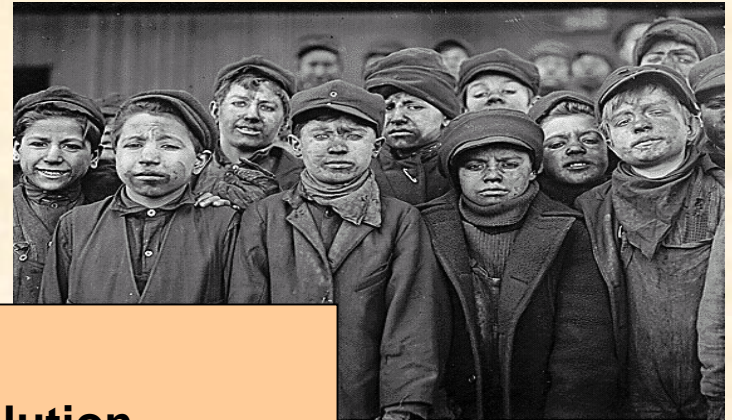
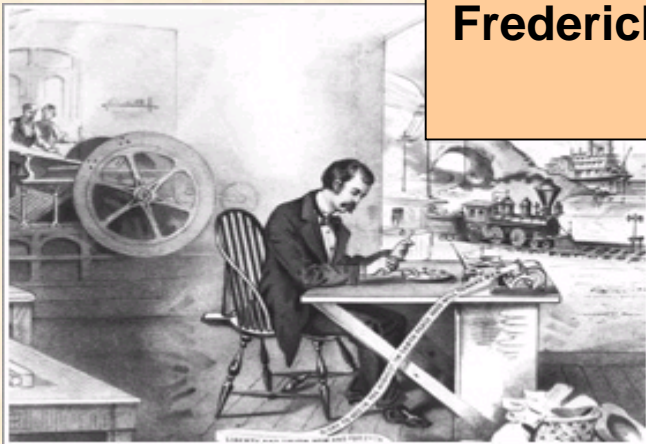


Work Measurement

Historical Development



**Industrial Revolution
(akhir abad 18-awal abad 19)
Istilah ini diperkenalkan oleh:
Frederich Engels dan Louis Auguste**

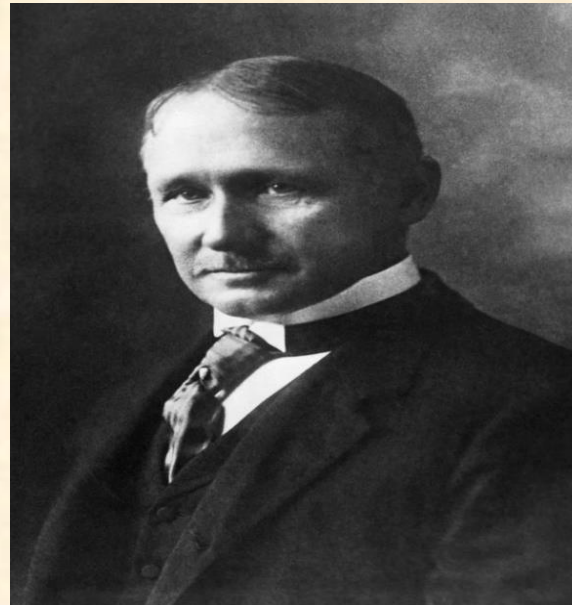


Historical Development



Frank (1868-1924)
Lilian Gilbreth (1878-1972)

**Known as a parents of
motion study**



F.W Taylor
(1856-1915)

**Known as a father of
scientific management, IE,
and Time Study**



Historical Development : Present...

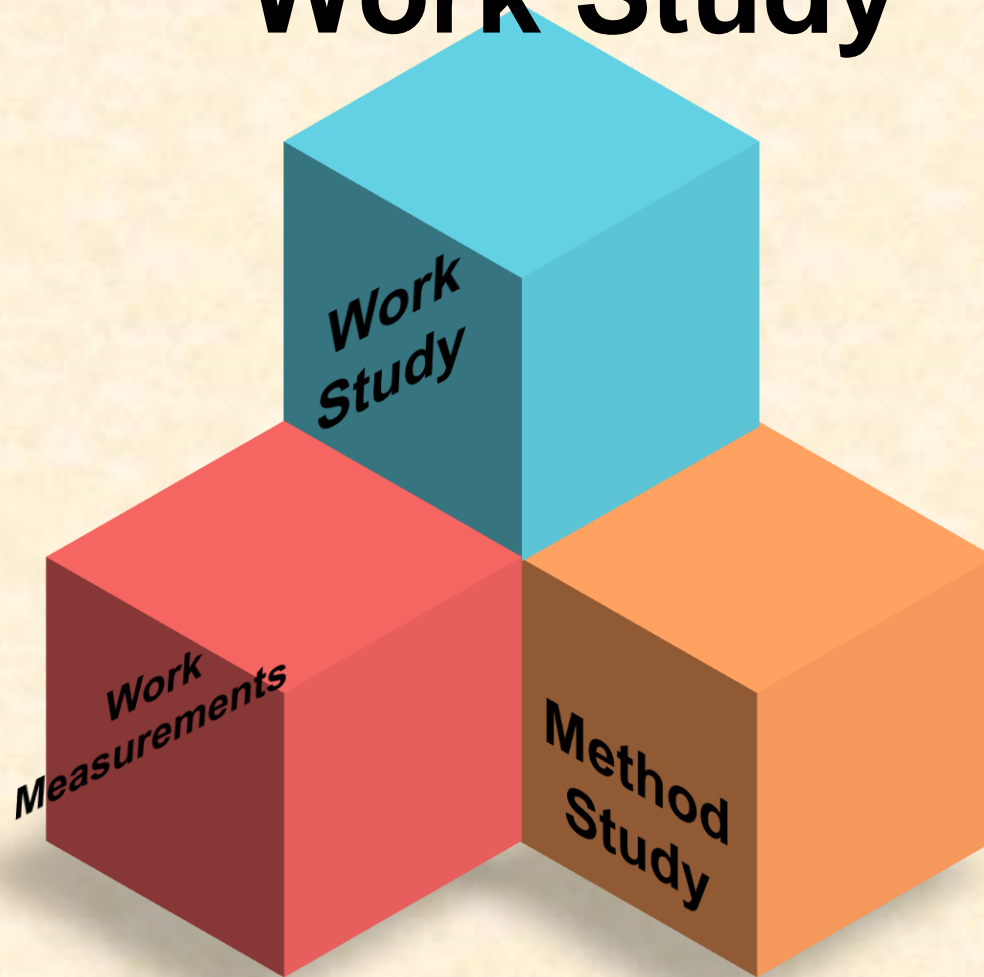


Work Measurements

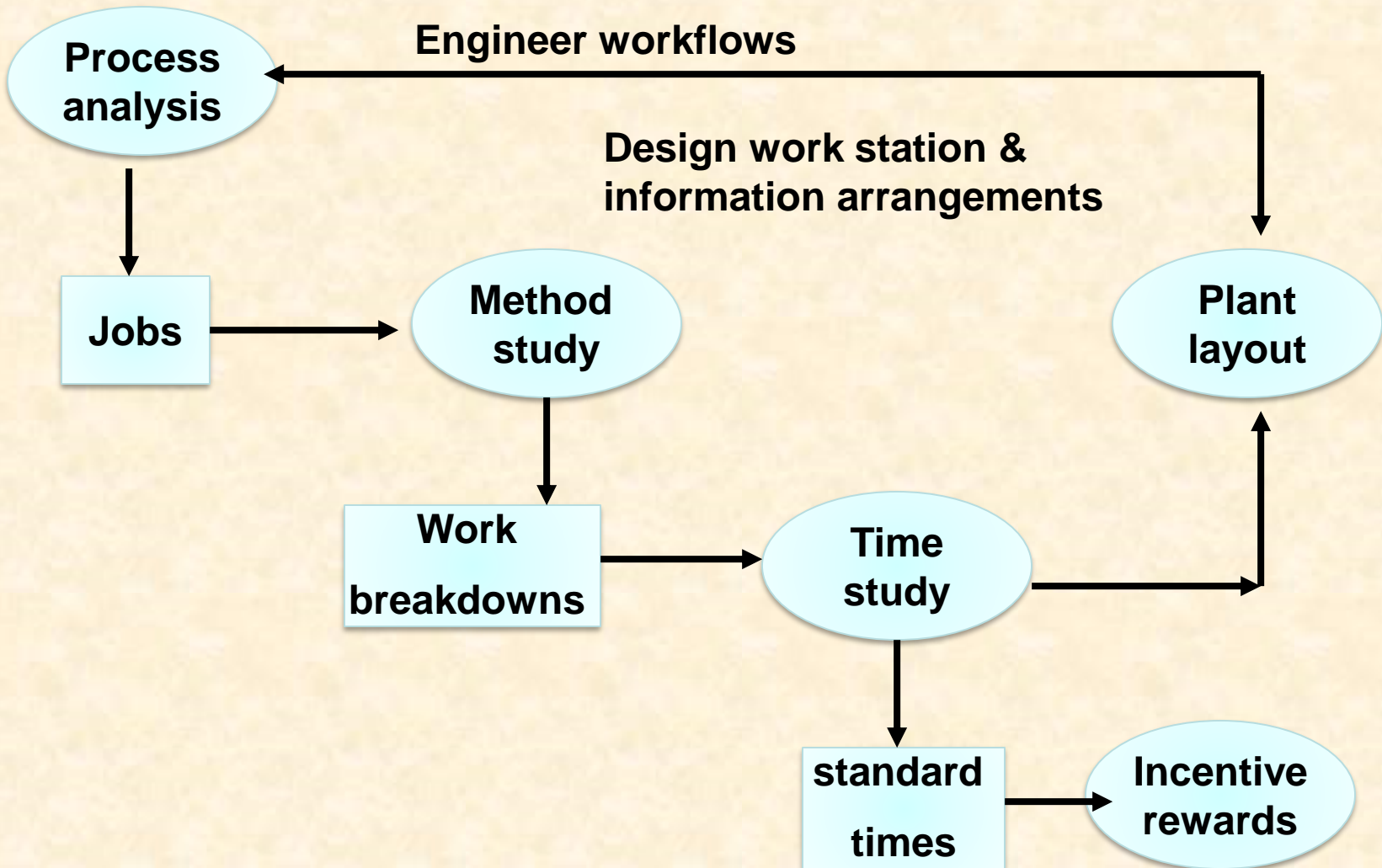
Work Study

- **Work Study** is a generic term for management services and system engineering techniques, used to investigate:
 - Methods of performing work (**Method Study**).
 - The time taken to do it (**Work Measurement**).

Work Study



System Relationships



Method Study

- **Method study** is a technique to reduce the work content mainly by eliminating unnecessary movements by workers, materials, or equipments.
- Already Discuss in Lecture

Work Measurement

Work measurements (WM) are techniques used to establish the time for a qualified, motivated worker to carry out a task at a defined rate of working.

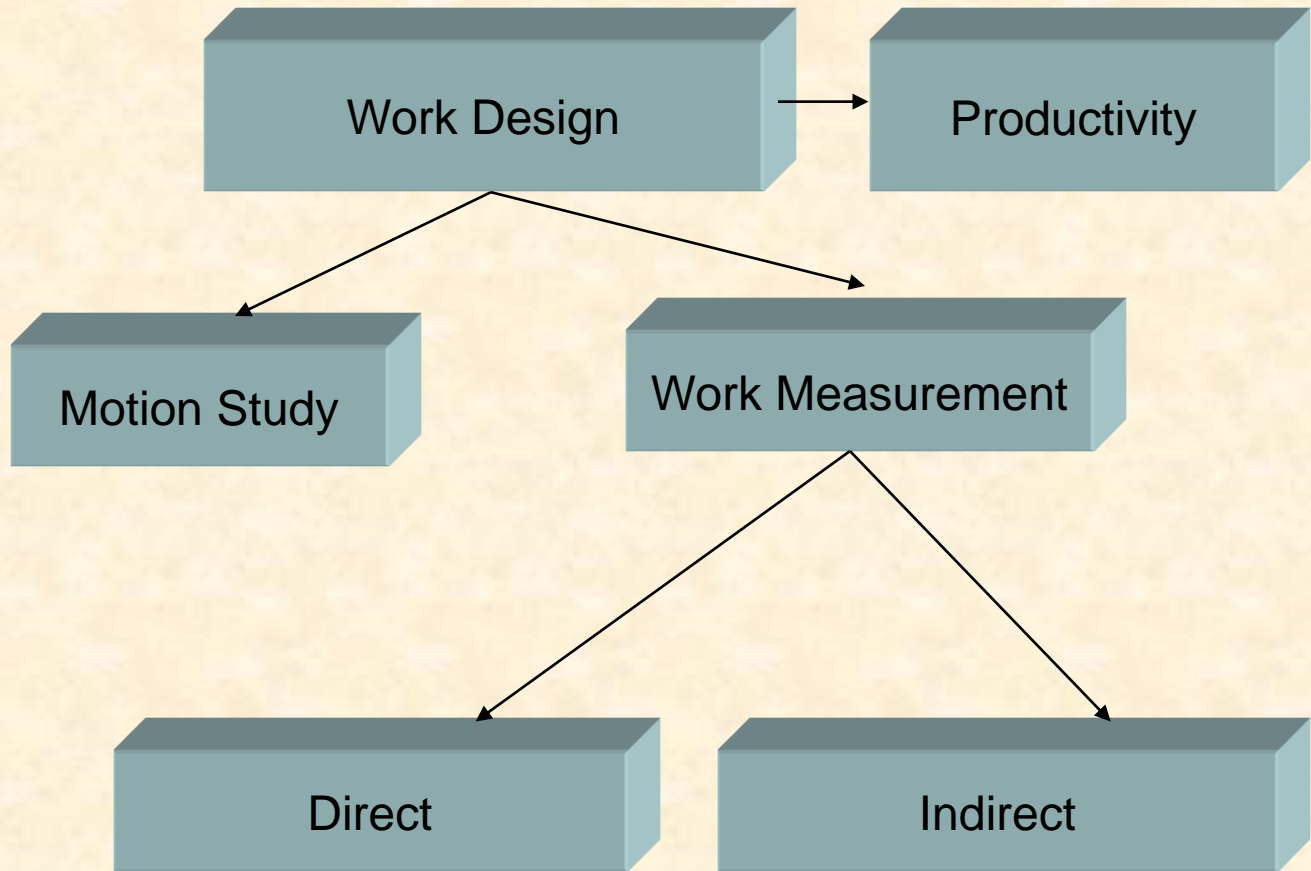
Qualified worker – A person who has the necessary physical and mental attributes and at the same time has the appropriate skills and tools to perform the job.

Time – the length of time taken to complete the job; usually expressed as labor standard or standard time.

Normal working condition – the acceptable working environment in term of temperature, humidity, lighting, noise, etc needed to perform the job.

Work Measurement

- Work measurement is concerned with investigating, reducing and eliminating ineffective time, whatever may be the cause.



Scheme of the study

Techniques for WM

- **Two alternative method:**
 - **Direct work measurement:**
 - **Time study:** “the most widely used”
 - **Work sampling:** Determines the proportion of time a worker spends on activities
 - **Indirect work measurement** (indirect method not on the task) with standard times are measured by standard data and formulation.
 - Synthesis from standard data.
 - PMTS
 - Analytical estimating.

Direct Work Measurement

Stop watch Time Study

Work Sampling

Indirect Work Measurement

Regression Analysis

Standard Data/Formula

Predetermined Motion Time System

General Approach

Functional Approach
(for specific purpose)

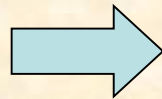
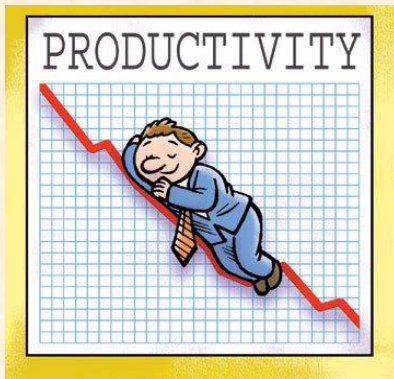
-MTM
-MOST

-MTM-M
-MTM-C
-MTM-V

Purpose of WM

- Work Measurement Purposes may be:
 - To reveal the nature and extent of ineffective time, from whatever cause.
 - So that action can be taken to eliminate it; and then,
 - To set standards of performance that are attainable only if all avoidable ineffective time is eliminated and work is performed by the best method available

Work Measurement:
Improve Productivity, Reduce Costs, Improve Profits



Applications of WM

- To compare the efficiency of alternative methods. Other conditions being equal, the method which takes the least time will be the best method.
- To balance the work of members of teams, in association with the multiple activity charts, so that, as far as possible, each member has tasks taking an equal time.
- To determine, in association with man and machine multiple activity charts, the number of machines a worker can run.

Uses of Time Standards

- To provide information on which the planning and scheduling of production can be based, including the plant and labor requirements for carrying out the program of work and utilization of resources.
- To provide information on which estimates for tenders, selling prices and delivery promises can be based.
- To set standards of machine utilization and labor performance which can be used for incentive scheme.
- To provide information for labor-cost control and to enable standard costs to be fixed and maintained.

Areas of Controversy

- Conflict between management and workers
 - Workers think standards too high
 - Management think standards too low
- Conflicts expensive
- Need achievable standards for costing, scheduling etc.
- Time studies dehumanising
- Industrial Engineering departments expensive
- Using work standards for piecework incentives reduces incentive to improve work methods
- Trade off with quality

Time Study

- **Time Study:** is the development of a standard time by observing a task and analyzing it with the use of a stopwatch
- Developed by FW Taylor
- It is the most versatile and the most widely used.
- Time study is a technique to estimate the time to be allowed to a qualified and well-trained worker working at a normal pace to complete a specified task.
- This technique is based on measuring the work content of the task when performed by the prescribed method, with the allowance for fatigue and for personal and unavoidable delays.

Stopwatch Time Study Basic Steps

The various steps are

- Select the job to be time studied and operations to be timed.
- Obtain the improved procedure of doing the job from method study department.
- Select the worker of the study.
- Take the worker & supervisor into confidence & explain the objective of study to them.
- Arrange the equipments and machinery to conduct time study and insure their accuracy
- Explain to workers the improved working procedure and use of tools and other attachments to do the job.
- Breakdown the operation into elements.

Stopwatch Time Study Basic Steps

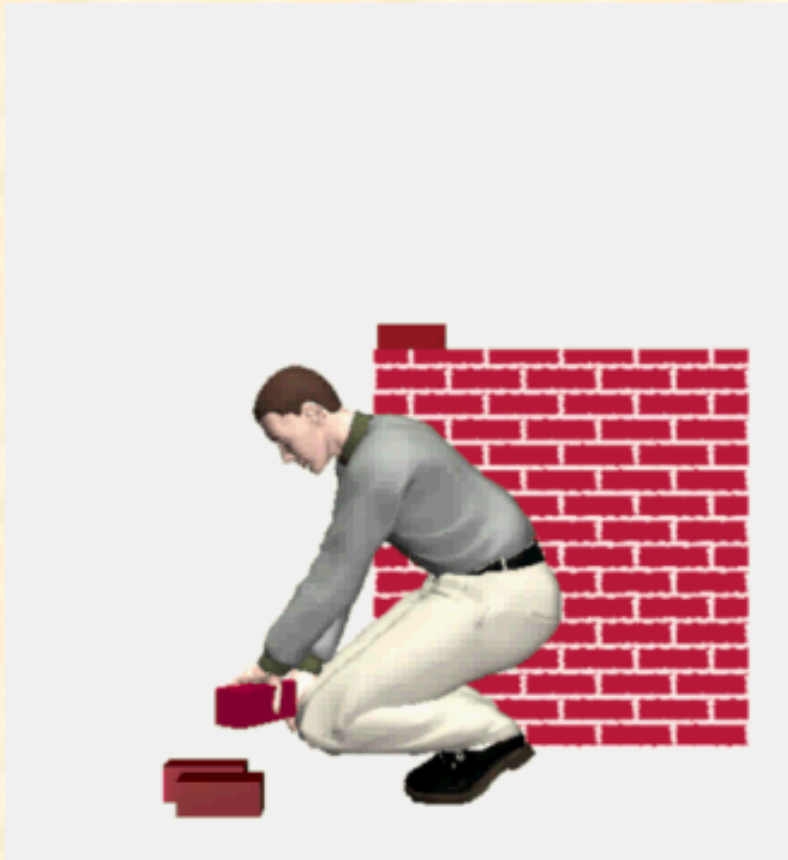
- Determine the number of observations to be timed for each element.
- Conduct the observations and record them in time study form
- Also rate the performance of the working while conducting the observation .
- After repeating above two steps Compute observe time.
- For each element calculate the representative watch time. Multiply it by the rating factory to get normal time.
- Normal time = Observed time * Rating factor

Stopwatch Time Study Basic Steps

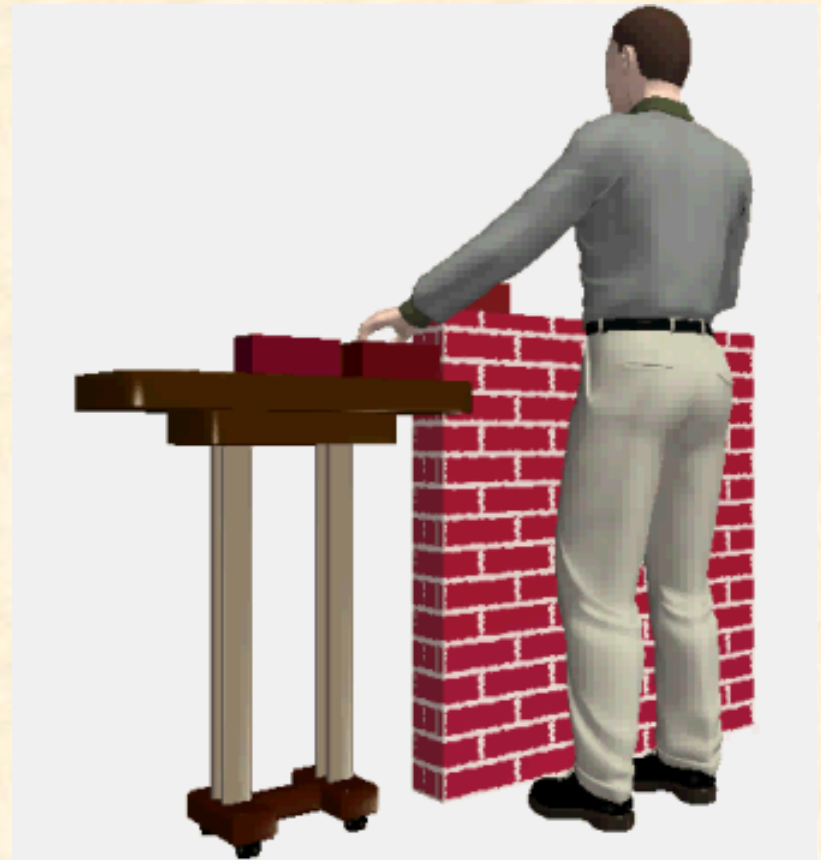
- Add the normal time of various elements to obtain the normal time for the whole operation.
- Determine allowances for various delays from the company's policy book or by conducting an independent study.
- Determine standard time by adding allowances to the normal time of operation.
- Standard time = Normal time + allowances

Time Study

Before Time Studies



After Time Studies



APPLICATIONS OF TIME STUDY

- Checking time standards obtained by other methods
- Timing repetitive operations employed in manufacturing different jobs
- Determine scheduling and planning work
- Determining standard cost and as an aid in preparing budgets
- Determining machine effectiveness

Reasons for Element Breakdown

- Data is more readily reusable when each element is described separately, esp. beginning and ending points.
- Standard (estimated) time values may be determined.
- Individual elements may be excessively short (e.g., inspection), or too long. These can be picked out more easily in element form.
- This allows for separate performance ratings for each.

TIME STUDY EQUIPMENTS

- **Time measuring devices**
 - Motion Picture Camera**
 - Stop Watch**
 - Time Recording Machine**
 - Electronic data collector and computer**
- **Time study board**
- **Time study form**
- **Auxiliary Equipment**

Stop watch

Stop watch is the one of the principle time measuring device. It measure the time taken by an operator to complete the job, besides stop watch , motion picture camera, time recording technique , electronic media are also used for time measurement . A stop watch can run continuously for one hour or half an hour normally and records time by short hand. One complete revolution of big hand of watch records one minute . A stop watch may be of following three types:

1. Non fly back
2. Fly back and
3. Split hand a split second type

MOTION PICTURE CAMERA

- This idea for recording methods as well as elapsed time. The time for the elements of an operation can be obtained from the motion pictures of the operation made with the synchronous motor driven motion picture camera. This camera operates at fixed speeds . The speeds most frequently used is thousand frames per minute, which permits the measurement of time in thousands of a minute. A motion picture of an operation forms a permanent record of the method used as well as time taken for each element of the operation . moreover , the film may be projected at the exact speed at which the picture was made and check may be made of the operators performance.

ELECTRONIC DATA COLLECTOR AND COMPUTER

Electronic data collector and computer make the time study more easy and systematic. Analyst using the hand held unit collects the data and computer performs the clinical work of computation, analysis, summarizes the data and computer the time standard.

TIME RECORDING MACHINES

- Considerable training is required to be able to read the stop watch, record the reading on the time study form, and still it observing operator performance so the correct performance rating can be applied. to relieve he time study man of some these simultaneous function, time study machines have been developed these machines permit precision timing elements or movement as small as 0.01 minutes in duration to the nearest 0.001 minutes in sequence. These are built to drive a graduated tape at a constant speed past a key or indenter this indenter when presses with mark tape indicating the termination of an elements are identified by depressing another key arranged on the machine . A permanent record of time study is represented by such a tape and elemental values can be calculated easily by making successive subtractions

TIME STUDY BOARD

When making a time study with the help of a stop watch , it always necessary to provide a suitable board to hold the time study form and stop watch . the time study board is simply a flat board , usually of plywood or suitable plastic sheet . stop watch is kept at upper right hand corner of the board observations sheets held at the top of the board

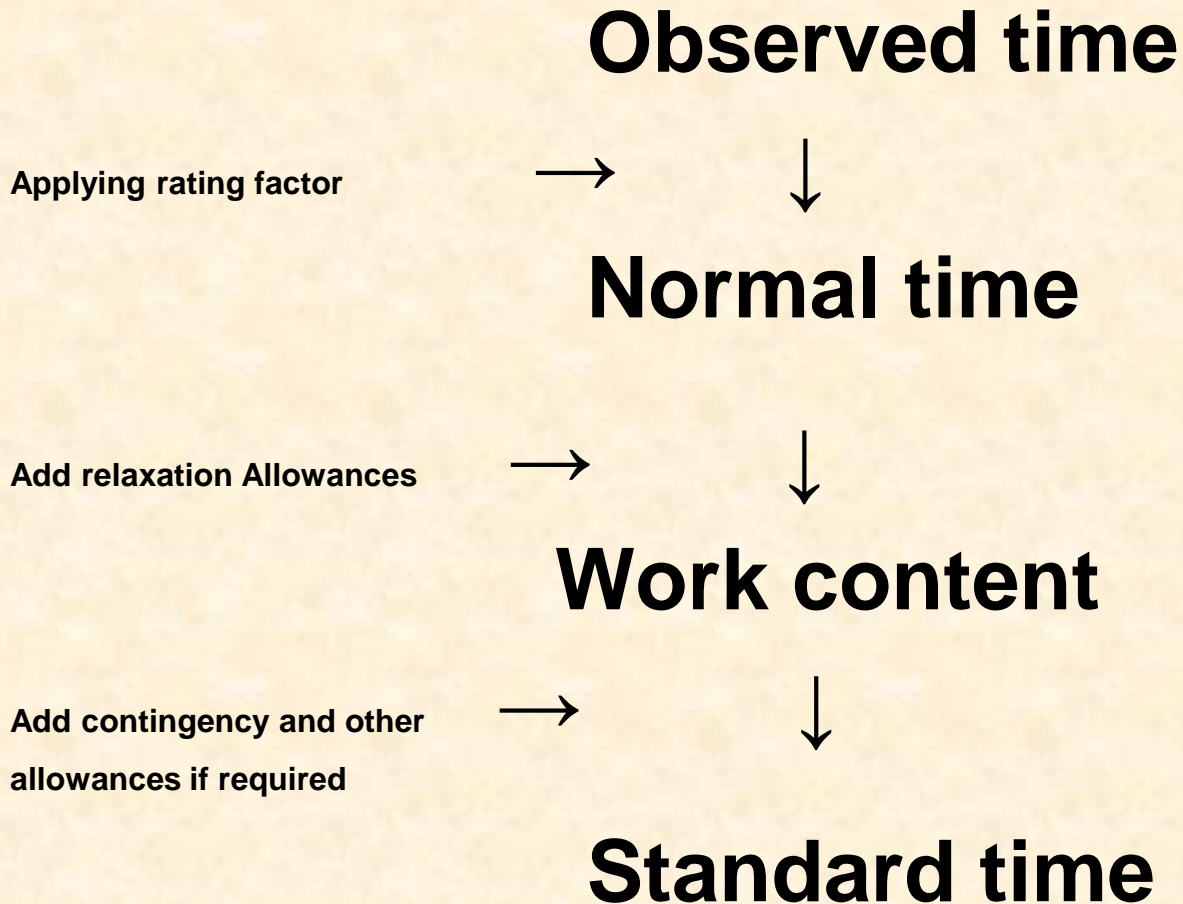
TIME STUDY FORM

Time study form is also called observation sheet . the observation sheet the detailed information about the details of operations , name of operator , name of time study operator , data , place etc. some times may be provided for a sketch it fits the standard file or finder.

Taking and Recording of Data

- **Continuous timing** - records readings at the end of each element as watch runs
- **Repetitive timing** - after recording, watch is snapped back to zero at the end of each element
- **Multiple watches** - connected by a lever; one runs, another is stopped, another set to go
- **Electronic watch** - may continue in “split” mode

BASIC PROCEDURE FOR WORK MEASUREMENT



Standard time

- **Standard time:**

The amount of time it should take a qualified worker to complete a specific task, working at a sustainable rate, using given methods, tools and equipment, raw materials, and workplace arrangement.

Standard Time

- **Two basic approaches to defining standard time.**
 - **Bottom-up**
 - Starts with a basic measurement of time, adjusts for operator pace, and then allows for fatigue, personal needs, and delays.
 - **Top-down**
 - used in many labor contracts, and it normally defines standard time as that time under which a qualified employee working under usual conditions can make an incentive pay (specified) percent above base pay.

Standard Time (Cont.)

- **Normal Time.**
 - The time required for an average, trained operator to perform a task under usual working conditions and working at a normal pace. (It does not include allowances for personal needs and delays that would be necessary if the task were done all 8 hours.)
- **Normal Pace.**
 - The pace of an average, trained, and conscientious operator working over an 8-hour day.
- **Actual Time.**
 - The observed time required for an operator to perform a task.
- **Allowances.**
 - The amount of time added to the normal time to provide for personal needs, unavoidable delays, and fatigue.

Doing Time Study

- When making a time study several decisions are made to assure desired results:
 - # of observations to make
 - Desired level of accuracy
 - Desired level of confidence for the estimated standard time

Performance Rating

- During the time study, time study engineer carefully observes the performance of the operator. This performance seldom conforms to the exact definition of normal or standard. Therefore, it becomes necessary to apply some 'adjustment' to the mean observed time to arrive at the time that the normal operator would have needed to do that job when working at an average pace. This 'adjustment' is called Performance Rating.

Performance Rating

- Determination of performance rating is an important step in the work measurement procedures. It is based entirely on the experience, training, and judgment of the work-study engineer. It is the step most subjective and therefore is subject to criticism.
- It is the procedure in which the time study engineer compares the performance of operator(s) under observation to the Normal Performance and determines a factor called Rating Factor.

$$\text{Rating Factor} = \frac{\text{Observed Performance}}{\text{Normal Performance}}$$

Performance Rating

- The **normal time** (NT) is the mean observed time multiplied by the Performance Rating Factor (PRF)
- The **PRF** is a subjective estimate of a worker's pace relative to a normal work pace.
- The **Performance Rating** is usually expressed in decimal form in these formulas. So a person working 10% faster than normal would have a Performance Rating of 1.10 or 110% of normal time. Working 10% slower, 0.90 or 90% of normal.
- The **frequency of occurrence (F)** is how often the element must be done each cycle.

System of Rating

- Pace Rating
- Westinghouse System of Rating
- Objective Rating
- Synthetic Rating

Pace Rating

- In this method, which is also called the speed rating method, the time study person judges the operators speed of movements, i.e. the rate at which he is applying himself, or in other words "how fast" the operator the motions involved.
- **Normal Time =**
$$OT * \text{Workers Speed} / \text{Speed Expected from worker}$$

Westinghouse System of Rating

- This method considers four factors in evaluating the performance of the operator: Skill, effort, conditions and Consistency.
- Skill may be defined as proficiency at following a given method. It is demonstrated by coordination of mind and hands. A person's skill in given operation increases with his experience on the job, because increased familiarity with work bring speed, smoothness of motions and freedom from hesitations.

Westinghouse System of Rating

- The Westinghouse system lists six classes of skill as poor fair, average, good, excellent. The time study person evaluates the skill displayed by the operator and puts it in one of the six classes. As equipment % value of each class of skill is provided, the rating is translated into its equivalent percentage value, which ranges from +15 % (for super skill) to -22 % (for poor skill). In a similar fashion, the ratings for effort, conditions, and consistency are given for each of the factors.

Objective Rating

- In this system, speed of movements and job difficulty are rated separately and the two estimates are combined into a single value. Rating of speed or pace is done as described earlier, and the rating of job difficulty is done by selecting adjustment factors corresponding to characteristics of operation with respect to (i) amount of body used, (ii) foot pedals, (iii) bimanual ness, (iv) eye-hand co ordination, (v) handling requirements and (vi) weight handled or resistance encountered

Objective Rating

- For an operation under study, the numerical value for each of the six factors is assigned, and the algebraic sum of the numerical values called job difficulty adjustment factor is estimated.
- The rating factor **R** can be expressed as
- **$R = P \times D$**

Where

P = PRF

D = Job difficulty adjustment factor.

Synthetic Rating

- This method of rating has two main advantages over other methods that (i) it does not rely on the judgment of the time study person and (ii) it give consistent results.
- The time study is made as usual. Some manually controlled elements of the work cycle are selected. Using a PMT system (Pre-determined motion time system), the times for these elements are determined.

Synthetic Rating

- The times of these elements are the performance factor is determined for each of the selected elements.
- Performance or Rating Factor, $R = P / A$
- Where P = Predetermined motion time of the element , A = Average actual Observed time of the element.
- The overall rating factor is the mean of rating factors determined for the selected elements, which is applied uniformly to all the manually controlled elements of the work cycle.