

UNIT – III

OPERATIONS MANAGEMENT

UNIT – III 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.

INTRODUCTION

“Production and Operations management is defined as the design, operation and improvement of the transformation process, which converts the various inputs into desired outputs of products and services.”

The term “**Production and Operations Management**” is being increasingly replaced by the simply operations management, as the production function relating to the manufacturing organizations has become a part of operations. Operations management also highlights the increasing importance of the service industry in the overall business environment.

"Production management deals with decision–making related to production processes so that the resulting goods or service is produced according to specification, in the amount and by the schedule demanded and at minimum cost.

DEFINITIONS:

Operations Management (OM) is a broad term which includes manufacturing as well as service organizations.

Operations Management (OM) is the management of transformations systems which convert inputs into good and/or services. The inputs to the system are materials, labor equipment's and capital

Operations Management (OM) is the science and art of ensuring that goods and services are created and delivered successfully to the customers.

PRINCIPLES OF OPERATIONS MANAGEMENT:

- 1) Understanding the needs of customers, measuring customer satisfaction and using that information to develop new and improved goods and services.
- 2) Using information about customers, goods, services, operations, supplier's employees, costs and finances to make better decisions.

- 3) Exploiting technology to design goods, services, manufacturing and service delivery processes that respond rapidly and flexibly to customer's requirements and to improve productivity.
- 4) Building quality into goods, services and processes and continually improving them to reduce error, defects and waste and to improve responsiveness and business performance.
- 5) Ensuring that material flows and associated operational activities are coordinated across hierarchical, organizational and functional boundaries.
- 6) Creating a high performance work place by developing the skills of employees and motivating them through education, training, rewards, recognition, teamwork, empowerment and other effective human resource practices.
- 7) Continually learning from co-workers, competitors, and customers and adapting the organization to global and environmental changes.

NATURE OF OPERATIONS MANAGEMENT:

- Operations management is dynamic in nature, it can be changed by the situation.
- Operation management is transforming the process from Raw material to finished goods.
- Operation management is the continuous process.
- Operation management is the main pillar of development and administration.
- Operation management helps to grow of the company.

IMPORTANCE OF OPERATIONS MANAGEMENT IN AN ORGANISATION:

There are various reasons which make operations management important. It encompasses both services and manufacturing, it's important in effectively and efficiently managing the productivity as every organization should have high productivity which can lead to economic growth and development, helps employees in receiving high wages as well as lead to increase in company's profit without causing inflation. Operations management is also important as it plays a strategic role in an organization's competitive success.

Below are few salient features indicating the importance of Operations Management for an organization:

- Operations management helps to **achieve the objectives** of the company.
- Operation management improves the **productivity of employees**.
- Operation management improves **goodwill and presence** of the organization.
- The manager will become more **able to utilize resources**.
- Operations management helps to **improve the motivation of employees**.

FUNCTIONS OF OPERATIONS MANAGEMENT IN AN ORGANIZATION:

1. Finance plays a main function in operations management. The operation manager should not waste finance in unproductive tasks.

2. The function of operation management is basically concerned with planning to directing of daily goals. So, the manager should make sure the effective work of the organization.
3. The strategy is also the main function of operation management. The manager should have pre-planned tasks.
4. It is the duty of operations manager to ensure the product's designed, that would be the market trends and demands.
5. Operations manager should ensure the quality of products. The manager should not compromise with the quality of Products.

SCOPE OF OPERATIONS MANAGEMENT:

The scope of operations management based on the interrelationship of three aspects, namely:

- ☞ **Structural aspects**, in the form of input that will be transformed according to criteria of the desired products, machinery, equipment, formulas and models.
- ☞ **Functional aspects**, namely the link between the component input, with the planning, implementation, control, and improvements to obtain optimum performance, so that operations can be run continuously.
- ☞ **Environmental aspects**, is the tendency that occurs outside the system, such as community, government, technology, economics, political, social, cultural, demonstrated ability to adapt.

Each manager will carry out basic functions of management processes. Management process consists of planning, organizing, Setting up employees, directing, and controlling.

Following are the activities, which are listed under Production and Operations Management functions

1. Location of facilities.
2. Plant layouts and Material Handling.
3. Product Design.
4. Process Design.
5. Production Planning and Control.
6. Quality Control.
7. Materials Management.
8. Maintenance Management.

1. LOCATION OF FACILITIES:

Location of facilities for operations is a long-term capacity decision, which involves a long-term commitment about the geographically static factors that affect a business organization. It is an important strategic level decision-making for an organization. It deals with the questions such as 'where our main operations should be based?'

The selection of location is a key–decision as large investment is made in building plant and machinery. An improper location of plant may lead to waste of all the investments made in plant and machinery equipment's. Hence, location of plant should be based on the company's expansion plan and policy, diversification plan for the products, changing sources of raw materials and many other factors. The purpose of the location study is to find the optimal location that will results in the greatest advantage to the organization.

2. PLANT LAYOUT AND MATERIAL HANDLING:

Plant layout refers to the physical arrangement of facilities. It is the configuration of departments, work centers and equipment in the conversion process. The overall objective of the plant layout is to design a physical arrangement that meets the required output quality and quantity most economically.

According to James More 'Plant layout is a plan of an optimum arrangement of facilities including personnel, operating equipment, storage space, material handling equipment's and all other supporting services along with the design of best structure to contain all these facilities'.

'Material Handling' refers to the 'moving of materials from the store room to the machine and from one machine to the next during the process of manufacture'. It is also defined as the 'art and science of moving, packing and storing of products in any form'. It is a specialized activity for a modern manufacturing concern, with 50 to 75% of the cost of production. This cost can be reduced by proper section, operation and maintenance of material handling devices. Material handling devices increases the output, improves quality, speeds up the deliveries and decreases the cost of production. Hence, material handling is a prime consideration in the designing new plant and several existing plants.

3. PRODUCT DESIGN:

Product design deals with conversion of ideas into reality. Every business organization have to design, develop and introduce new products as a survival and growth strategy. Developing the new products and launching them in the market is the biggest challenge faced by the organizations.

The entire process of need identification to physical manufactures of product involves three functions; Design and Marketing, Product, Development, and manufacturing. Product Development translates the needs of customers given by marketing into technical specifications and designing the various features into the product to these specifications. Manufacturing has the responsibility of selecting the processes by which the product can be manufactured. Product design and development provides link between marketing, customer needs and expectations and the activities required to manufacture the product.

4. PROCESS DESIGN:

Process design is a macroscopic decision–making of an overall process route for converting the raw material into finished goods. These decisions encompass the selection of a process, choice of technology, process flow analysis and layout of the facilities. Hence, the important decisions in process design are to analyze the workflow for converting raw material into finished product and to select the workstation for each included in the workflow.

5. PRODUCTION PLANNING AND CONTROL (PP&C):

Production planning and control can be defined as the process of planning the production in advance, Setting the exact route of each item, fixing the starting and finishing dates for each item, to give production orders to shops and to follow-up the progress of products according to orders. The principle of production planning and control lies in the statement 'First Plan Your Work and then Work on Your Plan'. Main functions of production planning and control include Planning, Routing, Scheduling, Dispatching and Follow-up.

- **Planning** is deciding in advance what to do, how to do it, when to do it and who is to do it.
- Planning bridges the gap from where we are, to where we want to go. It makes it possible for things to occur which would not otherwise happen.
- **Routing** may be defined as the selection of path, in which each part of the product will follow and which is being transformed from raw material to finished products. Routing determines the most advantageous path to be followed for department to department and machine to machine till raw material gets its final shape.
- **Scheduling** determines the program for the operations. Scheduling may be defined as 'the fixation of time and date for each operation' as well as it determines the sequence of operations to be followed.
- **Dispatching** is concerned with the starting the processes. It gives necessary authority so as to start a particular work, which has been already been planned under 'Routing' and 'Scheduling'. Therefore, dispatching is 'Release of orders and instruction for the starting of production for any item in acceptance with the Route sheet and Schedule Charts'.
- The function of **Follow-up** is to report daily the progress of work in each shop in a prescribed proforma and to investigate the causes of deviations from the planned performance.

6. QUALITY CONTROL (QC):

Quality Control may be defined as 'a system that is used to maintain a desired level of quality in a product or service'. It is a systematic control of various factors that affect the quality of the product. Quality Control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure.

Quality Control can also be defined as 'that Industrial Management technique by means of which product of uniform acceptable quality is manufactured'. It is the entire collection of activities, which ensures that the operation will produce the optimum quality products at minimum cost.

The main objectives of Quality Control are:

1. To improve the company's income by making the production more acceptable to the customers i.e. by providing long life, greater usefulness, maintainability, etc.
2. To reduce companies cost through reduction of losses due to defects.
3. To achieve interchangeability of manufacture in large-scale production.
4. To produce optimal quality at reduced price.

5. To ensure satisfaction of customers with productions or services or high quality level, to build customer good will, confidence and reputation of manufacturer.
6. To make inspection prompt to ensure quality control.
7. To check the variation during manufacturing.

7. MATERIALS MANAGEMENT:

Materials Management is that aspect of management function, which is primarily concerned with the acquisition, control, and use of materials needed and flow of goods and services connected with the production process having some predetermined objectives in view.

The main objectives of Material Management are:

1. To minimize material cost.
2. To purchase, receive, transport and store materials efficiently and to reduce the related cost.
3. To cut down costs through simplification, standardization, value analysis, import substitution, etc.
4. To trace new sources of supply and to develop cordial relations with them in order to ensure continuous supply at reasonable rates.
5. To reduce investment tied in the inventories for use in other productive purposes and to develop high inventory turnover ratios.

8. MAINTENANCE MANAGEMENT:

In modern industry, equipment and machinery are a very important part of the total productive effort. Therefore their idleness or downtime becomes are very expensive. Hence, it is very important that the plant machinery should be properly maintained.

The main objectives of Maintenance Management are:

1. To achieve minimum breakdown and to keep the plant in good working condition at the lowest possible cost.
2. To keep the machines and other facilities in such a condition that permits them to be used at their optimal capacity without interruption.
3. To ensure the availability of the machines, buildings and services required by other sections of the factory for the performance of their functions at optimal return on investment.

CLASSIFICATION/TYPES OF PRODUCTION SYSTEMS:

Production systems can be classified as

1. Job-shop Production,
2. Batch Production,
3. Mass Production and
4. Continuous production systems.



1. **JOB-SHOP PRODUCTION:**

Job-shop production are characterized by manufacturing one or few quantity of products designed and produced as per the specification of customers within prefixed time and cost. The distinguishing feature of this is low volume and high variety of products.

A job-shop comprises of general-purpose machines arranged into different departments. Each job demands unique technological requirements, demands processing on machines in a certain sequence.

Job-shop Production is characterized by:

1. High variety of products and low volume.
2. Use of general purpose machines and facilities.
3. Highly skilled operators who can take up each job as a challenge because of uniqueness.
4. Large inventory of materials, tools, parts.
5. Detailed planning is essential for sequencing the requirements of each product, capacities for each work center and order priorities.

ADVANTAGES:

Following are the advantages of Job-shop Production:

1. Because of general purpose machines and facilities variety of products can be produced.
2. Operators will become more skilled and competent, as each job gives them learning opportunities.
3. Full potential of operators can be utilized.
4. Opportunity exists for Creative methods and innovative ideas.

LIMITATIONS:

Following are the limitations of Job-shop Production:

1. Higher cost due to frequent Set up changes.
2. Higher level of inventory at all levels and hence higher inventory cost.
3. Production planning is complicated.
4. Larger space requirements.



2. BATCH PRODUCTION:

American Production and Inventory Control Society (APICS) defines Batch Production as a form of manufacturing in which the job pass through the functional departments in lots or batches and each lot may have a different routing. It is characterized by the manufacture of limited number of products produced at regular intervals and stocked awaiting sales.

Batch Production is characterized by

1. Shorter production runs.
2. Plant and machinery are flexible.
3. Plant and machinery Set up is used for the production of item in a batch and change of Set up is required for processing the next batch.
4. Manufacturing lead-time and cost are lower as compared to job order production.

ADVANTAGES:

Following are the advantages of Batch Production:

1. Better utilization of plant and machinery.
2. Promotes functional specialization.
3. Cost per unit is lower as compared to job order production.
4. Lower investment in plant and machinery.
5. Flexibility to accommodate and process number of products.
6. Job satisfaction exists for operators.

LIMITATIONS:

Following are the limitations of Batch Production:

1. Material handling is complex because of irregular and longer flows.
2. Production planning and control is complex.
3. Work in process inventory is higher compared to continuous production.
4. Higher set up costs due to frequent changes in Set up.

3. MASS PRODUCTION:

Manufacture of discrete parts or assemblies using a continuous process are called Mass Production.

This production system is justified by very large volume of production. The machines are arranged in a line or product layout. Product and process standardization exists and all outputs follow the same path.

Mass Production is characterized by

1. Standardization of product and process sequence.
2. Dedicated special purpose machines having higher production capacities and output rates.
3. Large volume of products.
4. Shorter cycle time of production.
5. Lower in process inventory.



6. Perfectly balanced production lines.
7. Flow of materials, components and parts is continuous and without any back tracking.
8. Production planning and control is easy.
9. Material handling can be completely automatic.

ADVANTAGES:

Following are the advantages of Mass Production:

1. Higher rate of production with reduced cycle time.
2. Higher capacity utilization due to line balancing.
3. Less skilled operators are required.
4. Low process inventory.
5. Manufacturing cost per unit is low.

LIMITATIONS:

Following are the limitations of Mass Production:

1. Breakdown of one machine will stop an entire production line.
2. Line layout needs major change with the changes in the product design.
3. High investment in production facilities.
4. The cycle time is determined by the slowest operation.

4. CONTINUOUS PRODUCTION:

Production facilities are arranged as per the sequence of production operations from the first operations to the finished product. The items are made to flow through the sequence of operations through material handling devices such as conveyors, transfer devices, etc.

Continuous Production is characterized by

1. Dedicated plant and equipment with zero flexibility.
2. Material handling is fully automated.
3. Process follows a predetermined sequence of operations.
4. Component materials cannot be readily identified with final product.
5. Planning and scheduling is a routine action.

ADVANTAGES:

Following are the advantages of Continuous Production:

1. Standardization of product and process sequence.
2. Higher rate of production with reduced cycle time.

3. Higher capacity utilization due to line balancing.
4. Manpower is not required for material handling as it is completely automatic.
5. Person with limited skills can be used on the production line.
6. Unit cost is lower due to high volume of production.

LIMITATIONS:

Following are the limitations of Continuous Production:



1. Flexibility to accommodate and process number of products does not exist.
2. Very high investment for Setting flow lines.
3. Product differentiation is limited.

WORK STUDY INTRODUCTION:

Productivity has now become an everyday watch word. It is crucial to the welfare of industrial firm as well as for the economic progress of the country. High productivity refers to doing the work in a shortest possible time with least expenditure on inputs without sacrificing quality and with minimum wastage of resources.

Work-study forms the basis for work system design. The purpose of work design is to identify the most effective means of achieving necessary functions. This work-study aims at improving the existing and proposed ways of doing work and establishing standard times for work performance. Work-study is encompassed by two techniques, i.e., method study and work measurement.

“Method study is the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective methods and reducing costs.”

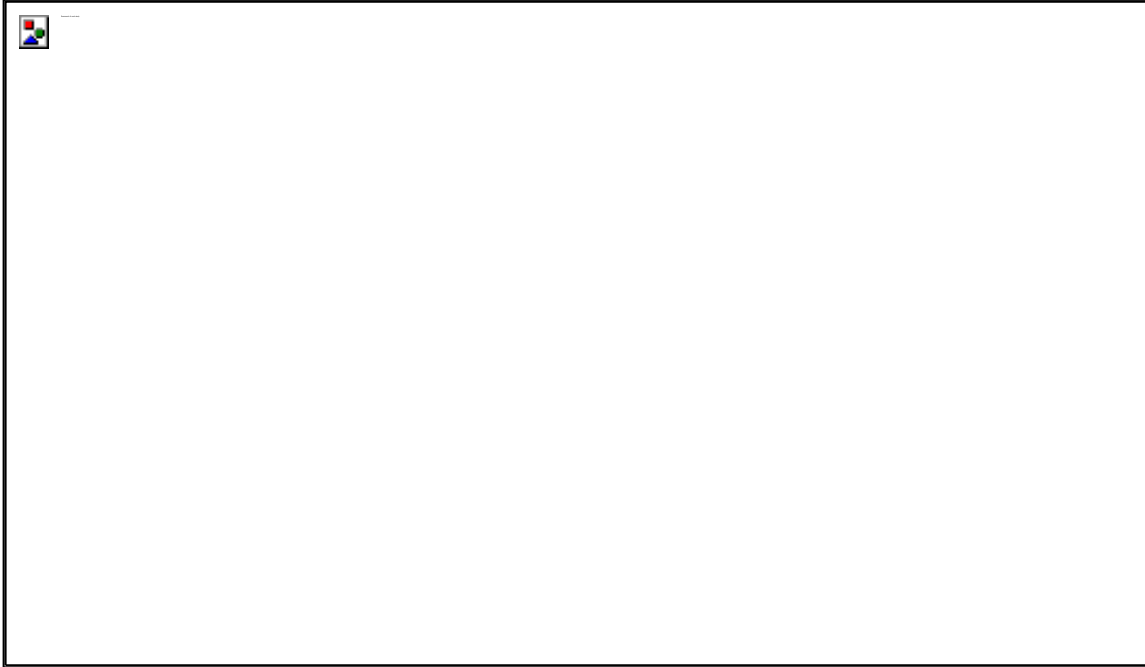
“Work measurement is the application or techniques designed to establish the time for a qualified worker to carry out a specified job at a defined level or performance.”

There is a close link between method study and work measurement. Method study is concerned with the reduction of the work content and establishing the one best way of doing the job whereas work measurement is concerned with investigation and reduction of any ineffective time associated with the job and establishing time standards for an operation carried out as per the standard method.

WORK STUDY IN PRODUCTION AND OPERATION MANAGEMENT:

“Work study is a generic term for those techniques, method study and work measurement which are used in the examination of human work in all its contexts. And which lead systematically to the investigation of all the factors which affect the efficiency and economy of the situation being reviewed, in order to effect improvement.”

FRAMEWORK OF WORK STUDY:



Work study investigates the work done in an organization and aims at finding the best and the most efficient way of utilizing the available resources (**man, material, money and machinery**) to achieve best possible quality work in minimum possible time.

Work Study is systematic study of methods of work in order to improve effective use of its resources and Set standards of performance. It can be applied where a Set of processes is involved.

Work Study introduces the most effective method of working. It is the most efficient tool in the hands of management to improve efficiency at all levels of the organization. Work study helps to reduce waste through standardization of element of the job.

Work study is conducted in order to identify the current situation in the organization and to find the opportunities of improvement. This will help organizations become more systematic and profitable.

Work study deals with the techniques of method study and work measurement, which are employed to ensure the best possible use of human, machine and material resources in carrying out a specified activity.

OBJECTIVES OF WORK STUDY:

- (i) Work study brings higher productivity;
- (ii) Work study improves existing method of work for which cost becomes lower;
- (iii) It eliminates wasteful elements;
- (iv) It Sets standard of performance;
- (v) It helps to use plant and human more effectively;
- (vi) It improves by saving in time and loss of material also.

STEPS INVOLVED IN WORK STUDY:

The steps of work study are:

- (i) It selects the jobs which are to be studied;
- (ii) It examines critically the recorded facts which are already done;
- (iii) It records from direct observations all the matters which are happened;
- (iv) It defines new method;
- (v) It also installs the new method;
- (vi) It also maintains the new standard;
- (vii) It develops most economic and appropriate methods.



It measures the work content in the method that is selected and compute a standard time.

APPLICATIONS OF WORK STUDY:

Work study finds applications in:

1. Industries (Production operations, research and development),
2. Marketing, sales and distribution,
3. Offices, stores and warehouses,
4. Material handling,
5. Design,
6. Building and other constructions,
7. Transport,
8. Hospital,
9. Army, and
10. Agriculture, etc.

BENEFITS OR ADVANTAGES OF WORK STUDY:

- ☞ It saves us a lot of time.
- ☞ Work study lays the foundation stone for all the work that will occur in the future.
- ☞ Work study provides you with tools and techniques that will help you to improve the way the production process is done.
- ☞ The work study helps you in Setting the standard or quality that is expected in the production process.
- ☞ The work study also helps you make decisions about the people involved, the process involved, machines and nature of jobs.
- ☞ With the help of work study the effect of production with respect to the employees, environmental factors, social factors can easily be understood.
- ☞ Also by doing work study you can come up with different ways to face any issues.

METHOD STUDY:

Method study of Motion study may be defined as the systematic investigation of existing method of doing job in order to develop and install an easy, rapid, efficient effective and less fatigue procedure for doing the same job at lower costs.

This is achieved by eliminating unnecessary motions involve in a certain procedure or by changing the sequence of operation of the process itself.

It is concerned with finding the facts about a situation and critical examination of these facts and developing a new and better methods of doing the work.

It is the systematic recording, analysis and critical examination of existing and proposed ways of doing

work.

Method–study results in a more effective use of material, plant, equipment and manpower.

PROCEDURE FOR METHOD STUDY:

The process is often seen as a linear, described by its main steps of:

- 1) Select (the work to be studied);
- 2) Define (defines the aims, scale, scope and constraints of the investigation)
- 3) Record (all relevant information about that work);
- 4) Examine (the recorded information);
- 5) Develop (an improved way of doing things);
- 6) Install (the new method as standard practice);
- 7) Maintain (the new standard proactive).

1) SELECT:

Work selected for method study may be an identified problem area or an identified opportunity. It may be identified through a systematic review of available data, normal monitoring or control processes, high levels of dissatisfaction and complaint or as part of a change in management policy, practice, technology or location, and usually because it meets certain conditions of urgency and/or priority.

2) DEFINE:

Before any method study investigation is begun, it is necessary to establish, clear terms of reference which define the aims, scale, scope and constraints of the investigation. This should also include an identification of who "owns" the problem or situation and ways in which such ownership is shared. This may lead to a debate on the aims of the project, on reporting mechanisms and frequencies, and on the measures of success. This process is sometimes introduced as a separate and distinct phase of method study, as the "Define" stage. It leads to a plan for the investigation which identifies appropriate techniques, personnel, and timescale.

3) RECORD:

The Record stage of method study involves gathering sufficient data (in terms of both quality and quantity) to act as the basis of evaluation and examination. A wide range of techniques are available

for recording; the choice depends on the nature of the investigation; the work being studied; and on the level of detail required. Many of the techniques are simple charts and diagrams, but these may be supplemented by photographic and video recording, and by computer based techniques.

Especially with "hard" (clearly defined) problems, method study often involves the construction and analysis of models, from simple charts and diagrams used to record and represent the situation to



full, computerised simulations. Manipulation of an experimentation on the models leads to ideas for development.

4) EXAMINE:

The recorded data are subjected to examination and analysis; formalised versions of this process are critical examination and systems analysis. The aim is to identify, often through a structured, questioning process, those points of the overall system of work that require improvements or offer opportunity for beneficial change.

5) DEVELOP:

The Examine stage merges into the Develop stage of the investigation as more thorough analysis leads automatically to identify areas of change. The aim here is to identify possible actions for improvement and to subject these to evaluation in order to develop a preferred solution.

Sometimes it is necessary to identify short-term and long-term solutions so that improvements can be made (relatively) immediately, while longer-term changes are implemented and come to fruition.

6) INSTALL:

The success of any method study project is realised when actual change is made 'on the ground', change that meets the originally specified terms of reference for the project. Thus, the Install phase is very important. Making theoretical change is easy; making real change demands careful planning and handling of the people involved in the situation under review. They may need reassuring, retraining and supporting through the acquisition of new skills. Install, in some cases, will require a parallel running of old and new systems, in others, it may need the build-up of buffer stocks, and other planning to manage the change. What matters is that the introduction of new working methods is successful. There is often only one chance to make change!

7) MAINTAIN:

Sometime after the introduction of new working methods, it is necessary to check that the new method is working, that it is being properly followed, and that it has brought about the desired results, this is the Maintain phase. Method drift is common when people either revert to old ways of work in, or introduce new changes. Some of these may be helpful and should formally be

incorporated; others may be inefficient or unsafe. A methods audit can be used to formally compare practice with the defined method and identify such irregularities.

WORK MEASUREMENT OR TIME STUDY:

Work measurement is also called by the name 'time study'. Work measurement is absolutely essential for both the planning and control of operations. Without measurement data, we cannot determine the capacity of facilities or it is not possible to quote delivery dates or costs. We are not in a position to determine the rate of production and also labor utilization and efficiency. It may not be possible to introduce incentive schemes and standard costs for budget control.

Time And Motion Study: According to ILO, Time Study means "A technique for determining as accurately as possible from a limited number of observations the time necessary to carry out a given activity at a different standard of performance". In other words, "time study is the art of observing and recording time required to do each detailed element of an individual operation." Practically, it studies the time taken on each element of a job.

Motion study, on the other hand, is the study of the body motion used in performing an operation, with the thought of improving the operation by eliminating unnecessary motion and simplifying necessary motion and thus establishing the most favourable motion sequence for maximum efficiency.

So, in short, 'Time Study' means the determination of standard time that is taken by a worker of average ability under normal working conditions for performing a job. But 'Motion Study' determines the correct method of doing a job to avoid wasteful movements, for which the workers are unnecessarily tired.

STEPS INVOLVED IN TIME AND MOTION STUDY:

The steps of Time And Motion Study are:

1. Time and Motion studies eliminate wasteful movements;
2. They examine the proposed method critically and determine the most effective one;
3. They determine for each element having a stop-watch;
4. They record all the parts of a job which are done by the existing method;
5. They install the method as standard one;
6. They critically observe the workers who are engaged with the work;
7. They assess the proper speed of the operator who is working.


Time Study or Work measurement is the application of techniques designed to establish the time taken for a qualified worker to carry out a specified job (task) at a defined level (rate) of performance.

Or

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.

MEANING OF WORK MEASUREMENT:

 The meaning of work measurement is mainly based on three key steps.

Work measurement means to:

- ❖ Find out the different elements (parts) of the production process (job).
- ❖ Find out the time taken by each element.
- ❖ Fix the standard time for performing the production process.



For example, publishing a book is a production process. There are many elements, which are involved in the publication of a book. In other words, book publication involves production steps like typing a manuscript, editing the written matter; proof reading, followed by printing and binding.

~~Work measurement involves finding out the time taken for doing each element. The time taken for each element is totalled. This is the standard time for publishing the book. Here, provisions are also made for relaxation, breakdown of machines, etc.~~

OBJECTIVES AND APPLICATIONS OF WORK MEASUREMENTS:

OBJECTIVES OF WORK MEASUREMENT:

The use of work measurement as a basis for incentives is only a small part of its total application. The objectives of work measurement are to provide a sound basis for:

1. Comparing alternative methods.
2. Assessing the correct initial manning (manpower requirement planning).
3. Planning and control.
4. Realistic costing.
5. Financial incentive schemes.
6. Delivery date of goods.
7. Cost reduction and cost control.
8. Identifying substandard workers.
9. Training new employees.

TECHNIQUES OF WORK MEASUREMENT IN PRODUCTION MANAGEMENT:

For the purpose of work measurement, work can be regarded as:

1. **Repetitive work:** The type of work in which the main operation or group of operations repeat continuously during the time spent at the job. These apply to work cycles of extremely short duration.
2. **Non-repetitive work:** It includes some type of maintenance and construction work, where the work cycle itself is hardly ever repeated identically.

Various techniques of work measurement are:

1. Time study (stop watch technique),
2. Synthesis,
3. Work sampling,
4. Predetermined motion and time study,
5. Analytical estimating.

Time study and work sampling involve direct observation and the remaining are data based and analytical in nature.

1. **Time study:** A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for analysing the data so as to determine the time necessary for carrying out the job at the defined level of performance. In other words measuring the time through stop watch is called time study.
2. **Synthetic data:** A work measurement technique for building up the time for a job or parts of the job at a defined level of performance by totalling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.
3. **Work sampling:** A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.
4. **Predetermined motion time study (PMTS):** A work measurement technique whereby times established for basic human motions (classified according to the nature of the motion and

conditions under which it is made) are used to build up the time for a job at the defined level of performance. The most commonly used PMTS is known as Methods Time Measurement (MTM).

5. **Analytical estimating:** A work measurement technique, being a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data. The work measurement techniques and their applications are shown in the following table.

WORK MEASUREMENT TECHNIQUES IN OPERATIONS MANAGEMENT:

Work measurement techniques and their application



PURPOSE OF WORK MEASUREMENT

THE PURPOSE OF WORK MEASUREMENT DATA:

1. Manpower planning.
2. Production Planning and Scheduling.
3. Estimating Productions Costs.
4. Cost Reduction and Control.
5. Rational Basis for Incentives.
6. Performance Appraisal.
7. Training of Employees.
8. Comparing Alternative Methods.
9. Accepting New Orders.
10. Fixing the Selling Cost.

1) **MANPOWER PLANNING:**

Work measurement data is used for manpower planning. This is because it gives information about the total hours required to perform the job. This helps to estimate the number and type of employees who are required to do the job. It ensures that there will not be any excess staff.

Work measurement data also helps to estimate the number of machines and equipment that will be required in the future. This helps to find out the number of employees who will be required to handle these machines and equipment.

2) **PRODUCTION PLANNING AND SCHEDULING:**

Work measurement data is used for production planning and scheduling. This is because this data is



used for making production standards. This data is also used for scheduling. Scheduling means to fix starting and finishing time for each job. This cannot be done without work measurement data.

3) **ESTIMATING PRODUCTIONS COSTS:**

Work measurement data helps to estimate the production cost. This is because it gives management accurate data about production time. This data helps to estimate the labor costs. Secondly, indirect costs such as fuel and power consumption, rent and salaries of staff, etc. also depends on the production time factor.

4) **COST REDUCTION AND CONTROL:**

Work measurement data is used to reduce and control costs. It helps to reduce the labor cost. This is because it provides a guideline to the employees to work efficiently and effectively. This helps to make optimum use of the available manpower. So the labor cost will reduce.

Work measurement data helps to reduce material costs. It also helps to increase machine productivity. All these steps help to reduce and control production costs.

5) **RATIONAL BASIS FOR INCENTIVES:**

Work measurement data is used for making incentive schemes for the employees. Incentive schemes motivate employees to work hard. The efficient employees are rewarded by giving them a higher wage rate.

Work measurement fixes the standard-time for doing the work. Those who complete their work within a standard time or faster than the standard-time are rewarded with higher wages. This encourages all employees to work fast and efficiently.

6) **PERFORMANCE APPRAISAL:**

Performance appraisals are done to find out whether the employees are efficient or not. It is done to find strengths & weaknesses of employees.

Work measurement helps to do performance appraisals. This is because it fixes the standard-output and standard-time for each employee. The employees who produce the standard-output within the standard-time are efficient and vice versa. Thus, it also helps to find out the strengths and weaknesses of the employees.

7) TRAINING OF EMPLOYEES:

Work measurement helps to train the employees, especially the new employees. It divides the full job into small elements (parts). It gives complete details about each element of the job. It gives details about; how to do each element, the time taken for each element, the machines and tools involved in each element, etc. These details are used for training the employees.

8) COMPARING ALTERNATIVE METHODS:

There are many methods for doing a job. Work measurement data helps to choose the best method for doing a job.

9) ACCEPTING NEW ORDERS:

Work measurement data tells us when each job will be completed. So, it helps the company to decide whether to accept new orders or not. In other words, it helps to find out whether the new-order will be completed within a specific time limit.

10) FIXING THE SELLING COST:

Work measurement data also helps to fix the selling cost of product. This is because it estimates the cost of production, especially the labor cost. Selling cost is decided after fixing the estimated production cost.

WORK SAMPLING:

Meaning of Work Sampling:

Work sampling, also called ‘Activity Sampling’ or ‘Ratio Delay Study’, is based on the statistical method first devised and was original developed by **Leonard Henry Caleb Tippett (1902–1985) in Britain in 1934**. He used this technique firstly, in the British textile industry. Later Morrow carried out several investigations.

In this technique, **the workers are observed many times at random**. It is done to find out for how much time the worker is actually on the job. It checks how long he is working and how much time he is not working (idle time).

Work sampling method does not involve stop watch measurement. The purpose of work sampling technique is to estimate what proportion of a worker’s time is devoted to work-related activities.

The results obtained by the all-day stop-watch time study and such other statistical methods were in most cases found to be in close agreement with the work sampling method, which places it on a sound reliable basis.

Though stop-watch time study proved to be very useful for repetitive operations but it cannot measure accurately and economically long and irregular work cycles. While most of the indirect activities are of

irregular nature and, therefore, there must be some way to control the indirect labour activities. For such tasks work sampling has been well established and gained lot of popularity.

Workers have wrong concept that the results of a time study may go against them and reduce their wage rates. Therefore, they oppose the stop-watch method. For this technique, workers have no such feelings.

“**Work Sampling** is a technique of getting idea about utilization of machines or human beings through a large number of instantaneous observations taken at random time intervals”.

OBJECTIVES OF WORK SAMPLING:

Work sampling is a fact finding tool and has the following two main objectives:

1. To measure activities and delays while a man is working and percentage of that he is not working. It means a fair day's work.
2. Under certain circumstances, to measure manual tasks that is to establish time standards for an operation.

Work sampling method involves following three main steps:

- ❖ Deciding what activities are defined as 'working'. Non-working are those activities which are not defined as working.
- ❖ Observe the worker at selected intervals and record (write down) whether he is working or not.
- ❖ Calculate the portion of time (P), a worker is working.

DETERMINATION OF TIME STANDARDS BY WORK SAMPLING:

With work sampling, it is possible to determine the percentage of the day a worker is idle and the percentage of the day he is working. The average performance index or the speed at which he worked during the working portion of the day, can also be determined.

For example, suppose Mohan Singh worked as a Drillman, and a work sampling study showed that he was idle 15% of the day or 72 minutes and that he worked the remainder of the day of 480 minutes at an average performance index of 110%. He drilled 400 items of acceptable quality during the day.

The standard time for the operation he performed can be calculated as shown below:

It is assumed that 15% of the total time is taken as fatigue and other personnel allowances.

As Standard Time



$$= \frac{100}{100 - 15} \times \frac{(480 \times 0.85 \times 1.10)}{400} \quad 1.32 \text{ Minutes}$$

APPLICATIONS OF WORK SAMPLING:

1. Work sampling can be applied for the estimation of the percentage utilization of machine tools, cranes, fork trucks etc.
2. Work sampling can also be used to estimate the unavoidable delay times for deciding the delay allowances.
3. To estimate the percentage of the time consumed by various job activities, i.e. supervision, repair, inspection etc.
4. Work sampling is also used to find out time standards, specially where the job is not repetitive and where time study by stop-watch method is not possible, e.g. for maintenance work, office work, repair work, ship building etc. Time standards can be calculated by combining rating with work sampling as illustrated in the following example:

Example 2:

A work sampling study showed that 20% of a work week of 48 hours was consumed by avoidable, delays. If each time a work sampling observation was made the operator was rated and the average of such rating was 110%. If 100 units were produced by the operator in that period, calculate standard time.

Solution:



ADVANTAGES OF “WORK SAMPLING” OVER “TIME STUDY”:

1. Operator is not subjected to long-period of observations.
2. Group operations can be easily studied by a single analyst.

3. It does not require continuous observation for a long period of time.
4. Many operations or activities which are impractical or costly to be measured by time study can be measured by this.
5. Observations may be taken over a period of days or weeks, thus decreasing the chance of day to day or week to week variations affecting the results.
6. The man hours spent by the analyst are much less.
7. A work sampling study can be stopped at any time without affecting the results.
8. In this, random observations are taken by avoiding prolonged observations.
9. This produces less fatigue and are less tedious to observer.
10. It generally requires less time in calculating the results.
11. No stop-watch or any other timing device is needed.
12. Clerical time is minimised.

DISADVANTAGES OF “WORK SAMPLING” OVER “TIME STUDY”:

1. It is not economical to study a single operator or machine or for studying operators or machines located over wide areas.
2. It does not permit finer breakdown of activities and delays.
3. Study made of a group presents average while there is no information about the magnitude of individual differences.
4. Management and workers may not be able to understand work sampling as easily as they do time study.
5. Some-time no record is kept about the study on the operator, therefore, a new study must be made when a change occurs in any element.

ERRORS IN WORK SAMPLING STUDY:

While conducting the Work Sampling Study some errors are likely to be occurred. Therefore, care must be taken to avoid these errors.


Following are some of the errors which generally occur:

1. Sampling Errors,
2. Bias in work sampling, and
3. Non-representativeness.

1. Sampling Errors: In sampling study, whole population is represented by a sample. If the size of the sample is small, then there are chances of errors in inference drawn from this sample. Therefore,

while conducting the study care must be taken that sample size must represent the same characteristics as that of the whole population.

The sample size can be calculated using the formulae, after a confidence level and level of accuracy is decided. After completing the study, it must be checked, whether sufficient number of observations have been taken or not.

 **2. Bias in Work Sampling:** As a consequence of bias in study, the proportion of an activity (working or idle) shall be different from the actual proportion of time devoted to that activity.

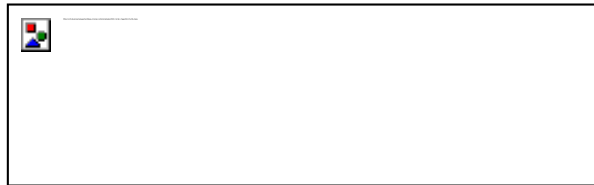
Following are the main sources of bias study:

I. A Non-Random Schedule of Observation: To avoid this error, randomised sampling procedure must be adopted. Before starting the study, actual schedule of observations must be designed.

Once the number of observations have been estimated (after deciding the confidence level and accuracy) using the formula and a representative period (number of days over which the study in spread-up) of study has been selected, the number of observations (N) are distributed over the total number of days selected.

Then this number is distributed randomly over the day. For this purpose any random number table may be used.

For example, following numbers are taken from the random number table:



Then using these numbers, we can fix the schedule as:

3rd hour 12th min. 58th sec.

2nd hour 54th min. 10th sec (leaving Number 9)

1st hour 35th min. 8th sec.

5th hour 14th min. 40th sec.

These times are then chronologically arranged to complete the observation schedule.

As a second way, these numbers can also be used to indicate as (leaving last number).



II. Bias on the Part of the Observer: Sometimes when the observer observes the worker he is in transitional states, i.e. he is changing from one state to another state, and then the observer can call it either way. In such cases, the observer's judgment is required.

To avoid any possibility of bias, following precautions must be taken to minimise the judgments:

(a) Categories must be defined very clearly.



(b) Clearly define the instant at which the observation is to be made. For this purpose, a turn of the corner is preferred so that the category at the time of first seeing can be noted.

(c) If any transitional stage cannot be defined clearly, even then judgment is avoided and tossing of coin must be done.

III. Change in the Behaviour of the Worker: Sometime when the observed person knows that he is being observed then he changes his behaviour.

To take care of this error, following precautions must be taken:

(a) Observations must be randomly spaced.

(b) Observations must be taken as soon as the operator is in sight of the observer.

(c) Randomise the order in which individual worker is observed, when more workers are to be observed.

3. Non-Representativeness in Work Sampling: Non-representativeness exists when the period studied do not give characteristics of the circumstances that prevail in the long run. For example, results taken on any one day cannot represent all the days. On Monday the worker is fresh while on Friday and Saturday he will be tired.

Similarly, the results taken in the day shift evening shift and in the night shift will be different. Some problems are for seasons, i.e. results taken in the summer cannot be applied in the winter or in the rainy seasons.

Therefore, designer of a work sampling study must give a careful attention to representativeness of the sample. Periods of abnormal activities and unusual conditions should be avoided.

ADVANTAGES/BENEFITS OF WORK SAMPLING:

1. Work sampling gives an unbiased result since workmen are not under close observation.
2. A work sampling study may be interrupted at any time without affecting the results.
3. Work sampling can be conducted by anyone with limited training. There is no need to have experts.
4. Team work can be studied by work sampling and not by the time-study.

5. Work sampling is economical and less time-consuming than time study. This is because more than one worker can be studied at the same time. Secondly, observer needs not to be present himself for a long time.

DISADVANTAGES/DEMERITS OF WORK SAMPLING:

1. Work sampling is not economical for short cycle jobs. It is also uneconomical to study a single worker or even small group of workers.
2. Unlike time study, it does not allow a small breakdown of activities and delays.
3. Working men may change their normal method of working when they see an observer. Therefore, the results from the work study may not be accurate.
4. In work sampling method, the observations are limited or insufficient. So, the results may not be accurate.
5. This method normally does not record the workers' speed of working.

PREDETERMINED MOTION TIME SYSTEM (PMTS):

A **Predetermined Motion Time System (PMTS)** may be defined as a procedure or method which analyses any manual activity/human motion in terms of the basic or fundamental motions required to perform it. Each of these motions is assigned to 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.

PMTS is a work measurement technique which comes next to synthetic times. They are more refined and accurate than the synthetic times because they are obtained gradually with more accuracy and often used as a source of synthetic time data.

PMTS technique is used mostly for jobs, which are planned for future. However, it can also be used for current jobs as an alternative to time study.

PMTS is better than motion studies because it gives the detailed analysis of the motion, and it fixes the standard time for doing that motion.

Applications of PMTS are for

- 1) Determination of job time standards.
- 2) Comparing the times for alternative proposed methods so as to find the economics of the proposals prior to production run.
- 3) Estimation of manpower, equipment and space requirements prior to Setting up the facilities and start of production.
- 4) Developing tentative work layouts for assembly lines prior to their working in order to minimize the amount of subsequent re-arrangement and re-balancing.

5) 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.

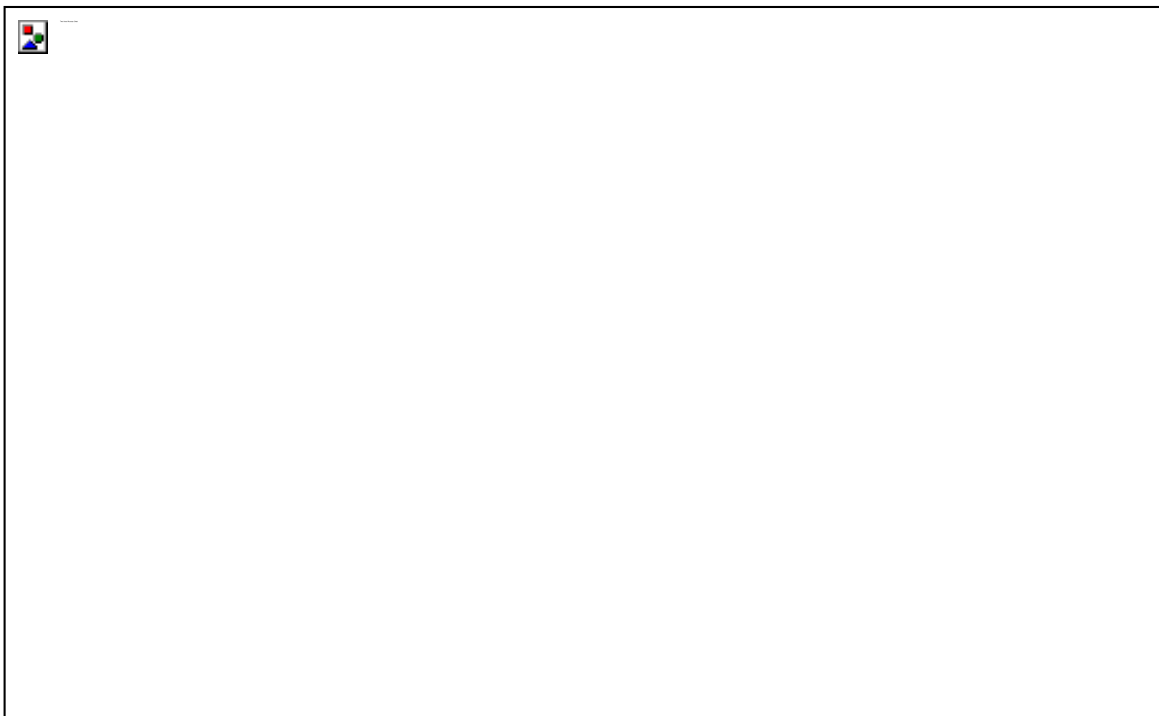
Some commonly used PMT systems are:

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

PROCEDURE OF PMTS:

- a. Study the complete operation cycle few times.
- b. Observe and record the activities of one hand at a time.
- c. Record only few symbols at a time.
- d. Recording should be started at a point of time that can be easily distinguished. For examples activity of picking up the such work piece at the beginning of cycle of work is a good point from which recording the movements should be started,
- e. Care should be taken that no activity is left while recording, as it will affect the method study badly.
- f. Combinations of operations and transport should be avoided, unless they actually occur at the same time.

A two hand process chart for nut and bolt assembly is shown in Fig. 18.13.



OBJECTIVES OF PMTS:

The predetermined time systems have been successfully applied to:

- a. Determine job time standards.
- b. Compare the times for alternative, proposed methods so as to determine the economics of the proposals before the production runs or other way round fabrication/ production of equipment to be employed.
- c. To estimate the manpower, equipment and space requirements before production or prior to Setting up of facilities.
- d. To develop tentative layouts for assembly lines before the work starts so as to minimize the investment on subsequent rearrangement and rebalancing etc.
- e. For improving and modifying work methods before stating the work on the job.
- f. To set time standards for various jobs.
- g. To provide a basis for estimation of labour cost and wage plans.
- h. To facilitate training of the workers and supervisory staff.
- i. To utilize for timing of those short and repetitive motion which are difficult to be measured by stop watch.

TECHNIQUE /DEVELOPMENT OF A PMT SYSTEM:

It consists following steps:

- a. In order to avoid the inaccuracies being introduced by use of human element, the technique used to build PMTS data does not measure element time by a stop watch.
- b. It is assumed that all manual tasks in industries consists of certain basic human movements such as move, reach, engage or disengage etc. which are common in almost all jobs.
- c. The average time taken by the (normal) industrial workers to perform a basic activity/ movement is practically constant.

Taking into consideration the facts mentioned above, the various steps involved in collecting PMTS data are as follows:

- (1) Select a large number of workers performing various activities or doing varieties of jobs under normal working conditions in industrial units.
- (2) Perform micro motion study i.e. record the job operations on a movie film.
- (3) After analysing the film, note down the time taken to complete each element and compile the data in the form of a table.

That point to be noted is that the jobs are selected in such a way that they involve most of the common basic activities/motions and are worked under different Set of conditions by workers of different ages and with other different characteristics.

Once the tables/charts for various basic activities/motions are ready, the normal time for any new job can be determined by breaking the job into its basic motions, noting time for each movement from charts and adding up the time values for all the basic movements involved in the job. In this way standard time may be obtained by adding proper allowances to normal time.

SELECTION OF A PARTICULAR PMT SYSTEM:

The following factors are considered while selecting a particular PMT system for application to a particular industry:

1. **Cost of Installation:** The cost of getting experts for applying the system under consideration constitutes the cost of installation.
2. **Operational Cost:** This is determined by the length of time required to Set a standard by the systems.
3. **Level of Performance of the System:** The level of performance, contained in the system under consideration may be different from the normal performance in the industry where it is to be utilized. However, this problem could be solved by calibration which is nothing but multiplication of the times given in the charts by calibration factor (some constant) or by application of an adjustment allowance.
4. **Consistency of Standards:** The vital factor to be considered is consistency of standards Set by a system on different jobs. The system can be utilized for this on a trial basis on a Set of operations in the industrial unit and examined for consistency among them.
5. **Nature of Operation:** Best results can be achieved if the type and nature of operations in the plant are resembling the nature land type of operations being studied for developing the system under consideration.

USES OF PMTS:

Most of the uses have been minted while explaining the advantages. Their uses are classified under the two heads i.e. work methods and work measurement.

USES IN WORK METHODS:

1. Existing methods improvement.
2. Evaluation of proposed methods in advance of actual production.
3. Evaluation of design of tools, jigs and equipment etc.

INDUSTRIAL ENGINEERING AND MANAGEMENT

4. Aiding in design of production.
5. Aiding in training operators.
6. Training members of the staff to become motion conscious.

USES IN WORK MEASUREMENT:

1. Establishing time standards.
2. Completion of standard data formulas for specific classes of work.
3. Checking standards established by time study.
4. Auditing time standards.
5. Balancing Production lines.
6. Estimating labour costs.

PMTS POSSESSES THE FOLLOWING ADVANTAGES:

- i. No timing is required so it eliminates in accuracies associated with stop watch time study.
- ii. The use of PMT eliminates the requirement of troublesome and controversial performance rating. So performance rating is not required.
- iii. The use of PMTS, force the analyst to be method conscious and to take care of method in detail. This sometimes help's to further improve the method.
- iv. Since times can be calculated before starting the work, this procedure is useful in methods design, equipment selection and design and production planning and control.
- v. They are an excellent training technique.
- vi. Once the analysts of an organization are familiar, they can be quickly applied.
- vii. The basic times determined with the use of PMT system are relatively more consistent.
- viii. Time standard for a job can be arrived at without going to the workplace.
- ix. The time and cost associated with finding the standard time for a job is considerably reduced.

LIMITATIONS OF PMTS:

- (1) PMTS can deal manual motions of an operation only.
- (2) They are not economical for non-repetitive operations.
- (3) They cannot be applied to restricted work (refer to process time studies).

- (4) PMTS's are restrictive in nature because they have been built on data taken from particular operations and thus PMTS provides better results if applied to that type of work/operation only.
- (5) All categories of motions have not been taken into consideration while collecting PMTS data.
- (6) The need of trained personnel. Although PMT System eliminates the utilization of rating quite a bit of judgment is still essentially exercised at various stages.

MICRO-MOTION STUDY:

Micro-motion study, which was originated by **Frank B. Gilbreth**, is one of the most exacting forms of work analysis available for job improvement.

“Micro Motion Study is a technique of recording and analysing the timing of basic elements of an operations with the objective of achieving the best method of performing the operation.”

It consists of taking motion pictures of the operation with a clock in the picture or with a video camera running at a known speed.

It is an analysis technique making use of motion pictures (or videotape) taken at a constant and known speed. The film becomes a permanent record of both the method being used and the time consumed in doing the work.

Although micro-motion study formerly made use of motion pictures, very few companies today are using them. As indicated earlier, videotape equipment has been developed so extensively that it has virtually supplanted the use of the motion picture camera. Further it is so cheap and easy to use that it makes the older approach archaic.

Micro-motion study provides a valuable technique for making minute analyses of those operations that are short in cycle, contain rapid movements, and involve high production over a long period of time. Thus it is very useful in analysing operations such as the sewing of garments, assembly of small parts and similar activities.

PURPOSES OF MICRO-MOTION STUDY:

- ☞ To study the nature and path of movements for obtaining the elements of an operation.
- ☞ To study the activities of the machine and the operator.
- ☞ To impart training to the workers or operators regarding motion-economy so that unnecessary movement by the workers may be avoided.
- ☞ To study the relationship between the activities of operator and the machine.
- ☞ To keep permanent record of the most efficient way of performing a task for future reference.
- ☞ To obtain motion time data for developing synthetic time standards for various elements.
- ☞ For carrying out research in the field of method and time study.

ADVANTAGES OF MICRO MOTION STUDY:

It has the following important advantages:

3. It provides a permanent record of motion study on films.
4. A large number of operators can see the procedure at any time even after the completion of motion study work.
5. Films can easily reveal the difference between the present and the proposed technique.
6. Films can be demonstrated to large work force at any desired speed.
7. It provides very accurate time for each operation or motion in comparison to stop watch time study.
8. It helps in making detailed and accurate analysis of the prevailing technique.

METHODS–TIME MEASUREMENT (MTM):

"MTM" stands for **Methods–Time Measurement**. It is a procedure for improving methods and establishing time standards by recognizing, classifying, and describing the motions used or required to perform a given operation and assigning pre–determined time standards to these motions.

MTM evolved into a dynamic family of systems. It is continuing to grow and meet more needs of its practitioners and users. It has developed from a single system of work measurement and analysis to a family of systems that meets the varied demands of different users.

This system is defined as a procedure which analyses any manual operation or method into basic motions require to perform it, and assigns to each motion a predetermined time standard which is determined by the nature of the motion and the conditions under which it is made.

The basic **MTM data was developed by H B Maynard, J L Schwab and G J Stegemerten** of the Methods Engineering Council during a consultancy assignment at the Westinghouse Brake and Signal Corporation, USA in the 1940's. This data and the application rules for the MTM system were refined, extended, defined, industrially tested and documented as a result of further work in later years.

WORK FACTOR SYSTEM:

ERGONOMICS INTRODUCTION

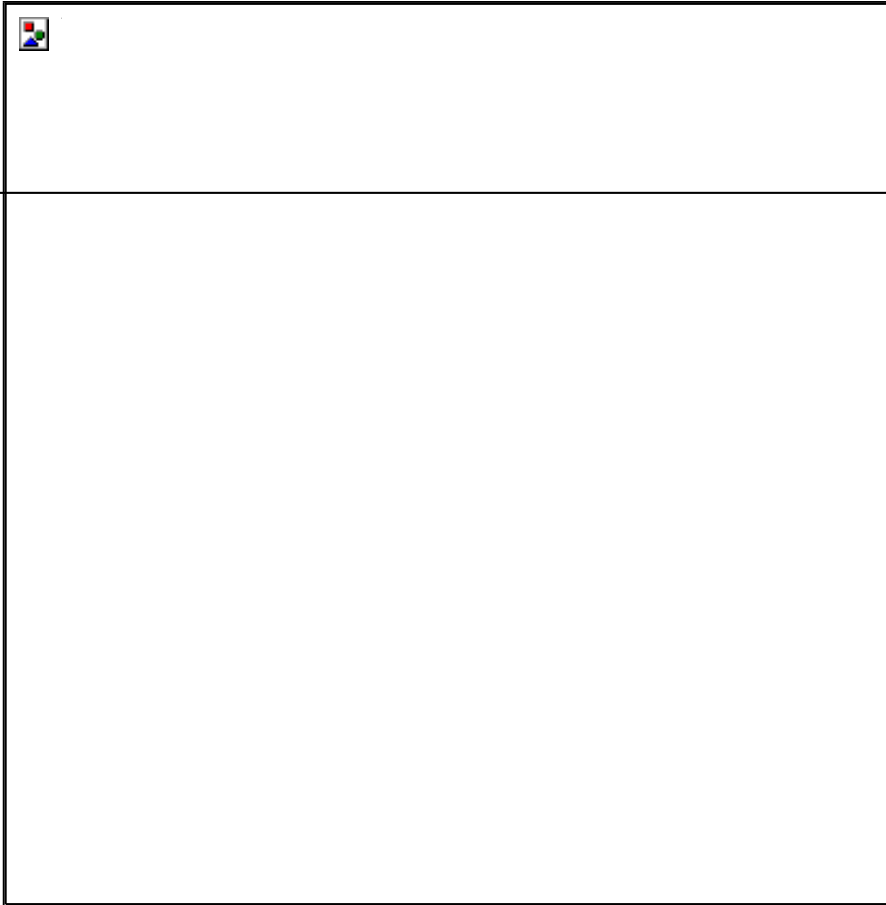
- ❖ **Webster: ergonomics:** An applied science concerned with designing and arranging things, people use so that the people and things interact most efficiently and safely.
- ❖ **Literal definition:**–Ergon (work) + Nomos (rules or habits) = “The rules of work.”

DEFINITION:

The practice of adapting products and processes to human characteristics and capabilities in order to improve people’s well–being and optimize productivity.

Simplest Definition: “Fitting the job to the worker”

Scientific discipline that studies the interaction between humans and the environment i.e. the person and their workstation.



Designing the job to match the worker rather than matching the worker to the job

Ergonomics covers all aspects of a job, from the physical stresses it places on joints, muscles, nerves, tendons, bones and the like, to environmental factors which can effect hearing, vision, and general comfort and health.

“Ergonomics applies information about human behaviour, abilities and limitations and other characteristics to the design of tools, machines, tasks, jobs and environments for productive, safe, comfortable and effective humanuse”

ERGONOMIC PRINCIPLES THAT CONTRIBUTE TO GOOD WORKPLACE DESIGN:

The goal for the design of workplaces is to design for as many people as possible and to have an understanding of the Ergonomic principles of posture and movement which play a central role in the provision of a safe, healthy and comfortable work environment. Posture and movement at work will be dictated by the task and the workplace, the body’s muscles, ligaments and joints are involved in adopting posture, carrying out a movement and applying a force. The muscles provide the force necessary to adopt a posture or make a movement. Poor posture and movement can contribute to local mechanical stress on the muscles, ligament and joints, resulting in complaints of the neck, back, shoulder, wrist and other parts of the musculoskeletal system.

S.NO.	ERGONOMIC PRINCIPLE	DESCRIPTION
1	Joints must be in a neutral position	In the neutral position the muscles and ligaments, which span the joints, are stretched to the least possible extent
2	Keep work close to the body	If the work is too far from the body, the arms will be out stretched and the trunk bent over forwards
3	Avoid bending Forward	The upper part of the body of an adult weighs about 40kg on average. The further the trunk is bent forwards, the harder it is for the muscles and ligaments of the back to maintain the upper body in balance
4	A twisted trunk strains the back	Twisted postures of the trunk cause undesirable stress to the spine
5	Alternate posture as well as movements	No posture or movement should be maintained for along period of time. Prolonged postures and repetitive movements are tiring.
6	Avoid excessive reaches	It is necessary to limit the extent of forward and sideways reaches to avoid having to bend over or twist the trunk
7	Avoid carrying out tasks above shoulder level	The hands and elbows should be well below shoulder level when carrying out a task
8	Limit the weight of a load that is lifted	There are guidance weight limits for both males and females detailed in Figure 2 of this document
9	Use mechanical aids	Many lifting accessories are available to help lift and move loads
10	Avoid carrying loads with one hand	When only one hand is used to carry a load, the body is subject to mechanical stress
11	Use transport accessories	There are a large number of accessories such as roller conveyors, conveyor belts, trolleys and mobile raising platforms, which eliminate or reduce manual handling.

FLOW PROCESS CHART:

A flowchart is a type of diagram that represents an algorithm, workflow or process. The flowchart shows the steps as boxes of various kinds, and their order by connecting the boxes with arrows. This diagrammatic representation illustrates a solution model to a given problem. Flowcharts are used in analysing, designing, documenting or managing a process or program in various fields.

A flowchart is a graphic representation of how a process works, showing at a minimum sequence of steps. Several types of flowcharts exist: the most simple (high level), a detailed version (detailed), and one that also indicates the people involved in the steps (deployment or matrix).

A flowchart is a picture of the separate steps of a process in sequential order.

Elements that may be included are: sequence of actions, materials or services entering or leaving the process (inputs and outputs), decisions that must be made, people who become involved, time involved at each step and/or process measurements.

WHEN TO USE A FLOWCHART:

- ☞ To develop understanding of how a process is done.
- ☞ To study a process for improvement.
- ☞ To communicate to others how a process is done.
- ☞ When better communication is needed between people involved with the same process.
- ☞ To document a process.
- ☞ When planning a project.

FLOWCHART BASIC PROCEDURE:

Materials needed: sticky notes or cards, a large piece of flipchart paper or newsprint, marking pens.

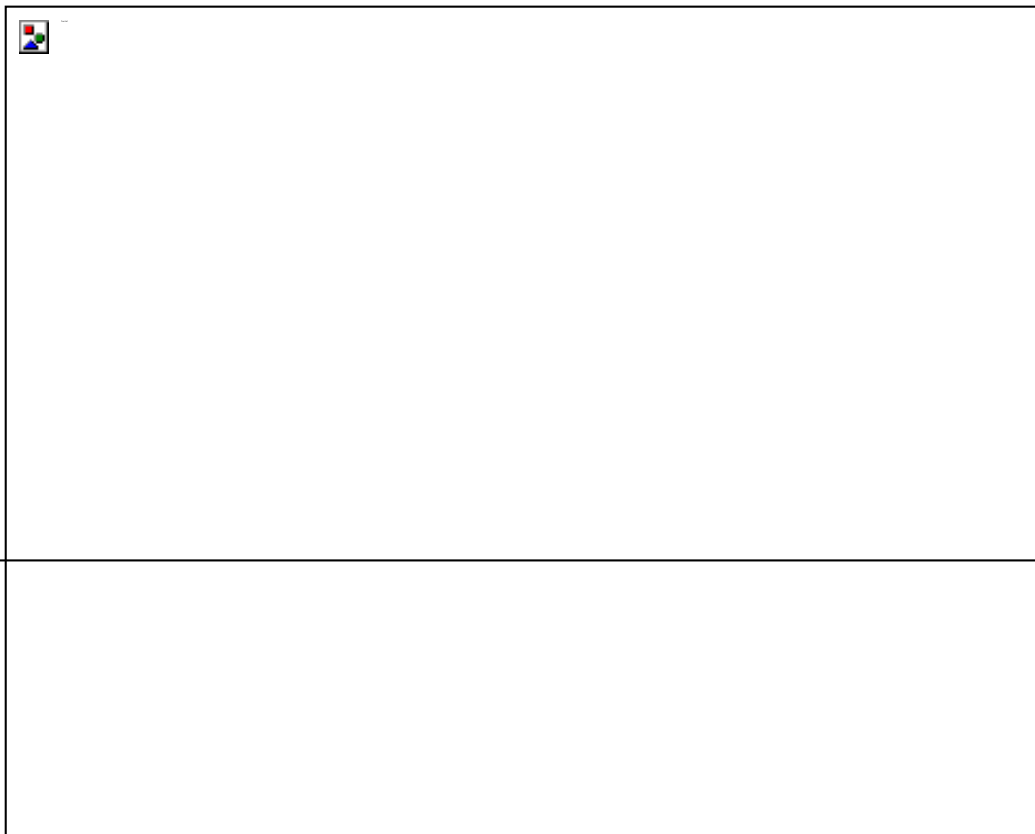
- ☞ Define the process to be diagrammed. Write its title at the top of the work surface.
- ☞ Discuss and decide on the boundaries of your process: Where or when does the process start? Where or when does it end? Discuss and decide on the level of detail to be included in the diagram.
- ☞ Brainstorm the activities that take place. Write each on a card or sticky note. Sequence is not important at this point, although thinking in sequence may help people remember all the steps.
- ☞ Arrange the activities in proper sequence.
- ☞ When all activities are included and everyone agrees that the sequence is correct, draw arrows to show the flow of the process.
- ☞ Review the flowchart with others involved in the process (workers, supervisors, suppliers, customers) to see if they agree that the process is drawn accurately

The flowchart is a means to visually present the flow of data through an information processing systems, the operations performed within the system and the sequence in which they are performed. In this lesson, we shall concern ourselves with the program flowchart, which describes what operations (and in what sequence) are required to solve a given problem. The program flowchart can be likened to the blueprint of a building. As we know, a designer draws a blueprint before starting to construct a building. Similarly, a programmer prefers to draw a flowchart prior to writing a computer program. As in the case of the drawing of a blueprint, the flowchart is drawn according to defined rules and using standard flowchart symbols

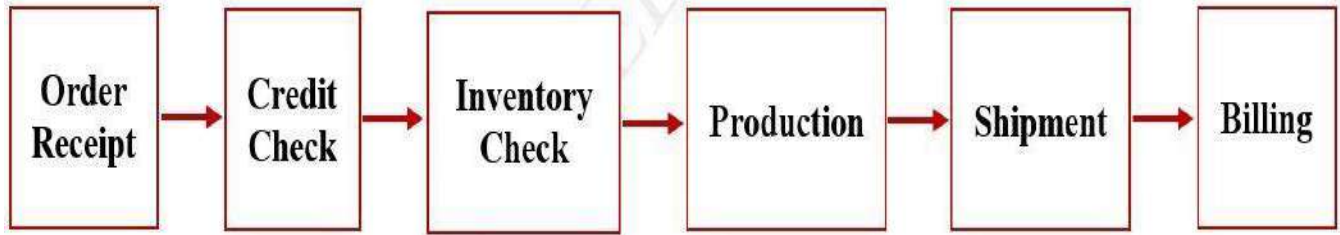
COMMONLY USED SYMBOLS IN DETAILED FLOWCHARTS:

S. No.	Symbols	Description
1		One step in the process – The step is written inside the box.
2		Direction of flow from one step or decision to another.
3		Decision making – Decision based on a question. The question is written in the diamond. More than one arrow goes out of the diamond, each one showing the direction the process takes for a given answer to the question. (Often the answers are “yes” and “no.”)
4		Delay or wait
5		Link to another page or another flowchart. The same symbol on the other page indicates that the flow continues there.
6		Input or output
7		Document
8		Alternate symbols for start and end points

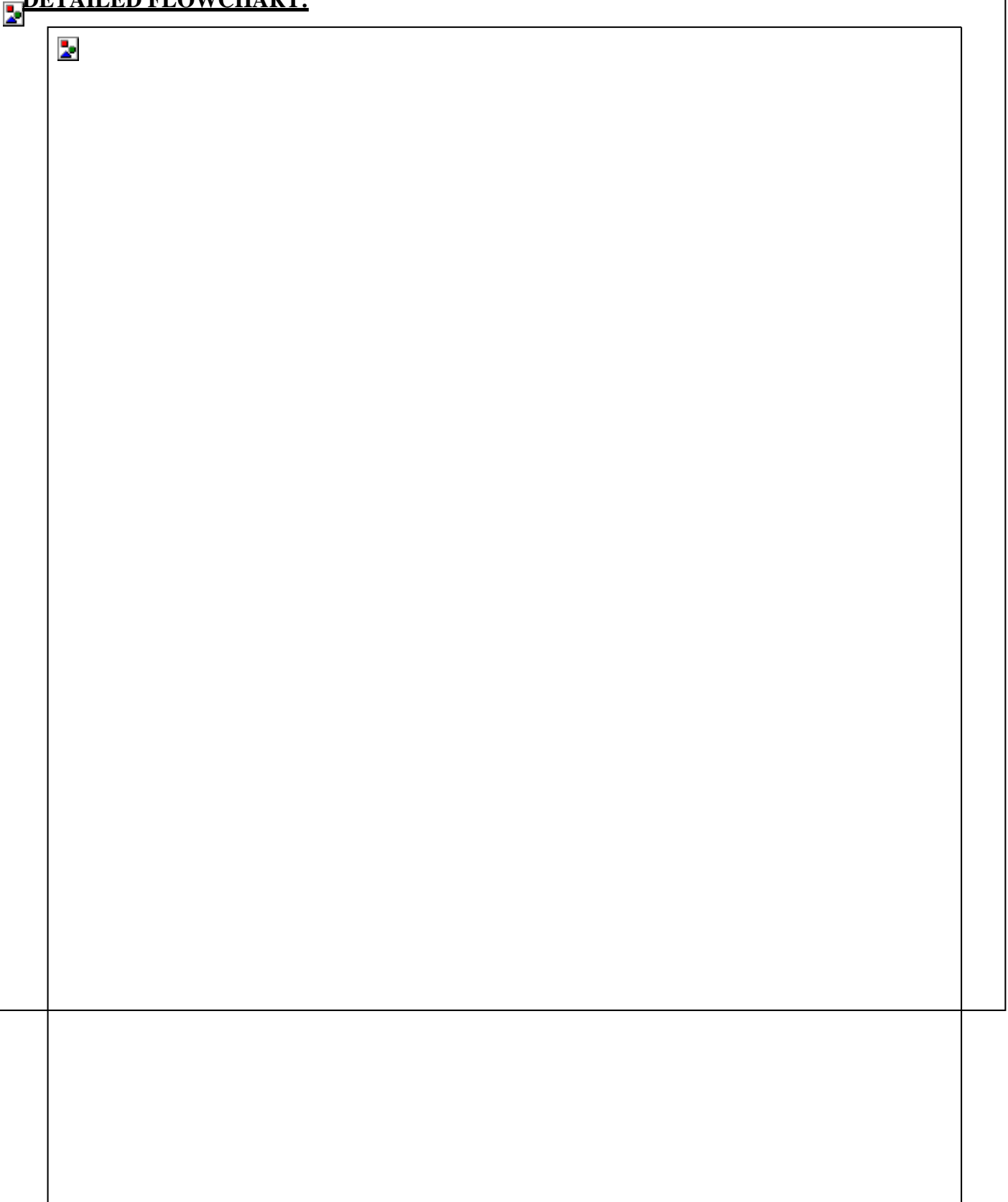
A Simple flowchart representing a process for dealing with a non-functioning lamp.



Flowchart Examples: High-Level Flowchart for an Order-Filling Process.



DETAILED FLOWCHART:



STRING DIAGRAM:

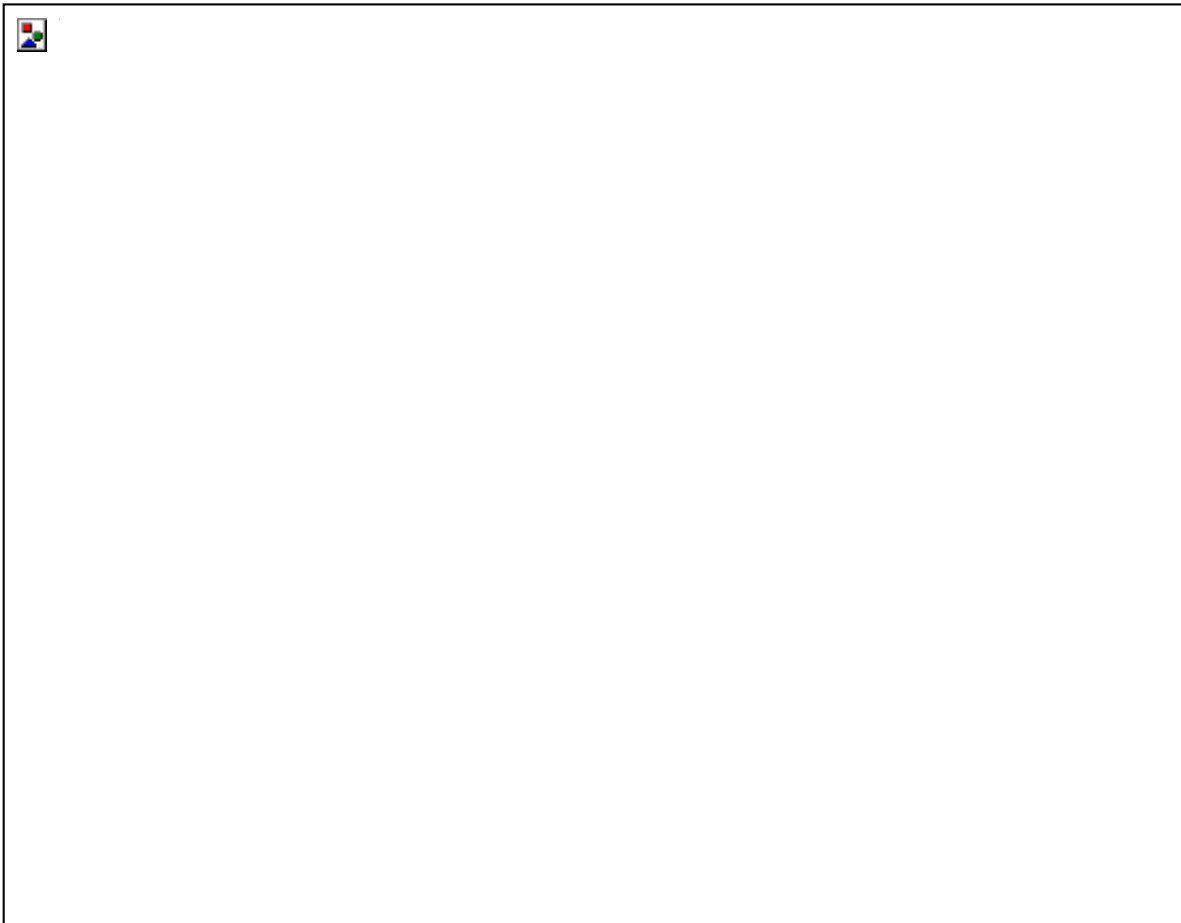
The **String Diagram** is a simple tool for analysing and designing work spaces such that movement can be minimized. The basic diagram simply consists of a map of the work area, with the actual movements drawn on top.

The term 'String Diagram' comes from the way the diagram may be created with a scale drawing, pins and a piece of string (you can then measure the string to see how far the movements are).

PROCEDURE AND PURPOSE OF STRING DIAGRAM:

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 is 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 typical string diagram is drawn in Fig.



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

- a. Study and record the complete information about the movement of various resources.
- b. Draw a scale layout of the shop area and mark various features such as machinery, work benches, stores etc.

- c. 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.
- d. A continuous colored unstretchable string, taken from the first to last warned to trace the path followed by operators or materials. Use strings/ threads of different colours if the movement of more subjects is being shown so that their movements are easily recognized and distinguished.
- e. Remove the string to measure their lengths which approximately gives distances travelled 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 results 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 is obtained.


A string diagram is a useful aid for following purposes (Benefits of String Diagram):

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:

The therblig is 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 labor 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.

THE BASIC MOTION ELEMENTS/KINDS OF THERBLINGS:

A basic motion element is one of a Set of fundamental motions required for a worker to perform a manual operation or task. Therbligs are 18 kinds of elemental motions used in the study of motion economy in the workplace each describing a standardized activity.

- 1) **Transport Empty** [unloaded] (TE): Receiving an object with an empty hand. (Now called "Reach")
- 2) **Grasp** (G): Grasping an object with the active hand.
- 3) **Transport Loaded** (TL): Moving an object using a hand motion.
- 4) **Hold** (H): Holding an object.
- 5) **Release Load** (RL): Releasing control of an object.
- 6) **Preposition** (PP): Positioning and/or orienting an object for the next operation and relative to an approximation location.
- 7) **Position** (P): Positioning and/or orienting an object in the defined location.
- 8) **Use** (U): Manipulating a tool in the intended way during the course working.
- 9) **Assemble** (A): Joining two parts together.
- 10) **Disassemble** (DA): Separating multiple components that were joined.
- 11) **Search** (Sh): Attempting to find an object using the eyes and hands.
- 12) **Select** (St): Choosing among several objects in a group.
- 13) **Plan** (Pn): Deciding on a course of action.
- 14) **Inspect** (I): Determining the quality or the characteristics of an object using the eyes and/or other senses.
- 15) **Unavoidable Delay** (UD): Waiting due to factors beyond the worker's control and included in the work cycle.
- 16) **Avoidable Delay** (AD): Waiting within the worker's control which causes idleness that is not included in the regular work cycle.

- 17) **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.
- 18) **Find (F):** A momentary mental reaction at the end of the Search cycle. Seldom used.



PROBLEMS

1) Assuming that the total observed time for an operation of assembling an electric switch is 1.00 min. If the rating is 120%, find normal time. If an allowance of 10% is allowed for the operation, determine the standard time.

Solution:

 **Given data:**

Observed time (or) Selected Time = 1.00 Min
 Rating = 120%
 Allowance = 10%

To Find: Standard Time?

We Know:

Standard Time = Normal Time + Allowances

As we know that Normal Time =
 =
 Allowance @10% =
 =
 Standard Time = Normal Time + Allowances
 = 1.20 + 0.12 = 1.32 min

2) An operator manufactures 50 jobs in 6 hours and 30 minutes. If this time includes the time for Setting his machine. Calculate the operator's efficiency, Standard time allowed for the job was:

Setting Time = 35 min.
 Production time per piece = 8 min

Solution:

Given data:

Set up time = 35 min
 Time Taken per Piece = 8 min
 No. of pieces produced = 50
 Actual time taken by operator for manufacturing of 50 pieces = 6 hours and 30 minutes = 390 min

To Find: Efficiency of Operator?

As we know that

Standard Time = Set up time + Time per piece \times No. of Pieces produced.

\therefore Standard Time for manufacturing 50 jobs = $35 + 8 \times 50$

= 435 min = 7 Hours and 15 min.



= 111.5 %

\therefore Efficiency of operator = 111.5%

3) Following data were obtained by a work study Man from a study conducted by hours.

i Maintenance time

- a) Get out and put away tools = 12.0 min/day
- b) Cleaning of machine = 5.0 min/day
- c) Oiling of machine = 5.0 min/day
- d) Replenish coolant supply = 3.0 min/day

ii Interruption

- a) Interruption of foreman = 5.0 min/day
- b) Interruption of porter etc. = 4.0 min/day

iii. Delay time due to power failure etc. = 6.0 min/day

iv. Personal Time = 20.0 min/day

Calculate total allowances, total available cycle time & production hours, considering a working day of 8 hours.

Solution:

Given Data:

i. Maintenance time

- a) Get out and put away tools = 12.0 min/day
- b) Cleaning of machine = 5.0 min/day
- c) Oiling of machine = 5.0 min/day
- d) Replenish coolant supply = 3.0 min/day

ii. Interruption

a) Interruption of foreman = 5.0 min/day

b) Interruption of porter etc. = 4.0 min/day

iii. Delay time due to power failure etc. = 6.0 min/day

iv. Personal Time = 20.0 min/day



v. Total working day = 8 hours (480 min.)

To Find:

1. Total Allowances?
2. Total Available Cycle Time?
3. Production Hours?

We Know that:

1. Total Allowances (Sometimes also Known as station time) = Total Maintenance time + Interruption Time + Delay time + Personal Time
2. Total Available Cycle Time = Total work period – Total Allowances
3. Productive Hours = Time available/ No. of Hours

Now

$$\begin{aligned}
 1. \text{ Total Allowances} &= \text{Total Maintenance time} + \text{Interruption Time} + \text{Delay time} + \text{Personal Time} \\
 &= (12.0 + 5 + 5 + 3.0) + (5.0 + 4.0) + 6.0 + 20.0 \\
 &= 25.0 + 9.0 + 6.0 + 20.0
 \end{aligned}$$

$$\therefore \text{Total Allowances} = \mathbf{60.0 \text{ min per day.}}$$

$$\begin{aligned}
 2. \text{ Total Available Cycle Time} &= \text{Total work period} - \text{Total Allowances} \\
 &= 480 - 60
 \end{aligned}$$

$$\therefore \text{Total Available Cycle Time} = \mathbf{420 \text{ min/day.}}$$

$$\begin{aligned}
 3. \text{ Productive Hours} &= \text{Time available/ No. of Hours.} \\
 &= 420/8
 \end{aligned}$$

$$\therefore \text{Productive Hours} = \mathbf{52.5 \text{ min}}$$

4) Find out the standard time using the following data:

Average time for machine elements = 6 min

Average time for manual elements = 4 min

Performance rating = 110%

Allowances = 10%

Solution:

Given data:

Average time for machine elements = 6 min

Average time for manual elements = 4 min



Performance rating = 110%

Allowances = 10%

To Find: Standard Time?

We Know:

Standard Time = Normal Time + Allowances

As we know that Normal Time

$$\begin{aligned} &= \boxed{\text{[redacted]}} \\ &= \boxed{\text{[redacted]}} \\ &= \boxed{\text{[redacted]}} \\ &= \boxed{\text{[redacted]}} \end{aligned}$$

Standard Time

$$\begin{aligned} &= \text{Normal Time} + \text{Allowances} \\ &= 10.4 (1 + 0.1) = 11.44 \text{ min} \end{aligned}$$

INDUSTRIAL ENGINEERING AND MANAGEMENT

IMPORTANT QUESTIONS IN UNIT – IILFROM PREVIOUS QUESTION PAPERS

1. Define ergonomics. Differentiate between static and dynamic ergonomics. Describe the ergonomic considerations in design of any system. [15M] April – 2015 Set 1
2. Define operations management. Explain the nature and scope of operations management. [8M] May/June – 2015 Set 1
3. Define the term work study and state its objectives. [7M] May/June – 2015 Set 1
4. Define production. Discuss the different types of production. [8M] May/June – 2015 Set 2
5. What are the objectives of time study and how is it organized? [7M] May/June – 2015 Set 2
6. What is PMTS? What are the different types of PMTS and explain them? [7M] May/June – 2015 Set 3
7. Explain the procedure, advantages and disadvantages of work sampling. [8M] May/June – 2015 Set 3
8. Define Ergonomics? Discuss the principles of ergonomics of posture and movement? [7M] May/June – 2015 Set 4
9. Define string diagram? How it is constructed? List out the advantages and disadvantages of string diagrams? [8M] May/June – 2015 Set 4
10. Discuss the steps involved in work study. [7M] Dec – 2015 Set 1
11. What are Therbligs? Explain their importance. Give their name, explanation, abbreviation and symbol.
Explain the factors governing the location of a plant. [8M] Dec – 2015 Set 1
12. Explain the term PMTS. [4M] April – 2016 Set 1
13. State the differences between method study and work measurement with their objectives. [8M] April – 2016 Set 1
14. Explain the need and procedure for conducting work sampling study. [8M] April – 2016 Set 1
15. Explain the importance of Ergonomics. [4M] April – 2016 Set 2
16. Explain the steps followed in method study of job process. [8M] April – 2016 Set 2
17. What is process Chart? Explain different types of process chart with relevant sketches. [8M] April – 2016 Set 2
18. Explain MTM. [4M] April – 2016 Set 3
19. What is time study? Describe the steps involved in time study. [8M] April – 2016 Set 3
20. Explain how a high productive design of a work place layout can be made with the concept of Ergonomics motion economy. [8M] April – 2016 Set 3
21. What is Therbligs? [4M] April – 2016 Set 4
22. Explain how micro–motion study is performed. [8M] April – 2016 Set 4

INDUSTRIAL ENGINEERING AND MANAGEMENT

23. Describe briefly the different technique of rating used in connection with work study of an operator's performance in a labor intensive industry. [8M] April – 2016 Set 4
24. What are the advantages of method study? [8M] Nov/Dec – 2016 Set 1
25. Explain the methodology of MTM. [7M] Nov/Dec – 2016 Set 1
26. What is work sampling and describe when it is used. [4M] Nov/Dec – 2016 Set 1
27. What are the techniques of work study and explain its significance. [8M] Nov/Dec – 2016 Set 1
28. What are the tools for recording information about method study? [8M] Nov/Dec – 2016 Set 1
29. What do you understand by 'work measurement' and elaborate the important techniques involved in work measurement? [8M] April – 2017 Set 1
30. What are the benefits of time study? [7M] April – 2017 Set 1
31. With neat sketch briefly explain string diagram. [4M] April – 2017 Set 1
32. Name the various recording techniques used in method study. Give the various symbols used in recording techniques with their meaning. [8M] April – 2017 Set 1
33. Explain the objectives of time study. [8M] April – 2017 Set 1
34. What is micro motion study? Explain. [3M] April – 2017 Set 2
35. Explain the utility of outline process chart in method study. Differentiate between outline process chary and flow process chart. [8M] April – 2017 Set 2
36. Explain the construction of a string diagram with neat sketch. [8M] April – 2017 Set 2
37. What do you understand from work sampling? Explain briefly. [4M] April – 2017 Set 3
38. What is a flow process chart? Discuss its utility for method study engineer. [8M] April – 2017 Set 3
39. Explain the objectives of micro–motion study. [8M] April – 2017 Set 3
40. What are the applications of operations management? [4M] April – 2017 Set 4
41. State and explain in brief the steps involved in method study procedure. [8M] April – 2017 Set 4
42. "Critical examination is a motive force to develop a new method". Justify. [8M] April – 2017 Set 4
43. Define operations management. Explain the nature and scope of operations management. [8M] Nov – 2017 Set 1
44. Explain the construction of a string diagram with neat sketch. [7M] Nov – 2017 Set 1
45. State the objectives of work measurement. [3M] Nov – 2017 Set 1
46. What are Therblings? List various Therblings and their use in method study. [10M] Nov – 2017 Set 1
47. Stop watch time study of an element is done on an operation, the readings were observed as follows
- 0.52 0.51 0.52 0.52 0.51 0.50 0.50 0.52
- The average rating factor for the operator is 120%. Find out the Standard time, assuming allowances 20%. [6M] Nov – 2017 Set 1

INDUSTRIAL ENGINEERING AND MANAGEMENT

48. Define work study. What are the advantages of work study? [4M] April – 2018 Set 1
49. What are flow process charts? Give their importance. [8M] April – 2018 Set 1
50. What do you understand by work measurement and elaborate the important techniques involved in work measurement? [8M] April – 2018 Set 1
51. What is method study technique? Explain its significance. [4M] April – 2018 Set 2
52. Explain in detail about travel chart? [8M] April – 2018 Set 2
53. What is PMTS? What are the different types of PMTS? Discuss the procedure involved in PMTS. [8M] April – 2018 Set 2
54. Discuss in detail about Therbligs. [4M] April – 2018 Set 3
55. What is performance rating? Explain various methods of rating. [8M] April – 2018 Set 3
56. Explain about “SIMO” chart and state its applications. [8M] April – 2018 Set 3
57. How do you estimate time by MTM method? Explain. [4M] April – 2018 Set 4
58. Discuss in detail about work factor system? [6M] April – 2018 Set 4
59. Write in detail about the applications and objectives of operations management? [10M] April – 2018 Set 4
60. Define work study. [2M] Nov – 2018 Set 1
61. Discuss the various types of production. [7M] Nov – 2018 Set 1
62. What do you understand by work measurement and elaborate the important techniques involved in work measurement? [7M] Nov – 2018 Set 1