Time study

- It was proposed by Frederick Taylor and later modified to include a performance rating (PR) adjustment.
- Once the method is established, the next objective is to set the standard time for the work. This aspect of work study is called Time study (or Work measurement).
- The main objectives of time study are:

   1) To determine the standard time for various operations which helps in fixing wage rates and incentives.
   2) To estimate the cost of product accurately.
   3) To predict accurately the duration for a particular work and customer is promised accordingly.
   4) To determine the number of machines an operator can run.
   5) To determine the optimum number of men and machine.
   6) To provide information for planning and scheduling.
   7) To balance the work of all workers working in a group.
   8) To compare the work efficiency of different workers/operators.

Work measurement techniques

   1. Time study using stop watch.
   2. Predetermined motion time system (PMTS).
   3. Work sampling.
   4. Analytical estimating.

The following table shows the application of each technique and unit of measurement.

Technique	Application	Unit of measurement
Time study using stop watch	Short cycle repetitive jobs	Centiminute (0.01 min)
PMTS	Manual operations confined to one work centre	TMU (I TMU = 0.006 min)
Work sampling	Long cycle jobs/ Heterogeneous operation	Minute
Analytical estimating	Short cycle non-repetitive job	Minute

Time study using stop watch is the most popular technique for determining standard time. The first task of the analyst is to divide the work/job into smaller work elements in such a way that the time for each element should not be less than 3 seconds because for such elements, recording time is difficult. The steps of time study are as follows:

Step 1: First select the job to be studied. Breakdown the work content of the job into smallest possible elements. Then, inform the worker and define the best method.

Step 2: Observe the time for appropriate number of cycles (such as 25 to 50).
Step 3: Determine the average cycle time (CT)

$$CT = \frac{\sum Times}{No. \, of \, cycles}$$

Step 4: Determine the normal time (NT)

NT = CT (PR)

Where, PR is the performance rating.

Step 5: Determine the standard time using the following formula.

$$ST = NT\ (AF) \text{ where } AF = \frac{1}{1 - \%\ Allowance}$$

AF being the allowance factor.

Selection of job for Time Study

Time Study is conducted on a job

- which has not been previously time-studied.
- for which method change has taken place recently.
- for which worker(s) might have complained as having tight time standards.

Selection of Worker for Time Study

The worker on which time study should be conducted must

- have necessary skill for the job.
- have sufficient experience with the given method on the job (that is, he should have crossed the learning stage).
- be an 'average' worker as regards the speed of working.
- be temperamentally suited to the study (those who can't work in normal fashion when watched, are not suitable for the study).
- have knowledge about the purpose of study.

Time Study Equipment

The following equipment is needed for time study work.

- Timing device
- Time study observation sheet
- Time study observation board
- Other equipment

Timing Device. The stop watch is the most widely used timing device used for time study, although electronic timer is also sometimes used. The two perform the same function with the difference that electronic timer can measure time to the second or third decimal of a second and can keep a large volume of time data in memory.

Time Study Observation Sheet. It is a printed form with spaces provided for noting down the necessary information about the operation being studied, like name of operation, drawing number, and name of the worker, name of time study person, and the date and place of study. Spaces are provided in the form for writing detailed description of the process (element-wise), recorded time or stop-watch readings for each element of the process, performance rating(s) of operator, and computation. Fig. shows a typical time study observation sheet.

OBSERVATION SHEET

SHEET 1 OF 1 SHEETS	DATE	
OPERATION	OP.NO.	
PART NAME	PART NO.	
MACHINE NAME	MACH.NO.	
OPERATOR'S NAME & NO.	MALE ☐ / FEMALE ☐	
EXPERIENCE ON JOB	MATERIAL	
FOREMAN	DEPT.NO.	

BEGIN	FINISH	ELAPSED	UNITS FINISHED	ACTUAL TIME PER 100	NO. MACHINES OPERATED

ELEMENTS		SPEED	FEED	1	2	3	4	5	6	7	8	9	10	SELECTED TIME
1.				T R										
2.				T R										
3.				T R										
4.				T R										
5.				T R										
6.				T R										
7.				T R										
8.				T R										
9.				T R										
10.	(1)			T R										
11.	(2)			T R										
12.	(3)			T R										
13.	(4)			T R										
14.	(5)			T R										
15.	(6)			T R										
16.	(7)			T R										
17.	(8)			T R										
18.				T R										

SELECTED TIME	RATING	NORMAL TIME	TOTAL ALLOWANCE	STANDARD TIME

SKETCH OF COMPONETS:	TOOLS.JIGS.GAUGES:
	TIMED BY:

Time Study Board. It is a light -weight board used for holding the observation sheet and stopwatch in position. It is of size slightly larger than that of observation sheet used. Generally, the watch is mounted at the center of the top edge or as shown in figure near the upper right-hand corner of the board. The board has a clamp to hold the observation sheet. During the time study, the board is held against the body and the upper left arm by the time study person in such a way that the watch could be operated by the thumb/index finger of the left hand. Watch readings are recorded on the observation sheet by the right hand.
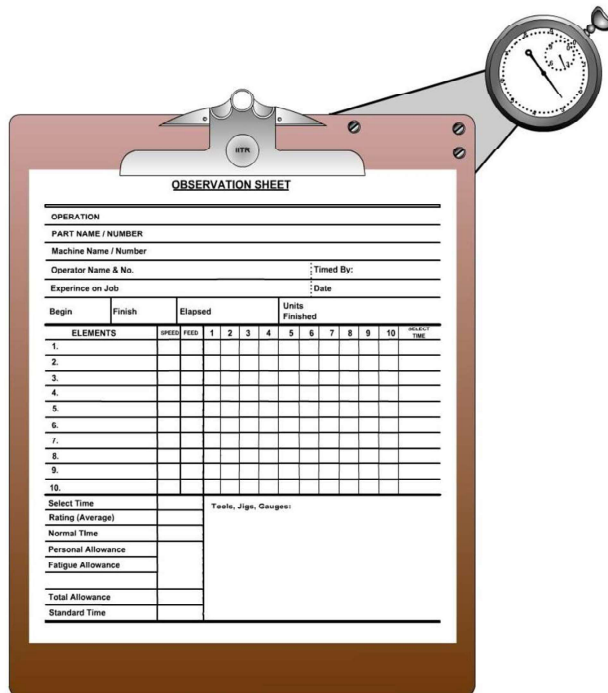
Other Equipment. This includes pencil, eraser, device like tachometer for checking the speed, etc.

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.

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.

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 o of these *(N)* observations is calculated as

$$\sigma = \sqrt{\left[\frac{1}{N}(t-T)^2\right]} = \frac{1}{N}\sqrt{N(\Sigma t^2) - (\Sigma t^2)}$$

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

$$X.\varepsilon = A.T$$

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

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

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. Te rating factor is used to convert the observed time into normal time.

Normal time = Observed time × $\dfrac{\text{Performance level of worker}}{\text{Standard performance level}}$

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) faulty material (iv) faulty 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

   Cycle time (CT) = (20×2+24×1+29×1+32×1)/5 = 25 min

   Normal time (NT) = CT×PR = 25×100% = 25 min

   Standard time (ST) = NT/(1-%A) = 25/(1-0.10) = 27.78 min

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

   Cycle time (CT) = (20×2+24×1+29×1+32×1)/5 = 25 min

   Normal time (NT) = CT×PR = 25×120% = 30 min

   Standard time (ST) = NT/(1-%A) = 30/(1-0.10) = 33.33 min