preceding processes, or intermittent supplies, require a delay in time analysis, until the preceding operations or departments, or the control of production, are brought into line; (3) operations of hand, and sometimes of machine, work where the method of performing the operations can be studied coincidentally with the timing, and the time or motion study data used with the recorded notes in determining the best methods of operation or process; (4) operations, such as stitching or other simple repetitive work, which are of a standard elementary nature and can be time studied whenever desired.

In addition to these might be mentioned operations involving process where time is not a direct element but where standards of quality and of process must be fixed by research, with little or no utilization of time study. Still another condition occurs when in starting up a new plant it may be necessary, in order to keep down labor cost, to set temporary standards by approximate studies. In such cases, if incentives are set, the operators must be informed by written notice that they are temporary and will only continue for a definite period. All this, however, is makeshift and should be avoided. It is better to concentrate on fixing accurate incentives promptly.

5. *Selecting Workmen for Observations.* In the fixing of standards of performance, the workmen observed must be adapted to a degree representative of the average of the best group of workers available in the particular locality. These average workers must receive a fair reward, which, if gauged by measured output, must produce earnings appreciably in excess of a day wage. Exceptional workers must earn exceptional returns. Inferior workers must be trained to their jobs and if they cannot attain earnings higher than the ordinary day wage must be transferred to other jobs for which they are adapted.

Although the standards are designed for the average man, operatives for most extensive timing should be peculiarly adapted to their work. These are steadier workers (a necessity for good results), and will give the best co-operation and are apt to use the best methods of work. It is important, of course, that standards should be fixed from, or based upon, the observation of a sufficient number of operatives to obtain fair average results.

6. *Approach to the Operator.* The co-operation of the worker observed must be gained before starting time study by interesting him in the work, getting his opinion and advice on methods and making him understand that the prime object is to give him regular work and higher total earnings.

7. *Making a Time Study.* Begin a period of time study with the hand of the watch at zero, but after this allow it to run continuously without throwing back between operations, or operation elements. By this plan the delays can be recorded more accurately, smaller elements noted, and a complete chronological record of the job made.

Record stops and delays. The time of each element is recorded in a vertical column and the individual times afterwards computed in another vertical column at the right. The time of every

[1] The decimal dial was designed originally by the writer and first used in 1894.

delay and stoppage must also be recorded, with the cause.

Time the units. The elements of the operation must be small enough to utilize in computing the times for new operations containing all or some of the same units. Note, for example, hand folding in shoe making described earlier in this paper.

Be sure that the worker is not working too fast for the required quality of product. Bear in mind, however, that fast workers usually are skillful workers. Have the output produced while timing inspected by a foreman or inspector to see that it is satisfactory in quality.

The number of observations to be taken must be governed by the conditions of the work. If the operation occurs infrequently in practice, less attention is needed than for one (like the operation of hand folding previously described) whose units are to be used constantly and in a multitude of combinations. Where there is a necessary appreciable variation in the time of the same unit more observations are needed than otherwise to properly distribute the larger times. Theoretically the number of observations should be such that an equal number taken independently will not appreciably alter the average time. In general a large number of observations should be made on, say, two or three operators particularly fitted for their work, and a smaller number on others. The number of operatives to observe must be sufficient to obtain a fair average of the group. Careful studies on a few (say, eight or ten out of fifty), carefully selected as representative, are better than haphazard studies of the entire force.

Fatigue is an element which in most cases takes care of itself, provided long-time observations are made extending consecutively over several hours. In certain cases separate studies of fatigue are needed.

No so-called "job try outs" are needed with the proper time study, although for psychological purposes it is best to introduce changes slowly.

8. *Necessary Delays.* As already stated, delays, as well as effective time, must always be recorded. Sometimes, however, the delay is part of a unit, in which case the time in excess of the average must be included as delay time. For example, in stitching, a thread may break in the middle of a seam. After taking out the actual time for rethreading, the time up to the break, plus the time to complete the seam after stoppage for rethreading, will be longer than where a break has not occurred. Here, then, the extra time is considered to be the difference between the normal time and the observed time including the stoppage. This may be charged to the delay caused by the broken thread.

At times the observer notes as he makes the time study that the time required for an element is inexcusably long. It is then marked "slow" and the difference between it and the average normal time is thrown into the delay time.

Delays are of four kinds; namely, (1) necessary delays—delays in actual operation that are unavoidable; (2) unnecessary delays—such delays as loafing, stopping to talk and performing extra operations not required (sometimes with the belief of the operator that he is "padding" the time); (3) job time—the time required at the end of a job to record the job, move the work away from the operator, take the next piece of work and get ready to work on it, but not the time included in placing the material ready to operate upon; (4) personal needs. After computing the average times and utilizing the long-time observations in which the operator is apt to stick to his work sixty seconds to the minute and sixty minutes to the hour, there must be a period allowed for relaxation or "personal needs." For this there is no definite time allowance, but usually it is fair to add ten per cent.

9. *Continuous Timing.* Wherever practicable, before computing the standard times, a continuous study should be made covering several hours (from three to eight), allowing the watch to run continually during the entire period and making complete records of effective times and delays. Sometimes such long-time observations can be used with advantage in making all of the time studies.

10. *Computing Standard Times.* Taking account of the corrections noted above, net unit times can be averaged directly to obtain the standard net unit time. Various other methods are used by different observers, but in practice this simpler plan of direct averages works to good advantage when used along with careful study and analysis of the conditions involved.

Summing up, the standard time of any operation is obtained by taking the sum of the net effective unit times, plus the actual time for necessary delays, plus the time required to change from one job to the next, with ten per cent added to this