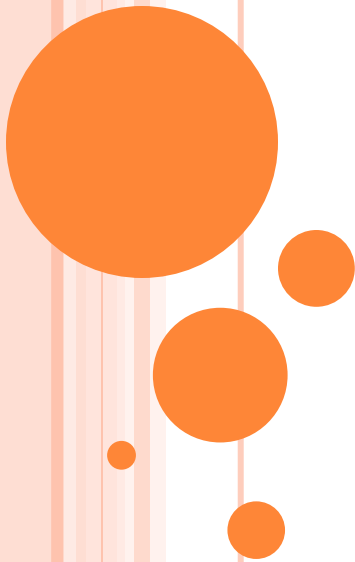



INDUSTRIAL ENGINEERING

Time Study



Objectives of (or advantages achieved through) work measurement:

1. Determines the time required to do a job; compares alternative methods and establishes the fastest method
 2. Decides man power required for a job; it helps in man power economy
 3. Decides equipment requirements
 4. Provides information for effective production planning and maintenance procedures
 5. Aids in calculating exact delivery dates
 6. Decides realistic labour budgeting and provides a basis for standard costing system
 7. Provides a basis for fair and sound incentive schemes
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8. Results in effective labour control.

Irrespective of the advantages mentioned above, the introduction of work study has always been looked by the supervisors, workers or union with suspicion. They probably feel insecure and think that work study will result in reduction in their salaries. Even otherwise a sudden change is never appreciated, therefore, workers and union should be taken into confidence and properly convinced before introducing work study.




Time Study Procedure: The various steps involved are:

1. Establish the quality to be achieved in the product. Strike a balance between a low and very high quality. Low quality means more rejection & scrap and very high-quality marks uneconomical production.
2. Identity the operations to be timed
3. Obtain the improved procedure from the method study department
4. Collect the necessary equipments (discussed later) and ensure their accuracy.
5. Select the worker to be observed.
6. Take the worker as well as supervisor into confidence and explain to them the objectives of the project.

7. Explain to the worker the improved working procedure and the use of tools, jigs and fixtures etc.
8. Break the operation into small elements and write them on the proper form.

An element may be defined as a distinct part of an operation.

The objectives of element breakdown are:

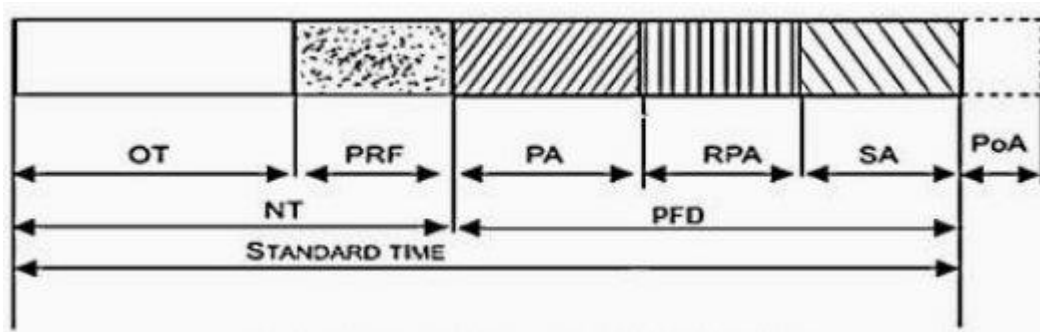
- i. To separate productive and unproductive activities or effective and idle times
 - ii. To get complete and accurate information
 - iii. To access accurately operator's performance
 - iv. To produce detailed work specification
 - v. To select the best method by comparing the work elements of two or more given methods
 - vi. To collect information to compile standard data.
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9. Separate constant (time) elements from variable (time) elements. (Machine elements and manual elements are the examples of constant time and variable time elements).
10. Determine the number of observations to be timed for each element
11. Conduct the observations (of timing the elements) and record them on the time study form.

Measurement of time can be done by any one of the three; non-fly back, fly back or split hand techniques. In continuous timing method a non-fly back type of stop watch is employed. It is started as the first element begins and the reading is taken as the first element ends and the second element begins. Stop watch hands move continuously and the reading is noted again as second element ends and third begins and so on. At the end, the time for each element is found as follows:

Element No.	Total time read at any instant (minutes)	Actual time for an element (minutes)
1	20	20
2	40	$40 - 20 = 20$
3	70	$70 - 40 = 30$
4	100	$100 - 70 = 30$

12. Rate also the performance of the worker during step (11).
13. Repeat steps (11) and (12) for more than one observations.
14. Compute observed time from the measure of central tendency.
15. Calculate normal time from observed time by using performance rating factor.
16. Add process allowance, rest and personal allowances and special allowances to the normal time in order to obtain Standard time or Allowed time. Policy allowances are in addition to standard time. (Fig.).



- OT - Observed time
- PRF - Performance rating factor
- NT - Normal time.
- PA - Process allowances
- RPA - Rest and personal allowances
- SA - Special allowances
- POA - Policy allowances

Fig. Conversion of observed time to standard time



Standard Time may be defined as the amount of time required to complete a unit of work, (a) under existing working conditions, (b) using the specified method and machinery, (c) by an operator, able to the work in a proper manner and (d) at a standard pace.

Stop watch study is employed:

- a) for checking time standards obtained by other methods;
- b) for timing repetitive operations employed in manufacturing different jobs;
- c) where it becomes necessary to breakdown an activity (involving motions of head, leg, foot, trunk, etc.) in detail and study.



Stop Watch Time Study Equipment:

- Stop watch is one of the principle timing devices used for measuring the time taken by an operator to complete the job.
- Besides stop watch, motion picture cameras and time recording machines have also been used.
- Stop watch can run continuously for one hour or half an hour normally and records time by its small hand. One revolution of the big hand of the watch (Refer Fig.) records one minute and the scale covering one minute may be calibrated in intervals of $\frac{1}{300}$ th of a minute or $\frac{1}{100}$ th of a minute.

A stop watch may be of the following types:

1. Non-fly back 2. Fly back 3. Split hand or split second type.



- Non-fly back stop watch is preferred for continuous timing. First pressing of the winding knob starts the watch and long hand begins moving. If winding knob is pressed second time, the long hand stops and with third pressing, hands return to zero position.

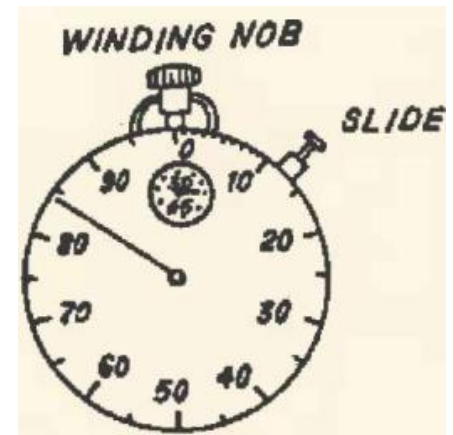


Fig. 9.14. Stop Watch

- If two elements are to be timed and the second element is immediately after the first, the non-flyback system does not work well because it involves stopping the watch at the end of first element, pressing the knob to bring hands back to zero, and again pressing the knob to start the hands; which consume quite some time and hence the second element cannot be timed accurately. Such cases require the use of fly back or split hand type of watch.

- In fly back, the watch is started and stopped with the help of the slide. Pressing the winding knob brings the hands back to zero, but they do not stop, start immediately moving forward again. To stop the hands at any point, slide is used. This stop watch is preferred for continuous timing observations.
- Split hand watch gives greater accuracy in reading when two elements are to be timed and one immediately follows the other. As one element finishes, pressing the winding knob makes one hand to stop (so that an observer can read time accurately) while the other keeps moving. After the reading has been taken, a second pressing on the knob restarts the (stopped) hand and the two hands go together.
- The other equipments needed for time study are, time study form (Fig.), time study board, steel rule or measuring tape, tachometer, micrometer, pencil, slide rule or calculator etc.

Performance Rating: Rating means gauging and comparing the pace rate or the performance of a worker against a standard performance level set by the time study engineer. The standard performance level is different for different jobs. The (performance) rating factor is used to convert observed time into normal time.

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

A rating factor or the levelling factor is a factor by which the observed time (i.e. The actual time taken by the worker to perform a job) is multiplied in order to adjust for differences in operator's performances.

Performance rating becomes necessary in order to differentiate between the performances of two or more operators. Secondly, it can also show day-to-day variations in the level of performance of the same worker.

The rating can be

- (a) Standard-rating: It is the average rate of pace at which a qualified worker will naturally work if he is motivated to apply himself to his work.
- (b) Normal rating: It is the average rate or pace at which a qualified worker will naturally work even if he has no specific motivation to apply himself to his work.

Time Study Form

Product.....

Time Study Engineer.....

Operation No.....

Date.....

Operation description.....

No. of cycles..... 5.....

Standard time found

[illegible]

Various rating techniques:

1. Speed rating,
2. Skill and effort rating,
3. Westing-house system of rating,
4. Synthetic rating,
5. Objective rating, and
6. Physiological evaluation of performance level.

Speed rating: Speed of the movements of a worker is the only factor in speed rating. Rating personnel observes the speed of the movements of the worker against a standard expected pace or speed and notes the relationship between them as a rating factor. Rating can be applied to different elements.


$$\text{Normal time} = \text{Observed time} \times \frac{\text{Worker's speed}}{\text{speed expected from the worker}}$$



Skill and effort rating: This rating system was suggested by C.E. Bedaux in 1916. The units of work are expressed as B's. If a worker acquires 60 B's in one hour, it would be standard performance. While timing the elements the operator is rated for the speed of his movements and his skill. An efficient worker earns points in excess of 60 B's and a poor worker-below 60 B's. B-points for a job can be calculated by adding the same (i.e., B-points) for each element involved in the job. B-points for an element are equal to

$$\frac{\left(\begin{array}{c} \text{Observed time} \\ \text{in minutes} \end{array} \right) \times \left(\begin{array}{c} \text{B-points earned} \\ \text{by the worker} \end{array} \right) \times (\text{Relaxation factor})}{60}$$

Relaxation factor depends upon the nature of the work and may vary from 1 to 3 for light to very heavy duty works or jobs.



d) Westing-house system of rating:

- It is based upon four factors, which are further divided into subfactors and have numerical values attached with them. The various factors are,

- Skill

Superskill (+0.15), Excellent (+0.11) , Good (+0.08), Average (0.00), Fair (-0.05), Poor (-0.16)

Similarly other three factors named below are sub grouped and each subgroup has a numerical value.

- Effort
- Conditions (of temperature, noise, smoke, fumes, etc)
- Consistency


A worker is rated on the basis of the above four factors.

Synthetic rating:

- In this system the speed or the pace rate of an operator is evaluated with the help of predetermined motion time standards (PMTS).

$$\text{Rating factor} = \frac{\text{Time value extracted from PMTS}}{\text{Observed Time}}$$

Objective rating: This system involves; rating the speed of the worker against a standard pace, independent of job difficulty and then adding an allowance depending upon the job difficulty. The job difficulty is decided from the following

- (a) The amount of body used
 - (b) Foot movements involved
 - (c) Eye-hand co-ordination (if any)
 - (d) Weight moved or lifted
 - (e) Handling requirements, etc.
- 

Physiological Evaluation of performance level :

- Performance level of a worker can also be estimated physiologically, because heart beat rate increases with the muscular activities and amount of oxygen consumed by a worker increases with the severity of physical labour.

Allowances: Allowances are added to the normal time in order to arrive at standard time.

Process Allowances: They are meant to compensate workers for the enforced idleness due to the character or nature of a process or an operation.

A worker generally feels discouraged if unluckily the idle time becomes a major portion of the total cycle time because even if he works at a fast pace rate during the non-idle time, he can hardly boost his low earnings.

Personal and Rest Allowances: The allowances provided to worker in order to satisfy his personal needs (like visiting toilet etc.) and to recover from the physiological and psychological effects of energy spent while performing an operation under existing working conditions. Rest allowance is a relaxation allowance to a worker to overcome fatigue incurred during working. The allowances may vary from 12% to 20% (or more).

Special Allowances: Temporary or permanent and given for activities which are not generally the part of work cycle but are considered essential for performing the work satisfactorily.

(a) Periodic activity allowance: The activities to be carried out periodically during work cycle, e.g. setting up of a planer etc.

Interference Allowance. When a worker is looking after two or more machines and one or more of them stop (at random or cyclically) while he is attending to another (machine).

Analytical Estimating: Setting the time standards for long and non-repetitive operations by Stop Watch Method are uneconomical.

Analytical Estimating technique determines the time values for such jobs either by using the synthetic data or on the basis of the past experience of the estimator when no synthetic or standard data is available. In order to produce accurate results the estimator must have sufficient experience of estimating, motion study and time study.

Procedure:

(a) Find out job details which include job dimensions, standard procedure and especially the job conditions, i.e., poor illumination, high temperatures, hazardous environments, availability of special jigs, fixtures or toolings etc.

(b) Break the job into constituent elements.

(c) Select time values for as many elements possible from the library of element time values (i.e., synthetic data).

(d) To the remaining elements for which no synthetic data is available, usually the estimator gives suitable time values from his past knowledge and experience.

(e) Add (c) and (d) and this is the total basic time at a 100% rating.

(f) Add to (e) an appropriate Blanket Relaxation Allowance. In analytical estimating, Relaxation Allowance is not added to individual elements, rather a blanket, RA., depending upon the type of job and job conditions, is predecided as a percentage (10-20%) of the total basic time and is added to the total basic time.

(g) Any additional allowances if applicable may be added to (/) in order to arrive at Standard Time for the given job or task.

Advantages:

- i. Possesses almost the same advantages as enjoyed by synthesis technique of Work Measurement.
- ii. Aids in planning and scheduling.
- iii. provides a basis for rate fixing for non-repetitive works.
- iv. Improves labour control.

Drawback: Since analytical estimating relies upon the judgement of the estimator, the time values obtained are not as accurate and reliable as estimated by other work measurement techniques.

Applications: (i) for non-repetitive jobs, jobs involving long cycle times (ii) in Repair and Maintenance work, Tool rooms, Engineering construction, Job production, One time large projects and Office routines, etc

Predetermined Motion Time System (PMTS): PMTS deal with M-T-M and Work Factor Systems which are known as Micro data. Micro data is based upon much smaller division of motions (i.e. therbligs) compared to Macro data used in Standard Data. PMTS as a time study technique whereby times established for basic human motions (classified according to the nature of the motion and the conditions under which it is made) are used to build up the time for a job at a defined level of performance.

Technique: (i) The technique to build PMTS data does not measure element time by a stop watch and thus it avoids the inaccuracies being introduced owing to the element of human judgement.

(ii) It is assumed that all manual tasks in industries are made up of certain basic human movements (like reach, move, disengage etc.) which are common to almost all jobs.

(iii) The average time taken by the (normal) industrial workers to perform a basic movement is practically constant.

- Objects and uses of PMTS:**
- (i) Very useful in Method Analysis.
 - (ii) Helps modifying and improving work methods before starting the work on the job.
 - (iii) Sets time standards for different jobs.
 - (iv) Assists in constructing time formulae.
 - (v) Aids in the prebalancing of the manufacturing lines.
 - (vi) Provides a basis for wage plans and labour cost estimation.
 - (vii) It facilitates training of the workers and supervisor.

Advantages:

- i. Eliminates inaccuracies associated with stop watch time study.
- ii. It is superior to stop watch time study when applied to short cycle highly repetitive operations.

- iii. Time standard for a job can be arrived at without going to the place of work.
- iv. Unlike stop watch study, no rating factor is employed.
- v. PMTS data, since it is the result of very large number of observations, is more reliable and accurate as compared to stop watch time study data.
- vi. The time and cost associated with finding the standard time for a job is considerably reduced.
- vii. Alternative methods are compared easily.
- viii. PMTS helps in tool and product design

Drawbacks: (i) PMTS can deal only with manual motions of an operation.

(ii) All categories of motions have not been considered while collecting PMTS data.

Applications of PMTS:

- (a) Machining work,
- (b) Maintenance work,
- (c) Assembly jobs,
- (d) Servicing, and
- (e) Office work.

