

Other Equipment. This includes pencil, eraser, device like tachometer for checking the speed, etc.

5.7 Why Dividing Work into Short Elements is essential?

For the purpose of time study, the task is normally broken into short elements and each element is timed separately for the following reasons:

- To separate unproductive part of task from the productive one.
- To improve accuracy in rating. The worker may not work at the same speed throughout the cycle. He may perform some elements faster and some slower. Breaking of task into short elements permits rating of each element separately which is more realistic than just rating once for the complete cycle.
- To identify elements causing high fatigue. Breaking of task into short elements permits giving appropriate rest allowances to different elements.
- To have detailed job specifications. This helps in detection of any variation in the method that may occur after the time standard is established.
- To prepare standard data for repeatedly occurring elements.

The following guidelines should be kept in mind while dividing a task into elements.

(1) The elements should be of as short duration as can be accurately timed.

(This in turn, depends on the skill of the time study man, method of timing and recording, and many other factors. Generally, with the stop watch, elements of duration less than 0.03 to 0.05 minute are difficult to time accurately. The elements should not normally be longer than 0.40 min.).

(2) Manually performed elements should be separated from machine paced elements.

(Time for machine paced elements can be determined by calculation). Machine elements are not rated against a normal. This rule also helps in recognition of delays.

(3) Constant elements should be separated from variable elements.

(Constant elements are those elements which are independent of the size, weight, length, or shape of the workpiece. For example, the time to pick screw driver from its place and bring it to the head of a screw is constant, whereas the time to tighten or loosen the screw is a variable, depending upon the length and size of the screw).

(4) The beginnings and endings of elements should be easily distinguishable. These should preferably be associated with some kind of sound.

(5) Irregular elements, those not repeated in every cycle, should be separated from regular elements. For example, if the jig is cleaned off after every ten parts produced, "cleaning" is an irregular element, and its time should be spread over ten cycles.

(6) Unnecessary motions and activities should be separated from those considered essential.

(7) Foreign or accidental elements should be listed separately. Such elements are generally of non-repetitive type.

5.8 Number of cycles to be timed.

The following general principles govern the number of cycles to get the representative average cycle time.

- (1) Greater the accuracy desired in the results, larger should be the number of cycles observed.
- (2) The study should be continued through sufficient number of cycles so that occasional elements such as setting-up machine, cleaning of machine or sharpening of tool are observed for a good number of times.
- (3) Where more than one operator is doing the same job, short study (say 10 to 15 cycles) should be conducted on each of the several operators than one long study on a single operator.

It is important that enough cycles are timed so that reliable average is obtained.

5.9 Following techniques are used to determine the number of cycles to be timed.

(i) **Use of Tables:** On the consideration of the cost of obtaining the data and the desired accuracy in results, most companies have prepared their own tables for the use of time study, which indicate the number of cycles to be timed as a function of the cycle time and the frequency of occurrence of the job in the company.

(ii) **Statistical methods:** On the basis of the requirements of the particular situation involved, *accuracy* and *confidence level* are decided (An accuracy of a confidence level of 95% is considered reasonable in most cases). A preliminary study is conducted in which some (say N) cycles are timed. Standard deviation σ of these (N) observations is calculated as

$$\sigma = \sqrt{\frac{1}{N} \sum (t - T)^2} = \frac{1}{N} \sqrt{N(\sum t^2) - (\sum t)^2}$$

Where t = each watch reading

T = average of N watch reading

n = number of watch readings in the preliminary study.

Now, to find M , the number of cycles to time, the following statistical method can be used.

calculated standard error of mean ϵ from the equation

$$X \cdot \epsilon = A \cdot T$$

Where A = accuracy desired

t = average of N watch reading

X = a factor corresponding to confidence level desired. Its values is 1 for 68%, 2 for 95%, and 3 for 99% confidence level.

Determine the required sample size M from the equation

$$\epsilon = \frac{\sigma}{\sqrt{M}}$$

5.10 Performance Rating

It is a process of comparing the performance rate of a worker against standard performance. The standard performance is different for different jobs. The rating factor is used to convert the observed time into normal time.

$$\text{Normal time} = \text{Observed time} \times \frac{\text{Performance level of worker}}{\text{Standard performance level}}$$

5.11 Allowances

Allowances are added to normal time in order to arrive at standard time. The various allowances are:

1. **Process allowance:** This is an allowance provided to compensate for enforced idleness during a process. This includes loss of time due to (i) no work (ii) power failure (iii) faculty material (iv) faculty tool or equipment.
2. **Personal and Rest allowance:** This is allowed to compensate for the time spent by worker in meeting the physical needs, for instance a periodic break in the production routine. The amount of personal time required by operator varies with the individual more than with the kind of work, though it is seen that workers need more personal time when the work is heavy and done under unfavorable conditions.

The amount of this allowance can be determined by making all-day time study or work sampling. Mostly, a 5 % allowance for personal time (nearly 24 minutes in 8 hours) is considered appropriate.

Rest allowance is a relaxation allowance to a worker to overcome fatigue incurred during working. Excessive fatigue badly affects the performance of worker. This rest/relaxation may vary from 12% to 20% of normal time from light to heavy.

3. **Special Allowances:** These allowances are given under certain special circumstances. Some of these allowances and the conditions under which they are given are:

Policy Allowance: Some companies, as a policy, give an allowance to provide a satisfactory level of earnings for a specified level of performance under exceptional circumstance. This may be allowed to new employees, handicap employees, workers on night shift, etc. The value of the allowance is typically decided by management.

Small Lot Allowance: This allowance is given when the actual production period is too short to allow the worker to come out of the initial learning period. When an operator completes several small-lot jobs on different setups during the day, an allowance as high as 15 percent may be given to allow the operator to make normal earnings.

Training Allowance: This allowance is provided when work is done by trainee to allow him to make reasonable earnings. It may be a sliding allowance, which progressively decreases to zero over certain length of time. If the effect of learning on the job is known, the rate of decrease of the training allowance can be set accordingly.

Rework Allowance: This allowance is provided on certain operation when it is known that some percent of parts made are spoiled due to factors beyond the operator's control. The time in which these spoiled parts may be reworked is converted into allowance.

4. **Policy allowance:** It depends on the policy of an organization controlled by workers union.

Problem 1: In a welding shop, a direct time study was done on a welding operation. One inexperienced industrial engineer and one experienced industrial engineer conducted the study simultaneously. They agreed precisely on cycle time but their opinion on rating the worker differed. The experienced engineer rated the worker 100% and the other engineer rated the worker 120%. They used a 10% allowance.

Cycle time (in minutes)	Number of times observed
20	2
24	1
29	1
32	1

From the above statement,

- (a) Determine the standard time using the experienced industrial engineer's worker rating.
- (b) Find the standard time using the worker rating of inexperienced industrial engineer.

Solution:

- (a) Rating of worker at 100% by the experienced industrial engineer

$$\text{Cycle time (CT)} = (20 \times 2 + 24 \times 1 + 29 \times 1 + 32 \times 1) / 5 = 25 \text{ min}$$

$$\text{Normal time (NT)} = \text{CT} \times \text{PR} = 25 \times 100\% = 25 \text{ min}$$

$$\text{Standard time (ST)} = \text{NT} / (1 - \%A) = 25 / (1 - 0.10) = 27.78 \text{ min}$$

- (b) Rating of worker at 120% by the inexperienced industrial engineer

$$\text{Cycle time (CT)} = (20 \times 2 + 24 \times 1 + 29 \times 1 + 32 \times 1) / 5 = 25 \text{ min}$$

$$\text{Normal time (NT)} = \text{CT} \times \text{PR} = 25 \times 120\% = 30 \text{ min}$$

$$\text{Standard time (ST)} = \text{NT} / (1 - \%A) = 30 / (1 - 0.10) = 33.33 \text{ min}$$