work to eliminate waste activity are available to all. It would emphasize this most strongly, but would add that its chief claim to usefulness lies in the fact that it enables the user, through the refinements and devices, to take up more intelligently and with greater interest, all the problems of getting times and motions.

Standardization of Conditions and Analysis of Operations

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Introduction

AS YOU know, the time study man has been referred to as an engineer, an efficiency man, a rate setter, an estimator, a limit setter and an analyst. It seems to me that the most appropriate term for this discussion is "time study engineer." In the works which I am proud to represent, we do not tolerate the man who accepts conditions as they are, records several cycles of watch readings, arrives at a representative time value for each element of the job, and passes on to the man an allowance which means little or nothing.

On the other hand, we insist upon and instruct our men to analyze carefully each job with a view to making improvements in methods, tools, design and the like, before any watch readings are recorded. To be able to read a stop watch and make a record of such figures is probably the easiest and least important part of the time study. Far better is it to know what should or should not be observed, the proper sequence of elements, and the amount of skill and effort the man is applying to the job.

Analysis and standardization, therefore, play a very important part in time study work and, in the paper which follows, the term "time study engineer" should be construed to mean one who not only makes time studies for wage incentives, but in addition, one who subjects to thorough analysis every part of every job he studies with a view to eliminating the unnecessary and standardizing the necessary operations.

I have chosen to reverse the order of my assignment and to deal first with the "Analysis of Operations," following this by a discourse on the "Standardization of Conditions," since that seems to be the more logical sequence.

Analysis of Operations

In analyzing a job, many things will of necessity be taken into consideration. Not only will tools, materials and the method of procedure be scrutinized but attention will also be given the worker performing the job and the conditions under which he is obliged to work.

To make an intelligent analysis of a job requires that one be well versed in the practical knowledge peculiar to that particular job. The time study engineer must not only know the proper tools for performing a given operation but must be able to determine whether or not the workman is proficient in the use of such tools.

In addition to this practical knowledge, a thorough understanding of human nature and ability to judge effort and skill solely from the evidence at hand are essential, regardless of any opinion that might be entertained concerning the workman's honesty.

Before one can be expected to pass judgment on the proper way to perform a job it is necessary that he have a good idea of how the part is to be used. He must know why the operation is being performed and the function the part will fulfill in the finished product. Roughing cuts are sometimes as satisfactory as fine finishing cuts and grinding. Apparatus which is to be obscured from view in its installation need not be so pleasing to the eye as that which is to be constantly in full vision of passersby.

It is necessary to know when a part being machined is to have a running fit or a driving fit, an electric contact surface or a surface merely smoothed up for appearance. The effect that a close or a loose fit will have on the performance of the apparatus should be understood. In general, the reason for every detail operation being performed and its effect in the ultimate use and success of the product should be determined. Then it will be possible to make intelligent suggestions with the ends in view of improving the product, eliminating unnecessary operations, and facilitating necessary work.

After the purpose of the operation has been determined, the inspector should be consulted in order to ascertain the inspection requirements. The inspection requirements, too, should be based on a thorough knowledge of the purpose of the operation. It should be known whether a dimension

should be held to within a few thousandths or whether a variation of one sixty-fourth of an inch is allowable. The time study engineer and inspector must work in close harmony in this respect in order that time allowances may apply closely to the work at hand.

Every possible effort should be put forth to eliminate abnormal conditions as concerns materials. If the physical properties of materials are not meeting specifications, the cause should be ascertained and an attempt made to bring about a correction. Excess material on castings over that necessary to insure the required finish should be eliminated at the foundry if practicable to do so. Excess material not only requires more time to machine without improving the finish of the product but it also results in a great waste. It is very common to see a machine hand removing one-half inch or more of material when it should not be necessary to remove more than one-quarter inch to make a perfect job. Fewer cuts would here be required and the amount of scrap would be greatly reduced.

In assembly work, specifications should be closely followed to avoid unnecessary filing and fitting. Shop practice should be made to conform with specifications or the latter should be revised to suit conditions.

Expense materials such as oil, cutting compounds and molding sand should be suited to the nature of the work. It is necessary to use a fine sand in making aluminum castings, but it would be wasteful to use this same sand for some brass alloys because of the additional venting that would be required. In general, anything in the material which has a tendency to cause unnecessary work should be determined and corrected before establishing standard allowances.

When a job is started it is necessary to perform some operations which will not occur after the first piece is finished. These are usually termed "set-up" operations. Getting time slips, drawings, instruction cards, material, tools, arranging the tools in the machine, setting stops by trial cuts and locating dial positions, arranging tools and equipment for a bench operation, and making templates are all considered as set-up operations. Whatever the nature of the work, there will always be a certain amount of preparation work required, and in most cases, the ease and the efficiency with which the work will be done depend largely on the preparatory work. This fact must be recognized and the set-up subjected to a thorough analysis keeping ever in mind the idea of improving and simplifying the operation with a resultant saving in time and improvement of quality. Any work which will be required to get the job started each time it is done should be considered as a set-up operation.

In shops where time study does not exist it is found that the output of operators on the same line of work varies greatly. Here each individual does his own work according to his own ideas and, in most cases, never stops to consider whether or not the method can be improved upon. It makes little difference to these operators how the job is performed so long as it meets certain established inspection requirements. In the event that several or all of these operations were studied, it would probably develop that, if the advantages of all methods were combined and followed as a standard, production would be greatly increased without increasing effort. A thorough analysis will often show that those operators turning out the greatest production are not expending so much energy as those turning out the lesser production. The former know that brain work is essential to systematic handwork and have developed a smooth method of procedure which may be applied to the less efficient operators by careful instruction.

Labor saving hand tools, such as socket and ratchet wrenches, air hammers, air chippers, and the like, should be used whenever a saving in time would result. In assembling brackets to frames in one of our assembly departments the substitution of Yankee socket wrenches for common hand socket wrenches cut the time required to perform this operation in half.

Cutting tools used on machines should be properly ground and should have the correct clearances and shapes. Machine tools and all driving equipment and belts should be in good repair. The time study engineer should determine whether or not the work is being done on the machine best suited to the job being studied. No job should be finished on a milling machine, lathe, or boring mill that could be worked to an advantage on a grinder or vice versa. In analyzing the tools used on a job, it is sometimes found that the operation could be segregated to an advantage, that is, part of it could be done on one machine and part on another with