divisions, of each such division, according to sections of machines to be manipulated. For this purpose the classification of machines and work-places used in the planning and control of work and in accounting serves as a base. The symbols are extended to designate the various sections of the machine. Such a classification also serves a useful purpose in the operation of a properly devised system for plant maintenance.

A great number of the small tools used in the performance of a specific operation may be used on other jobs quite different in character, and not only on the same but on different machines. In the work mentioned above as an illustration, a screw driver, scissors, small soldering-iron and a knife were used. One of our first steps in installing a system of scientific management should be to standardize, classify and symbolize small tools, and to arrange for their storage, provision and maintenance. The classification serving these needs lends itself admirably to the tabulation and filing of time-study data covering the use of small tools.

Materials, whether they be commercially purchased articles or semi-manufactured parts of a product, may also be classified with respect to those characteristics that affect the manner and time required to handle them. This, like many other tasks, is much less formidable when we get down to doing it than when we stand off and consider it. In this, as in the two preceding cases, the classification is useful in other ways. Needless to say, the same materials may in many cases enter into the making of several products and certain parts may have to be handled in several successive operations.

Morris L. Cooke's chapter on Classification and Symbolization in the Taylor Society book, "Scientific Management in American Industry," gives a good idea of the kind of classification to which I have referred.

Machine operating time is, as a rule, a simple matter of computation which can be facilitated by the use of tables, slide rules or calculating machines. The speeds at which machines may best be run when working on various materials inevitably involve research on the part of the methods man where no authoritative information exists. Even when it does exist, a little checking up is advisable.

To sum up, a logical plan should always be adopted for classifying, tabulating and filing data. In working out such a plan the methods man should have in mind: (1) accessibility and convenience in its use; (2) the fact that elementary operations occurring in one job may also occur on others; (3) applicability to new jobs or new products; (4) possible changes in equipment, products and materials.

With time studies made and tabulated in the manner I have attempted to describe, instruction cards defining methods and time have been successfully prepared in one non-repetitive shop for the past twenty years. In a large machine shop and foundry, operated solely for repair and maintenance, and building special new equipment for a very large works, instruction cards and tasks for every operation have been made up in this way since 1922. In the last mentioned instance, as a result of the installation of a complete system of scientific management, production was increased more than 100 per cent with an annual saving of half a million dollars.

VI. Selection of Standard Elementary or Unit Time

The methods advocated for selecting the standard time for a given element from a series of observations vary in detail, but most of them involve an averaging of the various times recorded. If all conditions were standard and if the worker being observed were first class there should be no variation, at least in theory, in the times for a given element, in which case, selection would be exceedingly simple and require no computation. It is equally true that in such a case an average would represent the correct standard unit time and require no computation for its determination.

Any considerable variation in a number of observed times for a given element (apart from unusual delays, which can be eliminated) indicates something wrong. With properly made studies the methods man will be able to identify the cause. The cause usually can and should be corrected before "standard unit times" are established. When this has been done it will be found that for each element the same time occurs in a majority, or at least a plurality, of the observations, and that consequently, the time that should be adopted as standard is evident at a glance, making computation unnecessary. This is a gauge of the quality of

standardization, of the workers' ability and of the time-study work.

It should be borne in mind that, in using a stop watch, the recorded readings even of an experienced observer may be .005 to .01 of a minute above or below the actual time. Such errors are in many cases apparent from the finished time-study sheet and should be taken into account. Any averaging or calculation tends to establish inaccurate standards. To illustrate the foregoing, the following, based on a good example of time study of a cycle of elements, shows the results of selection by the calculation method described by Dwight V. Merrick, and the more direct method of selecting the predominant time in a series of observations. There were ten observations made.

ITEM	MERRICK'S METHOD (IN MIN.)	VISUAL METHOD (MODE) (IN MIN.)	PER CENT OF OCCURRENCES	MINIMUM TIME (In Min.)
A	.03	.03	70	.03
B	.0209	.02	70	.02
C	.0309	.03	70	.03
D	.0336	.03	50	.03
E	.0545	.06	40	.05
F	.0263	.03	90	.02
G	.05	.05	80	.04
H	.0565	.06	40	.05
I	.02	.02	100	.02
J	.0527	.05	50	.05
Total	.3754	.38		.34

Item F showed .03 occurring nine times and .02, the minimum, once. This single occurrence resulted in the calculated time being 12 per cent lower than if it had been discarded as abnormal. The lowering effect of a single .01 reading, together with nine .02 readings, would be more marked. In considering the visually selected time for items D, E, H and J, in relation to the percentage of total occurrences, light is thrown on the selection by the following. In the case of item D, .03 occurred five times, .04 twice, .05 twice and .06 once. In item E, .08 occurred twice, .07 twice, .06 four times and .05 twice. This item consisted of sprinkling a parting powder on the face of a pattern plate. The time which occurred twice as many times as any other reading, .06, was decided upon as ample for sprinkling a sufficient quantity of powder on the pattern. In passing, let me say that the methods man here observed three elements instead of one. They were: (1) pick up bag of powder; (2) sprinkle on pattern; (3) put bag back. It would have been physically impossible for him to record the stop-watch readings, however, as he would have then had eight consecutive readings averaging .028 minute each. Item H, an operation of the same nature as item C, contained .07 three times, .06 four times, .05 twice and .03 once. Item J contained .07 three times, .06 twice and .05 five times.

In the case of the study in question, we would have arrived at the same results, for all practical purposes, if we had discarded abnormal values, either high or low, and averaged the normal values as recommended by another authority. For the ten elements, this method would give us the following:

ITEM	MINUTES
A	.033
B	.023
C	.032
D	.033
E	.056
F	.029
G	.055
H	.061
I	.02
J	.052
Total	.394

As a further illustration of this point, I cite an example of time-study work by Mr. H. V. Williams at the Corona Typewriter plant. This was used by Richard H. Lansburgh as an illustration in his book, "Industrial Management."[30] Out of one hundred observations on two items, I find in the case of one item, that .09 occurred twenty times, .10 forty times and .11 thirty times. The average was .1022, and the minimum, .08, occurred but once. On the other item, .05 occurs twenty-three times, .06 forty-three times and .07 twenty-five times, with an average of .062. It is obvious that such time-study work requires no formula or calculation to ascertain the standard unit time. In passing I would remark that this is an example of excellent time-study work except for the fact that each of the six items shown includes several distinct elements.

There are various other methods, all involving averaging or other computation, which, as I have intimated, would be unnecessary if: (1) conditions and methods were standardized; (2) the work were performed by a "first-class" operator; (3) the time

[30] John Wiley & Sons, Inc., New York, 1923, p. 240.