Unit – III

UNIT SYLLABUS

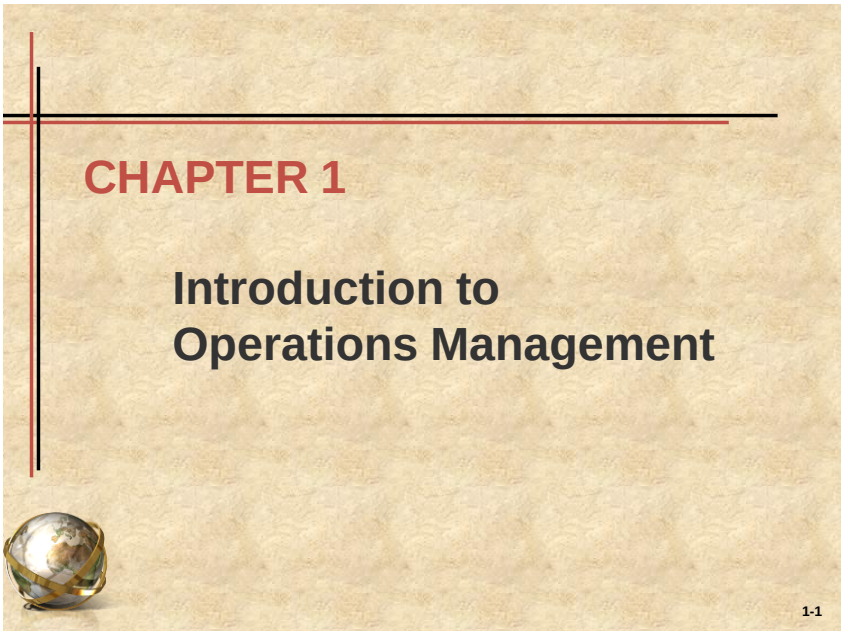
OPERATIONS MANAGEMENT: Importance, types of production, applications, work study, method study and time study, work sampling, PMTS, micro-motion study, rating techniques, MTM, work factor system, principles of Ergonomics, flow process charts, string diagrams and Therbligs.

Operations management

Operations management is an area of management concerned with designing and controlling the process of production and redesigning business operations in the production of goods or services. It involves the responsibility of ensuring that business operations are efficient in terms of using as few resources as needed and effective in terms of meeting customer requirements. It is concerned with managing the process that converts inputs (in the forms of raw materials, labor, and energy) into outputs (in the form of goods and/or services).

The relationship of operations management to senior management in commercial contexts can be compared to the relationship of line officers to highest-level senior officers in military science. The highest-level officers shape the strategy and revise it over time, while the line officers make tactical decisions in support of carrying out the strategy. In business as in military affairs, the boundaries between levels are not always distinct; tactical information dynamically informs strategy, and individual people often move between roles over time.

According to the United States Department of Education, operations management is the field concerned with managing and directing the physical and/or technical functions of a firm or organization, particularly those relating to development, production, and manufacturing. Operations management programs typically include instruction in principles of general management, manufacturing and production systems, factory management, equipment maintenance management, production control, industrial labor relations and skilled trades supervision, strategic manufacturing policy, systems analysis, productivity analysis and cost control, and materials planning.



PPT-3.1

4.3.4.1 Lecture 23

Types of production

Types of production are

(i) Job Production
(ii) Batch production
(iii) Mass or flow production

A production manager will have to choose most appropriate method for his enterprise.

The final decision regarding any particular method of production is very much affected by the nature of the products and the quantity to be produced. Production methods may be broadly classified as Job Production, Batch production and Mass or Flow Production.

(i) Job Production:

Under this method peculiar, special or non-standardized products are produced in accordance with the orders received from the customers. As each product is non- standardized varying in size and nature, it requires separate job for production. The machines and equipment's are adjusted in such a manner so as to suit the requirements of a particular job.

Job production involves intermittent process as the work is carried as and when the order is received. It consists of bringing together of material, parts and components in order to assemble and commission a single piece of equipment or product.

Ship building, dam construction, bridge building, book printing are some of the examples of job production. Third method of plant layout viz., Stationery Material Layout is suitable for job production.

Characteristics:

The job production possesses the following characteristics.

1. A large number of general purpose machines are required.

2. A large number of workers conversant with different jobs will have to be employed.

3. There can be some variations in production.

4. Some flexibility in financing is required because of variations in work load.

5. A large inventory of materials, parts and tools will be required.

6. The machines and equipment setting will have to be adjusted and readjusted to the manufacturing requirements.

7. The movement of materials through the process is intermittent.

Limitations:

Job production has the following limitations:

1. The economies of large scale production may not be attained because production is done in short-runs.

2. The demand is irregular for some products.

3. The use of labour and equipment may be an inefficient.

4. The scientific assessment of costs is difficult.

(ii) Batch production:

Batch production pertains to repetitive production. It refers to the production of goods, the quantity of which is known in advance. It is that form of production where identical products are produced in batches on the basis of demand of customers' or of expected demand for products.

This method is generally similar to job production except the quantity of production. Instead of making one single product as in case of job production, a batch or group of products are produced at one time. It should be remembered here that one batch of products may not resemble with the next batch.

Under batch system of production the work is divided into operations and one operation is done at a time. After completing the work on one operation it is passed on to the second operation and so on till the product is completed. Batch production can be explained with the help of an illustration. An enterprise wants to manufacture 20 electric motors.

The work will be divided into different operations. The first operation on all the motors will be completed in the first batch and then it will pass on to the next operation. The second group of operators will complete the second operation before the next and so on. Under job production the same operators will manufacture full machine and not one operation only.

Batch production can fetch the benefits of repetitive production to a large extent, if the batch is of a sufficient quantity. Thus batch production may be defined as the manufacture of a product in small or large batches or lots by series of operations, each operation being carried on the whole batch before any subsequent operation is operated. This method is generally adopted in case of biscuit and confectionery and motor manufacturing, medicines, tinned food and hardware's like nuts and bolts etc.

The batch production method possesses the following characteristics:

1. The work is of repetitive nature.

2. There is a functional layout of various manufacturing processes.

3. One operation is carried out on whole batch and then is passed on to the next operation and so on.

4. Same type of machines is arranged at one place.

5. It is generally chosen where trade is seasonal or there is a need to produce great variety of goods.

(iii) Mass or flow production:

This method involves a continuous production of standardized products on a large scale. Under this method, production remains continuous in anticipation of future demand. Standardization is the basis of mass production. Standardized products are produced under this method by using standardized materials and equipment. There is a continuous or uninterrupted flow of production obtained by arranging the machines in a proper sequence of operations. Process layout is best suited method for mass production units.

Flow production is the manufacture of a product by a series of operations, each article going on to a succeeding operation as soon as possible. The manufacturing process is broken into separate operations.

The product completed at one operation is automatically passed on to the next till its completion. There is no time gap between the work done at one process and the starting at the next. The flow of production is continuous and progressive.

Characteristics:

The mass or flow production possesses the following characteristics.

1. The units flow from one operation point to another throughout the whole process.

2. There will be one type of machine for each process.

3. The products, tools, materials and methods are standardized.

4. Production is done in anticipation of demand.

5. Production volume is usually high.

6. Machine set ups remain unchanged for a considerable long period.

7. Any fault in flow of production is immediately corrected otherwise it will stop the whole production process.

Suitability of flow/mass production:

1. There must be continuity in demand for the product.

2. The products, materials and equipments must be standardized because the flow of line is inflexible.

3. The operations should be well defined.

4. It should be possible to maintain certain quality standards.

5. It should be possible to find time taken at each operation so that flow of work is standardized.

6. The process of stages of production should be continuous.

Advantages of mass production:

A properly planned flow production method, results in the following advantages:

1. The product is standardized and any deviation in quality etc. is detected at the spot.

2. There will be accuracy in product design and quality.

3. It will help in reducing direct labour cost.

4. There will be no need of work-in-progress because products will automatically pass on from operation to operation.

5. Since flow of work is simplified there will be lesser need for control.

6. A weakness in any operation comes to the notice immediately.

7. There may not be any need of keeping work-in-progress, hence storage cost is reduced.

Types of Production Systems

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4.3.4.2 Lecture 24
Work Study

Work study may be defined as the analysis of a job for the purpose of finding the preferred method of doing it and also determining the standard time to perform it by the preferred (or given) method. Work study, therefore, comprises of two areas of study: method study (motion study) and time study (work measurement).

It is the systematic examination of activities in order to improve the effective use of human & other resources (British Standards). Had a very bad press / image problem with Taylorism. 'Bad old days.Work Study is not an assurance of Quality. However, the basic tools and techniques, togetherwith the mentality behind modern work study methods, can serve as part of Quality Drive (TQM). Becauseof the need to monitor improvements &quantify work on a continuous basis.

Role of Work Study in Improving Productivity

In order to understand the role of work study, we need to understand the role of method study and that of time study.

Method study (also sometimes called Work Method Design) is mostly used to improve the method of doing work. It is equally applicable to new jobs. When applied to existing jobs and existing jobs, method study aims to find better methods of doing the jobs that are economical and safe, require less human effort, and need shorter make-ready / put-away time. The better method involves the optimum use of best materials and appropriate manpower so that work is performed in well organized manner leading to increased resource utilization, better quality and lower costs.

It can therefore be stated that through method study we have a systematic way of developing human resource effectiveness, providing high machine and equipment utilization, and making economical use of materials.

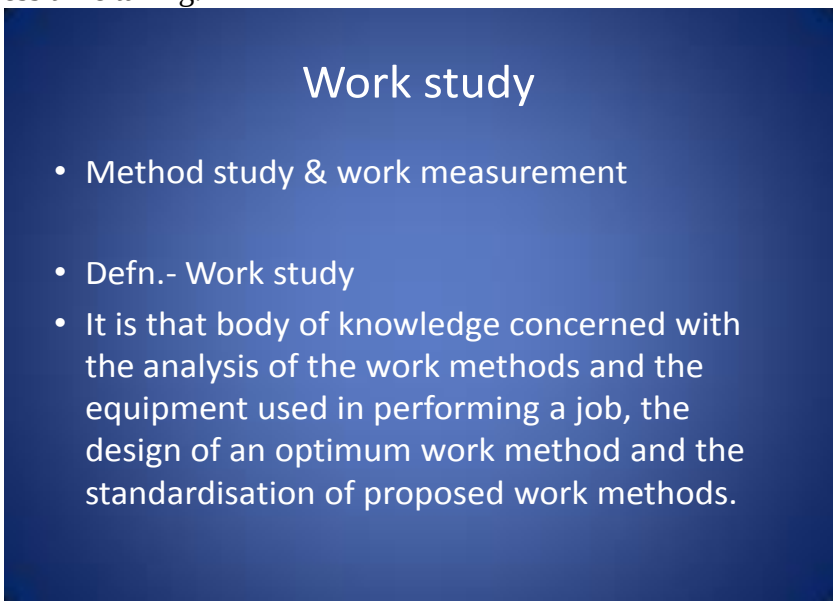
Time study, on the other hand, provides the standard time, that is the time needed by worker to complete a job by the standard method. Standard times for different jobs are necessary for proper estimation of

- manpower, machinery and equipment requirements
- daily, weekly or monthly requirement of materials
- production cost per unit as an input to better make or buy decision
- labor budgets
- worker's efficiency and make incentive wage payments.

By the application of method study and time study in any organization, we can thus achieve greater output at less cost and of better quality, and hence achieve higher productivity.

Work Study and Ergonomics

The work study and the ergonomics are the two areas of study having the same objective: design the work system so that for the operator it is safe, and the work is less fatiguing and less time taking.



Historical Developments

The Work of Taylor

Frederick W. Taylor is generally considered to be the founder of modern method and time study, although time studies were conducted in Europe many years before Taylor 's time. In 1760, Jean Rodolphe Perronet, a French engineer, made extensive time studies on the manufacture of No. 6 common pins.

Taylor began his time study work in 1881 while associated with the Midvale Steel Company in U.S.A.. He evolved a system based on the “task”, and proposed that the work of each employee be planned out by the management in advance. Each job was to have a standard time, deter mined by time studies made by experts. In the timing process, Taylor advocated dividing the work into small divisions of effort known as "elements." Experts were to time these individually and use their collective values to determine the allowed time for the task.

Early presentations of Taylor 's findings were received with little enthusiasm, because many interpreted his findings to be somewhat new piece-rate system rather than a technique for analyzing work and improving methods. Both management and employees were skeptical of piece rates, because many standards were earlier typically based on the supervisor's guess or even sometimes inflated by bosses to protect the performance of their departments.

The Work of Gilbreths

Frank and Lilian Gilbreth are considered as the founders of the modern motion study technique, which may be defined as the study of the body motions used in performing an oper ation, for the purpose of improving the operation by eliminating unnecessary motions, simplifying necessary motions, and then establishing the most favorable motion sequence for maximum efficiency. Frank Gilbreth originally implemented ideas into the bricklayer's trade in which he was employed. After introducing meth ods improvements through motion study, including an adjustable scaffold that he had invented, as well as operator training, he was able to increase the average num ber of bricks laid from 120 to 350 per worker per hour.

The Gilbreths also developed the cyclegraphic and chronocyclegraphic analysis techniques for studying the motion paths made by an operator. The cycle- graphic method involves fixing small electric light bulb to the finger or part of the body being studied and then photographing the motion while the operator is performing the operation. The resulting picture gives a permanent record of the motion pattern employed and can be analyzed for possible improvement. The chrono- cyclegraph is similar to the cyclegraph, but its electric circuit is interrupted regularly, causing the light to flash. Instead of showing solid lines of the motion patterns, the resulting photograph shows short dashes of light spaced in proportion to the speed of the body motion being photographed. Consequently, with the chronocyclegraph it is possible to determine direction and compute velocity, acceleration, and deceleration, in addition to study of body motions.

The Work of Others

Carl G. Barth, an associate of Frederick W. Taylor, developed a production slide rule for estimating the most efficient combinations of speeds and feeds for cutting metals of various hardnesses, considering the depth of cut, size of tool, and life of the tool. He is also known for his work on estimation of allowances by establishing the number of foot-pounds of work a worker could do in a day. He developed a relationship in which a certain push or pull on a worker's arms was equated with the amount or weight that worker could handle for a certain percentage of the day.

Harrington Emerson applied scientific methods to work on the Santa Fe Railroad and wrote a book, Twelve Principles of Efficiency, in which he made an attempt to lay down procedures for efficient operation. He reorganized the company, integrated its shop procedures, installed standard costs and a bonus plan, and introduced Hollerith tabulating machines for the accounting work. This effort resulted in annual saving of $ 1.5 million and recognition of his approach, called efficiency engineering .

WORK MEASUREMENT

PPT-3.2

4.3.4.3 Lecture 25
Method Study

The best way of doing a job ‘systematic & critical examination of the way ofdoing things in order to make improvements.

Method study can be defined as the procedure for systematic recording, analysis and critical examination of existing or proposed method of doing work for the purpose of development and application of easier and more effective method. Method study, aims to achieve the better method of doing work, and for this reason method study is sometimes called Work Method Design.
Method study is the systematic recording and critical examination of existing and proposed ways of doing work, as means of developing and applying easier and more effective methods and reducing costs.

Method Study Procedure

The following general steps describe the procedure for making a method study.

1. Select the job – on which method study is to be applied.
2. Obtain information and record.
3. Examine the information critically.
4. Develop the most practical, economical and effective method by considering real limitations of the situation.
5. Install the new method as standard practice.
6. Maintain the standard practice by regular follow up.

Selection of Job for Method Study

Practically, any activity or a job is a potential project for improvement but as the work study engineer is to sell his ideas and maintain his existence in the organisation, he should always attempt to select those jobs for improvement which are unpopular among employees or are considered “dirty” by them.

By improving such jobs, he would earn goodwill from the employees as well as the management, and can expect their full cooperation for other studies in the future.

Considerations may be given to the following factors while selecting a job for method study

- Economic Factors
- Technical Factors
- Human Factors

Economic Factors:

If the economic importance of a job is small, it is not wise to start or continue a long study. Priorities should be given to those types of job which offer greater potential for cost reduction. Such jobs are easily identifiable, as they have

- High labour content, i.e. they consume more time
- Excessive machine or man idleness
- Higher frequency of occurrence, i.e. they have large demand
- Bottlenecks in production line
- Higher proportion of accidents
- Movement of material or men over long distance
- High scrap and reprocessing costs
- High payment of overtime bills.

Technical Factors

The method study engineer must have the necessary technical knowledge about the job to be studied. Only surface knowledge about the subject may not lead to the right solution to the real problem. To illustrate, consider that a particular machine tool in proving bottleneck. The output from this machine is not reaching the assembly line in the required quantity. Through a preliminary study, it is found that it is running at lower speed and feed than that recommended for the pair of work and tool material used. Just increase in speed or feed may not be the solution of this problem. It may be possible that the machine itself is not rigid enough to operate at higher speeds or take a deeper cut. Just increase in speed may increase the output but the quality of job may be seriously affected. Technical expertise in machine tools and metal cutting process would be essential to solve problem of this kind.

Human Factors

Emotional reaction of the workers to the method study and changes in method are important considerations. If the study of a particular job is suspected to cause unrest or ill feeling, it should not be undertaken, however useful it may be from the economic point of view. It is always better to take up first those jobs which are considered ‘dirty', unsafe, unpleasant, boring, or highly fatiguing, and improvements brought about as a result of method study. This would possibly ensure cooperative from the workers for the other jobs as well.

After it is recognized that a problem exists, the first step is to properly formulate it. From the general statements like “Costs are too high, Increase the production, Reduce shop floor accidents”, it is necessary to determine just what the real problem is. After it is ascertained that the problem merits consideration, it is decided whether this is the proper time to solve it, and how much time can be spent in solving it. The problem may then be defined broadly giving minimum constraints at this stage, as it will permit the use of imagination and creativity in finding a solution. It may sometimes be desirable to divide the complete problem into a couple of small problems and solve them.

Objectives of method study:

The study is conducted to achieve the following objectives—

1. To bring improvement of work processes and procedures
2. To economize human efforts and to reduce unnecessary fatigue
3. To improve the usage of materials, machines and manpower
4. To develop better physical working condition and environment

Procedure:

Method study includes the following steps:

Select – choosing the job or procedure to be studies
Record – collect all the relevant facts about the present or proposed method.
Examine - critically scrutinizing these facts in an orderly sequence using the techniques best suited to the purpose
Develop – develop the best possible method
Install - practice the developed method
Maintain – checking the new standard practice by proper control procedures and regular routine checks.

Select:

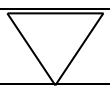
Only such jobs are to be selected that promise substantial improvement and dividends. Some of the prospective tasks for the study are those which are holding up certain other operations – bottleneck tasks which involve a long 'travel' of the forms, documents and materials. After selection of job, it will be a good practice to compile a list of specifications of the job

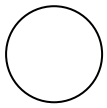
Ex: job particulars, who initiated the study, layout etc.

Record:

The current process of doing job has to be recorded. While doing so, every detail, however small it may be, has to be identified. Where the process is too long, involving many stages of production, inspection, the present process of doing the job is recorded sufficiently, together with all the relevant information, by using the process chart.

A process chart is a graphic representation of the sequence of events or steps that occur in the work method or procedure. Classifying them by symbols according to the nature of the event is as follows

Symbol	Meaning
	Operation: It involves change in the condition of a product
	Transport: Moving something from one location to another
	Storage: It occurs when object is kept and protected against unauthorized removal
D	Delay or Temporary storage: A delay occurs to an object when conditions do not permit the performance of next job
	Inspection: Quality and quantity of the product is good or not

	Operation cum Inspection: Inspection is taking place during the production process

Examine:

This is the most important phase of method study. After an activity has been suitably recorded by means of any method, the recorded events are to be critically examined. The analysis may be based on primary questions like purpose, place, sequence, person etc.
At the secondary stage, the questions are meant to seek alternatives so as to be able to think out a better, and finally the best way of accomplishing the task.

Develop:

Based on the recorded data, the alternative methods of doing the same job more effectively are to be identified and evaluated. From these alternatives, the best one is selected and developed to suit the requirements.

Install:

The new method so developed is to be installed in a phased manner. As part of installation, adequate planning of schedules and deployment of resources should be taken care of. Once the method is adopted, the workers have to be retrained, the equipment has to be provided, and the method has to be tested in order to seek improvement.

Maintain:

It should be ensured that the method is used in the manner intended. Complaints and improvements in productivity should be registered. Once the new method starts yielding the desired result, it is necessary to maintain the new method without any change for some time.

4.3.4.4 Lecture 26
TIME STUDY

Work Measurement

How long jobs should take ‘application of techniques designed to measure the timefor a qualified worker to carry out defined task’.
Work measurement, also called time study, establishes the time taken by a qualified worker to complete a specified jab at a defined level of performance. These techniques are used to answer the questions – how long? And when they usually follow the results of method study. They are employed for following purposes.

1. To develop costing system
2. To determine the production schedules
3. To develop incentive schemes
4. To compare the time taken by alternative methods of a given job

5. To standardize the job in terms of standard time, thus, supplementing the efforts of method study.
6. To determine the optimum number of men and machines to ensure their effective utilizations

Effective planning and control of production, distribution, administration and services cannot be achieved unless they are based on the facts. One of the most important facts is the time required to complete the job, which can be obtained by work measurement.

Procedure:

1. Break the job into elements which can be identified as distinct parts of an operation, capable of being observed, measure and analyzed
2. Measure time taken to perform each element using a stopwatch
3. Add the time taken to do all elements and arrive at the basic time required to do the entire job.

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 by using specified method.

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. Time study it is the most versatile and the most widely used technique of work measurement.

Time Study Procedure: The procedure for time study can best be described step-wise, which are self explanatory.

Step 1: Define objective of the study. This involves statement of the use of the result, the precision desired, and the required level of confidence in the estimated time standards.

Step 2: Verify that the standard method and conditions exist for the operation and the operator is properly trained. If need is felt for method study or further training of operator, the same may be completed before starting the time study.

Step 3: Select operator to be studied if there are more than one operator doing the same task.

Step 4: Record information about the standard method, operation, operator, product, equipment, and conditions on the Time Study observation sheet.

Step 5: Divide the operation into reasonably small elements, and record them on the Time Study observation sheet.

Step 6: Time the operator for each of the elements. Record the data for a few numbers of cycles on the Time Study observation sheet. Use the data to estimate the total number of observations to be taken.

Step 7: Collect and record the data of required number of cycles by timing and rating the operator.

Step 8: Calculate the representative watch time for each element of operation. Multiply it by the rating factor to get normal time.

Normal time = Observed time X Rating factor

Calculate the normal time for the whole operation by adding the normal time of its various elements.

Step 9: Determine allowances for fatigue and various delays.

Step 10: Determine standard time of operation.

Standard time = Normal time + allowances

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 selection of worker for time study is a very important factor in the success of the study. If there is only one person on the job, as usually is, then there is no choice. But if more than one person is performing the same operation, the time study man may time one or more of the workers. If all the workers are using the same method for doing the job and there is different in the rate of their doing it, it is necessary to select a suitable worker for the 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

PPT-3.3

4.3.4.5 Lecture 4
Work Sampling:

One of the methods of developing production standards i.e., work sampling differs from the other methods. It does not require a stop watch and involves observing a portion or sample of one or more work activities.

Work sampling is one of the very common techniques of work measurement which has gained widespread use on shop floor and office in nearly all types of manufacturing and non manufacturing organizations.

Work Sampling in other words

Work Sampling is a fact finding tool. In many cases, needed information about men or machines can be obtained in less time and at lower cost by this method than by other means.

Work Sampling has three main uses:

1. Activity and Delay Sampling : To measure the activities and delays of workers or machines (e.g. to measure the percentage of the day that a person is working or not working).

2. Performance Sampling : To measure working time and nonworking time of a person on a manual task, and to establish a performance index or performance level for the person during his or her working time.

3. Work Measurement : To establish a time standard for an operation.

Work Sampling is based upon the laws of probability. A sample taken at random from a large group tends to have the same pattern of distribution as the large group or universe.

Work Sampling: Definition, Theory and Confidence Level of Work Sampling

Definition:

"Work sampling is a method in which a large number of instantaneous observations are made at random time intervals over a period of time or a group of machines, workers or processes/operations. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity or delay/idleness is a measure of the percentage of time during which that activity or delay/idleness occurs".

Work sampling has a long and impressive list of applications but all of them fall into one of the following three categories:

(i) Work sampling can be used as ratio study of working and idle times.

(ii) It can be utilized as performance sampling study in which working and idleness on working times are measured and a performance index is prepared.

(iii) It can be used as a work measurement technique.

Theory of Work Sampling:

It states that the percentage of observations recorded on an operation/ process in any state is a reliable estimate of the percentage time the operation/ process is in that state, provided, "sufficient number of observations are taken at random".

It may be noted that here, particular stress should be paid on the words "random" and "sufficient number of observations". In this technique, some error may occur but the magnitude of error tends to decrease as the number of samples increases.

Work sampling is a sampling method and depends upon the laws of probability. A sample taken at random from a large population provides a good estimate of the distribution of the population. To make it clearer, let us consider the following example.

A worker while working during his shift either does the job assigned to him or remains idle for one or the other reason. The following table shows that out of total 50 observations, there were 45 working observations and five idle observations.

State of worker	**No of observations**
Working	45
Idle	5

This table indicates the working time and idle time.

In this Example, the idle time percentage would be 5/50 x 100 = 10%

Working time would be 45/50 x 100 = 90%

This investigation is for one worker for a shift of 8 hours a day and indicates that the operator was idle for 10% or 48 minutes in a shift of 8 hours (480 minutes) while working for 90% or 432 minutes in one shift.

Confidence Levels:

The results obtained by work sampling technique differ considerably from the results actually achieved by continuous recording of time. The accuracy of result depends upon the number or observations and the limits of confidence level because the sampling procedure used involves certain degree of error. So it is important to decide, what level of confidence is desired the final "Work Sampling" results.

During a investigation, if we increase the number of observations considerably and in each observation then number of activities are large we can obtain a smoother curve called normal distribution curve.

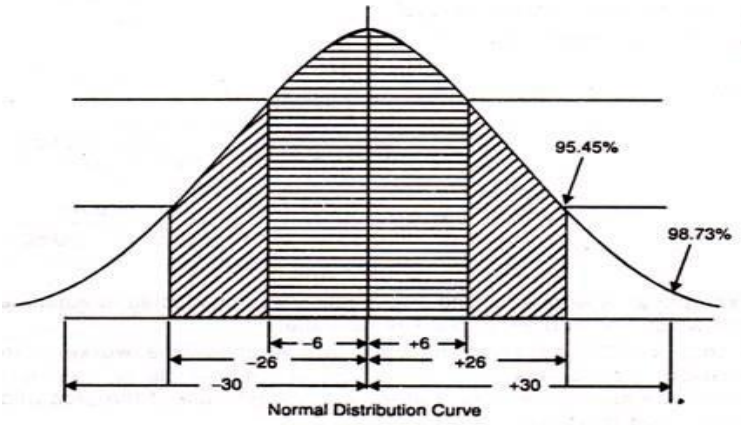


Fig. 7.1. Normal Distribution Curve.

The most common confidence level is 95%. The area under the curve at 2 sigma or two standard deviations is 95.45% which is rounded off gives 95% This indicates that the probability is 95% of the time the random, observations will be true or represents the fact and 5% of the time false or will not. For majority of cases, an accuracy of 5% is considered satisfactory. This is usually referred to as the percentage standard error.

Sample Size Determination. To obtain a desired accuracy level an analyst is required to take sufficient number of observations. Following formula may be used for finding the requisite number of observation in order to achieve the desired accuracy:

Limit of error = $Sp \; x\sqrt{\frac{p(1-p)}{N}}$

Where x =1, 2 or 3 for confidence level of 68%, 95% and 99% or one sigma, two sigma three sigma confidence levels respectively.

S = Desired relative accuracy.

P = Percentage occurrence of an activity or delay expressed in decimal e.g. 10% =0.10

N = Sample size or total number of random observations.

Predetermined Motion Time System

A predetermined motion time system (PMTS) may be defined as a procedure that analyzes any manual activity in terms of basic or fundamental motions required to perform it. Each of these motions is assigned a previously established standard time value and then the

timings for the individual motions are synthesized to obtain the total time needed for performing the activity.

The main use of PMTS lies in the estimation of time for the performance of a task before it is performed. The procedure is particularly useful to those organizations which do not want troublesome performance rating to be used with each study.

Applications of PMTS are for

(i) Determination of job time standards.

(ii) Comparing the times for alternative proposed methods so as to find the economics of the proposals prior to production run.

(iii) Estimation of manpower, equipment and space requirements prior to setting up the facilities and start of production.

(iv) Developing tentative work layouts for assembly lines prior to their working in order to minimize the amount of subsequent re-arrangement and re-balancing.

(v) Checking direct time study results: A number of PMTS are in use, some of which have been developed by individual organizations for their own use, while other organizations have developed and publicized for universal applications.

Some commonly used PMT systems are:

- Work factor (1938)
- Method Time Measurement (1948)
- Basic Motion Time (1951)
- Dimension Motion Time (1954)

Important considerations which may be made while selecting a PMT system for application to particular industry are:

- Cost of Installation. This consists mainly of the cost of getting expert for applying the system under consideration.
- Application Cost. This is determined by the length of time needed to set a time standard by the system under consideration.
- Performance Level of the System. The level of performance embodied in the system under consideration may be different from the normal performance established in the industry where the system is to be used. However, this problem can be overcome by 'calibration' which is nothing but multiplying the times given in the PMT Tables by some constant or by the application of an adjustment allowance.
- Consistency of Standards. Consistency of standards set by a system on various jobs is a vital factor to consider. For this, the system can be applied on a trial basis on a set of operations in the plant and examined for consistency in the so obtained operation times.
- Nature of Operation. Best results are likely to be achieved if the type and nature of operations in the plant are similar to the nature and type of operations studied during the development of the system under consideration.

Advantages and limitations of using PMT systems

Advantages

Compared to other work measurement techniques, all PMT systems claim the following advantages:

1. There is no need to actually observe the operation running. This means the estimation of time to perform a job can be made from the drawings even before the job is actually done. This feature is very useful in production planning, forecasting, equipment selection, etc.
2. The use of PMT eliminates the need of troublesome and controversial performance rating. For the sole reason of avoiding performance rating, some companies have been using this technique.
3. The use of PMT forces the analyst to study the method in detail. This sometimes helps to further improve the method.
4. A bye-product of the use of PM times is a detailed record of the method of operation. This is advantageous for installation of method, for instructional purposes, and for detection and verification of any change that might occur in the method in future.
5. The PM times can be usefully employed to establish elemental standard data for setting time standards on jobs done on various types of machines and equipment.
6. The basic times determined with the use of PMT system are relatively more consistent.

Limitations

There are two main limitations to the use of PMT system for establishing time standards. These are: (i) its application to only manual contents of job

(ii) the need of trained personnel.

Although PMT system eliminates the use of rating, quite a bit of judgment is still necessarily exercised at different stages.

4.3.4.6 Lecture 28

Micro Motion Study Technique: Introduction, Definition, Purpose and Advantages

Introduction:

Micro motion study technique is best suited for those operations or activities which are of short duration and which are repeated hundreds of time. These are the operations or motions which require very small time and it is quite difficult to measure time for these motions accurately and the time required by these motions cannot be neglected due to repetitive operations.

In such activities it is interesting to go into greater details in order to find out which movement and effort can be avoided. All this is done to develop the best possible pattern of movement so that the operator can perform the operations repeatedly with a minimum effort and fatigue.

Definition:

“Thus micro motion study is the technique of recording and analyzing the timing of basic elements of an operation with the objective of achieving the best method of performing

the operation." Such respective short duration activities involve quick movement of limbs which cannot be accurately studied and timed using two handed process charts. This is due to the fact that such record microscopic details such as different operation, Inspection and transport etc. Study of such microscopic movements in short cycle repetitive jobs is not sufficient.Short cycle operations require to be studied for microscopic motions e.g., operation of picking up a nut from bin and its fixing consists of three hand motions namely reach for the nut, grasp nut and move hand back to assembly position. Such detailed analysis help to develop the best possible pattern of movements and hence enabling the operator to perform various operations repeatedly with minimum effort and fatigue.

Micro motion study is one of the most accurate techniques of work analysis used for work improvement. It makes use of motion pictures of the different activities or movement, so with the help of camera. Very small time upto 0.0005 minute can be measured and recorded by this system.

When picture camera is utilized, the procedure is known as "MICR-MOTION STUDY". The motion time data from the film is transferred to simo chart. The simo chart data can be further analyzed for the purpose of work place layout or method improvement.

This technique was developed by Fran Gilbreth who considered that an operation consists of minute elements which may be repetitive or non repetitive. He termed these elements THERBLIG (after his name Gilbreth if spelt bank word is Therblig).

Purpose of Micro Motion Study:

It can be used for following purposes:

1. To study the nature and path of movements for obtaining the elements of an operation.

2. To study the activities of the machine and the operator.

3. To impart training to the workers or operators regarding motion; economy so that unnecessary movement by the workers may be avoided.

4. To study the relationship between the activities of operator and the machine.

5. To keep permanent record of the most efficient way of performing a task for future reference.

6. To obtain motion time data for developing synthetic time standards for various elements.

7. For carrying out research in the field of method and time study.

Advantages of Micro Motion Study:

It has the following important advantages:

1. It provides a permanent record of motion study on films.

2. A large number of operators can see the procedure at any time even after the completion of motion study work.

3. Films can easily reveal the difference between the present and the proposed technique.

4. Films can be demonstrated to large work force at any desired speed.

5. It provides very accurate time for each operation or motion in comparison to stop watch time study.

6. It helps in making detailed and accurate analysis of the prevailing technique.

Motion Study

Motion study is a technique of analyzing the body motions employed in doing a task in order to eliminate or reduce ineffective movements and facilitates effective movements. By using motion study and the principles of motion economy the task is redesigned to be more effective and less time consuming.

The Gilbreths pioneered the study of manual motions and developed basic laws of motion economy that are still relevant today. They were also responsible for the development of detailed motion picture studies, termed as Micro Motion Studies, which are extremely useful for analyzing highly repetitive manual operations. With the improvement in technology, of course, video camera has replaced the traditional motion picture film camera.

In a broad sense, motion study encompasses micro motion study and both have the same objective: job simplification so that it is less fatiguing and less time consuming. While motion study involves a simple visual analysis, micro motion study uses more expensive equipment. The two types of studies may be compared to viewing a task under a magnifying glass versus viewing the same under a microscope. The added detail revealed by the microscope may be needed in exceptional cases when even a minute improvement in motions matters, i.e. on extremely short repetitive tasks.

Taking the cine films @ 16 to 20 frames per second with motion picture camera, developing the film and analyzing the film for micro motion study had always been considered a costly affair. To save on the cost of developing the film and the cost of film itself, a technique was used in which camera took only 5 to 10 frames per minute. This saved on the time of film analysis too. In applications where infrequent shots of camera could provide almost same information, the technique proved fruitful and acquired the name Memo Motion Study.

Traditionally, the data from micro motion studies are recorded on a Simultaneous Motion (simo) Chart while that from motion studies are recorded on a Right Hand - Left Hand Process Chart.

Therbligs

On analysing the result of several motion studies conducted, Gilbreths concluded that any work can be done by using a combination of some or all of 17 basic motions, called Therbligs (Gilbreth spelled backward). These can be classified as effective therbligs and ineffective therbligs. Effective therbligs take the work progress towards completion. Attempts can be made to shorten them but they cannot be eliminated. Ineffective therbligs do not advance the progress of work and therefore attempts should be made to eliminate them by applying the Principles of Motion Economy. Table gives different therbligs along with their symbols and descriptions.

SIMO Chart

It is a graphic representation of an activity and shows the sequence of the therbligs or group of therbligs performed by body members of operator. It is drawn on a common time scale. In other words, it is a two-hand process chart drawn in terms of therbligs and with a time scale, see Figure.

Making the Simo Chart. A video film or a motion picture film is shot of the operation as it is carried out by the operator. The film is analyzed frame by frame. For the left hand, the sequence of therbligs (or group of therbligs) with their time values are recorded on the column corresponding to the left hand. The symbols are added against the length of column

representing the duration of the group of therbligs. The procedure is repeated for the right hand and other body members (if any) involved in carrying out the operation.

It is generally not possible to time individual therbligs. A certain number of therbligs may be grouped into an element large enough to be measured as can be seen in Figure.

Uses of Simo Chart

From the analysis shown about the motions of the two hands (or other body members) involved in doing an operation, inefficient motion pattern can be identified and any violation of the principle of motion economy can be easily noticed. The chart, therefore, helps in improving the method of doing an operation so that balanced two-handed actions with coordinated foot and eye motions can be achieved and ineffective motions can be either reduced or eliminated. The result is a smoother, more rhythmic work cycle that keeps both delays and operator fatigue to the minimum extent.

Micromotion Study

PPT-3.4

4.3.4.7 Lecture 29
Rating techniques, MTM, work factor system.

A time and motion study (or time-motion study) is a business efficiency technique combining the Time Study work of Frederick Winslow Taylor with the Motion Study work of Frank and Lillian Gilbreth (the same couple as is best known through the biographical 1950 film and book Cheaper by the Dozen). It is a major part of scientific management (Taylorism). After its first introduction, time study developed in the direction of establishing standard times, while motion study evolved into a technique for improving work methods. The two techniques became integrated and refined into a widely accepted method applicable to the improvement and upgrading of work systems. This integrated approach to work system improvement is known as methods engineering and it is applied today to industrial as well as service organizations, including banks, schools and hospitals.

Time study is a direct and continuous observation of a task, using a timekeeping device (e.g., decimal minute stopwatch, computer-assisted electronic stopwatch, and videotape camera) to record the time taken to accomplish a task and it is often used when there are repetitive work cycles of short to long duration,

- wide variety of dissimilar work is performed, or
- process control elements constitute a part of the cycle.

The Industrial Engineering Terminology Standard, defines time study as "a work measurement technique consisting of careful time measurement of the task with a time measuring instrument, adjusted for any observed variance from normal effort or pace and to

allow adequate time for such items as foreign elements, unavoidable or machine delays, rest to overcome fatigue, and personal needs."

The systems of **time and motion studies** are frequently assumed to be interchangeable terms, descriptive of equivalent theories. However, the underlying principles and the rationale for the establishment of each respective method are dissimilar, despite originating within the same school of thought.

The application of science to business problems, and the use of **time-study methods** in standard setting and the planning of work, was pioneered by Frederick Winslow Taylor. Taylor liaised with factory managers and from the success of these discussions wrote several papers proposing the use of wage-contingent performance standards based on scientific time study. At its most basic level time studies involved breaking down each job into component parts, timing each part and rearranging the parts into the most efficient method of working. By counting and calculating, Taylor wanted to transform management, which was essentially an oral tradition, into a set of calculated and written techniques.

Taylor and his colleagues placed emphasis on the content of a **fair day's work**, and sought to maximize productivity irrespective of the physiological cost to the worker. For example, Taylor thought unproductive time usage (soldiering) to be the deliberate attempt of workers to promote their best interests and to keep employers ignorant of how fast work could be carried out.[12] This instrumental view of human behavior by Taylor prepared the path for human relations to supersede scientific management in terms of literary success and managerial application.

Motion study

In contrast to, and motivated by, Taylor's time study methods, the Gilbreths proposed a technical language, allowing for the analysis of the labor process in a scientific context.The Gilbreths made use of scientific insights to develop a study method based upon the analysis of work motions, consisting in part of filming the details of a worker'sactivities and their body posture while recording the time.. The films served two main purposes. One was the visual record of how work had been done, emphasising areas for improvement. Secondly, the films also served the purpose of training workers about the best way to perform their work. This method allowed the Gilbreths to build on the best elements of these work flows and to create a standardized best practice.

Methods-Time Measurement (MTM)

Methods-Time Measurement (MTM) is a predetermined motion time system that is used primarily in industrial settings to analyze the methods used to perform any manual operation or task and, as a product of that analysis, set the standard time in which a worker should complete that task.

4.3.4.8 Lecture 30

Ergonomics

Ergonomics can be defined simply as the study of work. More specifically, ergonomics is the science of designing the job to fit the worker, rather than physically forcing the worker's body to fit the job. Adapting tasks, work stations, tools, and equipment to fit the worker can help reduce physical stress on a worker's body and eliminate many potentially

serious, disabling workrelated musculoskeletal disorders (MSDs). Ergonomics draws on a number of scientific disciplines, including physiology, biomechanics, psychology, anthropometry, industrial hygiene, and kinesiology.

Aims of Ergonomics

It will be clear already that the benefits of ergonomics can appear in many different forms, in productivity and quality, in safety and health, in reliability, in job satisfaction and in personal development.

The reason for this breadth of scope is that its basic aim is efficiency in purposeful activity—efficiency in the widest sense of achieving the desired result without wasteful input, without error and without damage to the person involved or to others. It is not efficient to expend unnecessary energy or time because insufficient thought has been given to the design of the work, the workspace, the working environment and the working conditions. It is not efficient to achieve the desired result in spite of the situation design rather than with support from it.

The aim of ergonomics is to ensure that the working situation is in harmony with the activities of the worker. This aim is self-evidently valid but attaining it is far from easy for a variety of reasons. The human operator is flexible and adaptable and there is continuous learning, but there are quite large individual differences. Some differences, such as physical size and strength, are obvious, but others, such as cultural differences and differences in style and in level of skill, are less easy to identify.

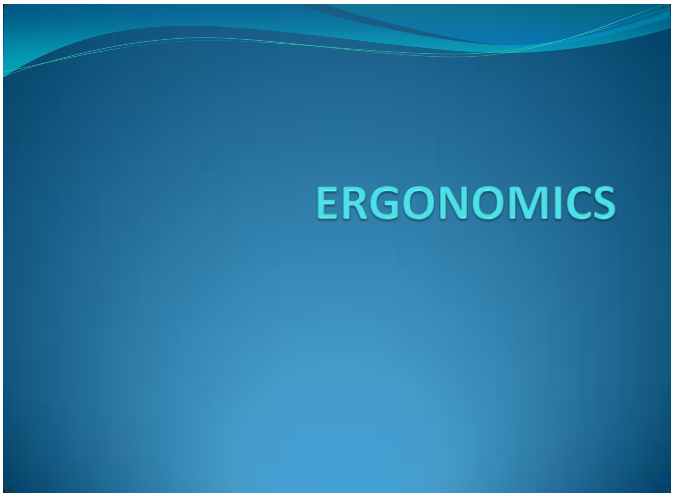
In view of these complexities it might seem that the solution is to provide a flexible situation where the human operator can optimize a specifically appropriate way of doing things. Unfortunately such an approach is sometimes impracticable because the more efficient way is often not obvious, with the result that a worker can go on doing something the wrong way or in the wrong conditions for years.

Thus it is necessary to adopt a systematic approach: to start from a sound theory, to set measurable objectives and to check success against these objectives. The various possible objectives are considered below.

1. Safety and health
2. Productivity and efficiency
3. Reliability and quality
4. Job satisfaction and personal development

Conclusion

Ergonomics is the systematic study of people at work with the objective of improving the work situation, the working conditions and the tasks performed. The emphasis is on acquiring relevant and reliable evidence on which to base recommendation for changes in specific situations and on developing more general theories, concepts, guidelines and procedures which will contribute to the continually developing expertise available from ergonomics.



PPT-3.5

Flow process chart

The flow process chart in industrial engineering is a graphical and symbolic representation of the processingactivities performed on the work piece.

Symbol	Letter	Description
O	O	Operation
Ⅰ	I	Inspection
→	M	Move
D	D	Delay
∇	S	Storage

- Operation: to change the physical or chemical characteristics of the material.
- Inspection: to check the quality or the quantity of the material.
- Move: transporting the material from one place to another.

- Delay: when material cannot go to the next activity.
- Storage: when the material is kept in a safe location.

4.3.4.9 Lecture 31

String diagrams and Therbligs

String diagram is one of the useful and simplest techniques of method study. It can be defined as a scale model on which a thread is used to trace the path or movements of man and materials during a specified sequence of events.

It can also be stated that string diagram in a special form of flow diagram. As a thread is used to measure distance, it is necessary that the string diagram should be drawn up to scale. The same is not necessary in case of flow diagram.

A brief procedure for the construction of string diagram in given as follows:

(I) Study and record the complete information about the movement of various resources.

(II) Draw a scale layout of the shop area and mark various features such as machinery, work benches, stores etc.

(III) Mark and insert panel pins at all workstations between which the journeys are made. More pegs/pins may be stretched in between the facilities to trace more or less the actual path followed by men and materials.

(IV) A continuous colored un stretchable string, taken from the first to last warned to trace the path followed by operators or materials. Use strings/ threads of different colors if the movement of more subjects is being shown so that their movements are easily recognized and distinguished.

(V) Remove the string to measure their lengths which approximately gives distances traveled by a worker or a machine or the material.

Like the flow diagram. It is also used to supplement a flow-process chart. Generally the work study man proceeds to follow the worker in whom he is interested or whose movements he wants to record. If area of the working is small, work study man can simply sit on a place and can notice the various movements of worker from there.

This recording of movements continues till the work study man thinks is that he has recorded all the movements. Totally misleading rewets are produced with insufficient data.

Examination of the diagram and development of new layout is done in same manner as we have earlier explained in case of flow diagrams. This can be done by moving the thread around the pins in the various positions. Length of thread left is subtracted from the original length of thread. Procedure is repeated till the maximum length of left thread in obtained.

A string diagram is a useful aid for following purposes:

(1) It represents the record of an existing set of conditions and thus helps the method engineer in visualizing the actual situation.

(2) It indicates complex movements, back tracking, congestion, bottle necks and over and underutilized paths on the shop floor.

(3) It is an aid for comparison between different layouts or methods of doing a job as far as the distances moved are involved.

(4) It helps in tracing existing paths of movement for incorporating necessary modifications, if any.

(5) It is prefixed when movements are not regular as far as frequency and distance moved are concerned.

(6) Indicates the pattern of movements and thus helps in deciding the most economical routes to perform a particular operation.

Therbligs:

Therbligs are 18 kinds of elemental motions used in the study of motion economy in the workplace. A workplace task is analyzed by recording each of the therblig units for a process, with the results used for optimization of manual labour by eliminating unneeded movements.

The word therblig was the creation of Frank Bunker Gilbreth and Lillian Moller Gilbreth, American industrial psychologists who invented the field of time and motion study. It is a reversal of the name Gilbreth, with 'th' transposed

.A **basic motion element** is one of a set of fundamental motions required for a worker to perform a manual operation or task. The set consists of 18 elements, each describing a standardized activity.

- Transport empty [unloaded] (TE): reaching for an object with an empty hand. (Now called "Reach")
- Grasp (G): grasping an object with the active hand.
- Transport loaded (TL):moving an object using a hand motion.
- Hold (H): holding an object.
- Release load (RL): releasing control of an object.
- Preposition (PP): positioning and/or orienting an object for the next operation and relative to an approximation location.
- Position (P): positioning and/or orienting an object in the defined location.
- Use (U): manipulating a tool in the intended way during the course working.
- Assemble (A): joining two parts together.
- Disassemble (DA): separating multiple components that were joined.
- Search (Sh): attempting to find an object using the eyes and hands.
- Select (St): choosing among several objects in a group.
- Plan (Pn): deciding on a course of action.

- Inspect (I): determining the quality or the characteristics of an object using the eyes and/or other senses.
- Unavoidable delay (UD): waiting due to factors beyond the worker's control and included in the work cycle.
- Avoidable delay (AD): waiting within the worker's control which causes idleness that is not included in the regular work cycle.
- Rest (R): resting to overcome a fatigue, consisting of a pause in the motions of the hands and/or body during the work cycles or between them.
- Find (F): A momentary mental reaction at the end of the Search cycle. Seldom used.

Effective and ineffective basic motion elements[edit]

Effective	**Ineffective**
Reach	Hold
Move	Rest
Grasp	Position
Release Load	Search
Use	Select
Assemble	Plan
Disassemble	Unavoidable Delay
Pre-Position	Avoidable Delay
	Inspect