BALAJI INSTITUTE OF I.T AND MANAGEMENT KADAPA

OPERATIONS MANAGEMENT (17E00206)

ICET CODE: BIMK

1st Internal Exam Syllabus

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Name of the Faculty: Dr. G. SARIKA

Units covered : **1 to 2.5 Units (1st Internal Syllabus)**

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SYLLABUS

(17E00206) OPERATIONS MANAGEMENT

The objective of the course is to enable students to understand the production Planning and Controlling aspects of a typical production and operations organization. Study understands the concepts of work study and Quality management.

1. Introduction: Overview of production and Operations Management(POM) Function, Historical Development of POM, POM scenario Today, product and process Design Product and Process Development, Manufacturing Process Technology, CAD/CAM analysis

2. **Facilities Management & Aggregate Planning:** Location of Facilities, Layout of Facilities, Optimization of Product/ Process Layout, Flexible Manufacturing and Group Technology: Aggregate Planning – Preparation of Aggregate Demand Forecast, specification of Organizational Policies For Something, Capacity Utilization, Determination of feasible Production Alternatives.

3. **Scheduling:** Scheduling In Job, Shop Type Production, Shop- Loading, Assignment and Sequencing, Scheduling In Mass, Line of Balance, Methods Production Control, World Class Production.

4. **Work Study and Quality Management:** Method Study, Work Measurement, Work Design, Job Design, Work Sampling, Industrial Engineering Techniques. Economics of Quality Assurance Inspection and Quality Control, Acceptance Sampling, Theory of Control Charts, Control Charts for Variables and Control Charts for attributes.

5. **Materials Management:** Introduction, Objectives, Importance of Materials management - Issues in Materials Management - Functions - Activities - Selection of Materials - Advantages of Materials Management.

Text Books:

Production and Operations Management, Aswathappa K - Himalaya Publishing House

"Production and Operations Management" - Dr. K.Sai Kumar, Kalyani Publishers

References:

- Operations Management and Control, Biswajit Banarjee - S.Chand
- Production and Operations Management - Dr.K.C.Arora, 2nd Edition - University Science Press Production and Operations Management, R.Panneerselvam: PHI Learning Private Ltd.
- Production Management, Martand T Telsang - S Chand
- Modern Production/Operations Management, Elwood S.Buffa and Rakesh K Sarin, Wiley ...
- Production and Operations Management, SN Chary, Tata McGraw Hill, New Delhi
- Operations Management, Mahadevan, Pearson Education, New Delhi
- Production and Operations Management - Text and Cases, Upendra Kachru, Excel Books

UNIT - 1
INTRODUCTION

1.1. OVERVIEW OF PRODUCTION & OPERATIONS MANAGEMENT (POM) FUNCTION

Production/Operation management is the process which combines and transforms various resources used in the production/operation subsystem of the organization into value added products/services in a controlled manner as per the policies of the organization.

The set of interrelated management activities which are involved in manufacturing certain products is called **Production Management** and for service management, then corresponding set of management activities is called as **Operation Management.**

Production Management can be defined as the management of the conversion process, which converts land, labor, capital, and management inputs into desired outputs of goods and services. It is also concerned with the design and the operation of systems for manufacture, transport, supply or service

A production system is a collection of people, equipment, and procedures organized to perform the manufacturing operations of a company (or other organization)

Operation Management-Operation Management is in charge of managing the conversion process. This unit handles the day-to-day running of the business to ensure operations within the organization are carried out smoothly. It is also in charge of production administration, manufacturing and other processes like the rendering of services.

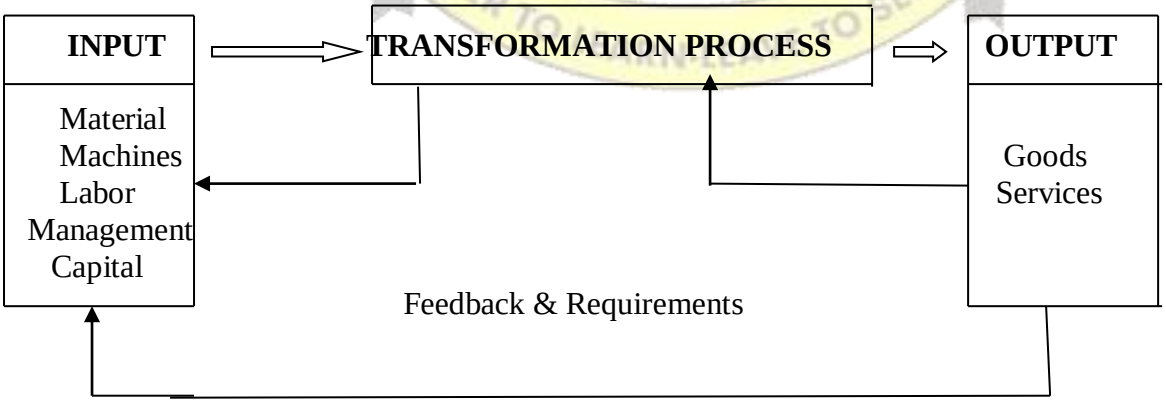

Fig:1.1.Transformation process

DIFFERENCE BETWEEN OPERATIONS AND PRODUCTION

In the transformation process, the inputs change the form into an output, by adding value to the entity. The output may be a product or service.

If it is a product centric that is known as **production**,
If it is a service centric then that is known as **operation**

Examples: (Products/goods)

Boiler with a specific capacity,

Constructing flats,

Car, bus, radio & television.

Examples: (Services)

Medical facilities,

Travel booking services.

In the process of managing various subsystems of the organization executives at different levels of the organization need to track several management decisions. The management decisions are Strategic, tactical and operational.

PRODUCTIVITY

Productivity is a relationship between the output (product/service) and input (resources consumed in providing them) of a business system. The ratio of aggregate output to the aggregate input is called productivity.

Productivity = Output/Input

For survival of any organization, this productivity ratio must be at least 1.If it is more than 1, the organization is in a comfortable position. The ratio of output produced to the input resources utilized in the production.

Strategic (Top level)	**Tactical (Middle level)**	**Operational (Bottom level)**
↓	↓	↓
Defining goals	Plant location	effective and efficient utilization
Making policies	new product establishment	of resources
	Monitoring of budgets	

AIM OF PRODUCTION: The aim of a production system is to provide goods and services for mankind

- **In right quantities**
- **At the appropriate place**
- **At the desired time**
- **With the required quantity**
- **At a reasonable cost**

Functions or departments in business „

Three primary functions:

Production: without production, no products or services could be produced.
Marketing: without marketing, no products or services could be sold.
Finance: without finance, financial failure would surly result.

FUNCTIONS OF PRODUCTION MANAGEMENT

The role of Production Management is quite elaborate. But the sole aim is to ensure the business produces quality products that can satisfy the needs of customers on a regular basis. Below are the functions of production management.

- **Production Control –** Here the manager supervises and directs the production process. He or she also must find out and ensure the right production plan is followed during the production process. If there are deviations, the production manager has to take the right steps to correct them.

- **Scheduling –** This function is critical in every organization. It has to do with planning when the actual production would begin and ends.

- **Cost and Quality Control –** Every company knows how essential quality control and price are. Customers are not just looking for the best products. But they also want to have them at the lowest possible price. Quality control is an essential duty the production manager has to perform. It entails multiple checks performed on the product to ensure quality is intact.

- **Maintenance of Machines** – Production management also entails making sure that instruments used are in good working condition. And that means replacing the ones that are underper forming or changing damaged parts to enable the machine to function optimally.

1.2. HISTORICAL SUMMARY OF OPERATIONS MANAGEMENT

Date	*Contribution*	*Contributor*
1776	Specialization of labour in manufacturing	Adam Smith
1799	Interchangeable parts, cost accounting	Eli Whitney and others
1832	Division of labour by skill; assignment of jobs by skill; basics of time study	Charles Babbage
1900	Scientific management time study and work study developed; dividing planning and doing of work	Frederick W. Taylor
1900	Motion of study of jobs	Frank B. Gilbreth
1901	Scheduling techniques for employees, machines jobs in manufacturing	Henry L. Gantt
1915	Economic lot sizes for inventory control	F.W. Harris
1927	Human relations; the Hawthorne studies	Elton Mayo
1931	Statistical inference applied to product quality: quality control charts	W.A. Shewart
1935	Statistical sampling applied to quality control: inspection sampling plans	H.F. Dodge & H.G. Roming
1940	Operations research applications in World War II	P.M. Blacker and others.
1946	Digital computer	John Mauchlly and J.P. Eckert
1947	Linear programming	G.B. Dantzig, Williams & others
1950	Mathematical programming, on-linear and stochastic processes	A. Charnes, W.W. Cooper & others
1951	Commercial digital computer: large-scale computations available.	Sperry Univac
1960	Organizational behaviour: continued study of people at work	L. Cummings, L. Porter
1970	Integrating operations into overall strategy and policy, Computer applications to manufacturing, Scheduling and control, Material requirement planning (MRP)	W. Skinner J. Orlicky and G. Wright
1980	Quality and productivity applications from Japan: robotics, CAD-CAM	W.E. Deming and J. Juran.

THE HISTORICAL EVOLUTION OF PRODUCTION/OPERATIONS MANAGEMENT

Even though systems of production have existed since ancient times (*for example*, the great wall of China and Egyptian pyramids were built long time ago) the production of goods for sale and the modern factory system had their roots in the Industrial Revolution (which began in the 1770's in England and spread to other countries in Europe and later to the US in 19th century).

However, the substitution of machine power to human power started with the most significant invention of steam engine by James Watt in 1764. followed by invention of spinning jenny (1770) and powerloom (1785). Adam Smith advocated the concept of "division of labour" in his book "The Wealth of Nations" in 1776 and in 1832, Charles Babbage recommended the use of scientific methods for analysing production problems.

However, the era of scientific management started with the work of F.W. Taylor in 1878 who studied work methods in great detail to identify the best methods for doing each job. Taylor's book "The Principles of Scientific Management" published in 1911, laid the foundation for the field of production management.

A number of other pioneers also contributed to this movement including the following :

Frank Gilbreth and his wife Lillian Gilbreth were recognised for their contribution to the development of the "Principles of motion economy" and the concept of "Therbligs" in 1911.

Henry Gantt recognised the value of non-monetary rewards to motivate workers and developed widely used system of scheduling (machine loading) called "Gantt chart" in 1912, Harrington Emerson applied Taylor's ideas to develop organisational structure and encouraged the use of experts to improve organizational efficiency.

Henry Ford developed the concept of mass production and assembly lines with conveyors in 1913, in his automobile plant. Ford also used the concepts of "**interchangeable parts**" and **division of labour** (of Adam Smith) which enabled him to tremendously increase the production rate in his factories.

F.W. Harris developed the concept of "Economic Order Quantity" in 1915 which is still recognised as a classical work in inventory control systems. In 1931, Dodge and Romig and W. Shewhart developed the concept of sampling inspection and use of statistical tables for acceptance sampling plans. Earlier in 1924, Shewhart developed the concept of statistical quality control and use of control charts to control the quality of on-going processes. The "human relations movement" was started by Elton Mayo in 1930's, through his famous experiments at Western Electric's Hawthorne plant and his findings

came to be known as "Hawthorne effect". His studies revealed that in addition to physical and technical aspects of work, worker motivation is critical for improving productivity. During the 1940's, Abraham Maslow developed motivational theory known as "Hierarchy of Needs Theory" which was later refined by Frederick Herzberg as "Motivation-Hygiene" theory in 1950s. Douglas McGregor added "Theory X" and "Theory Y" in 1960. In 1970, William Ouchi added "Theory Z" which combined the Japanese approach and the traditional Western approach to management. After World War II, operations research and quantitative techniques were applied to production management resulting in decision models for forecasting, inventory management, project management and other areas of production management. Widespread use of personal computers and user-friendly softwares have popularised application of these quantitative techniques in production management since the 1980's. Development in Management Information Systems (MIS) and Decision Support Systems (DSS) provided a further boost to the developments in production management. Advanced manufacturing technology enabled production managers to use Computer-Aided-Design (CAD), Computer-Aided-Manufacturing (CAM), Computer Numerically Controlled (CNC) machines, Robots, Computer Integrated Manufacturing (CIM), Flexible Manufacturing System (FMS), etc., in the field of production management. Moreover, a number of Japanese manufacturers have developed modern management practices that have increased the productivity of their operations and the quality of their products. The new approaches in production management emphasize quality (Total Quality Management) and continuous improvement (Kaizen), worker teams and empowerment to achieve customer satisfaction. The Japanese have spawned the "quality revolution" and adopted Just-In-Time (JIT) production system to put themselves in the forefront of time based competition.

Production management becomes the acceptable term from 1930s to 1950s. As F.W. Taylor's works become more widely known, managers developed techniques that focused on economic efficiency in manufacturing. Workers were studied in great detail to eliminate wasteful efforts and achieve greater efficiency. At the same time, psychologists, socialists and other social scientists began to study people and human behavior in the working environment. In addition, economists, mathematicians, and computer socialists contributed newer, more sophisticated analytical approaches.

With the 1970s emerge two distinct changes in our views. The most obvious of these, reflected in the new name **operations management** was a shift in the service and manufacturing sectors of the economy. As service sector became more prominent, the change from 'production' to 'operations' emphasized the broadening of our field to service organizations. The second, more suitable change was the beginning of an emphasis on synthesis, rather than just analysis, in management practices.

1.3. POM SCENARIO TODAY

TECHNOLOGY BASED

1. Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Integrated Manufacturing Systems (CIMS**):**

   CAD refers to design of products, processes or systems with the help of computers.

   a. Speed of evaluation of alternative designs,
   b. Minimization of risk of functioning, and
   c. Error reduction.

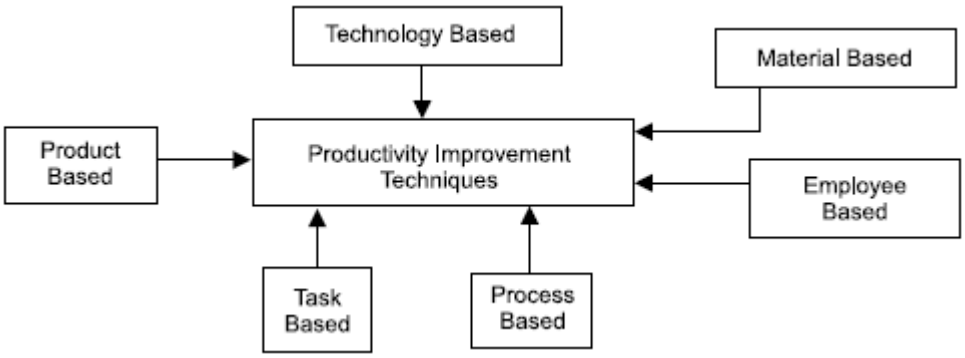

Fig: 1.2. Production process

   CAM is very much useful to design and control the manufacturing. It helps to achieve the effectiveness in production system by line balancing.

   d. Production Planning and Control
   e. Capacity Requirements Planning (CRP), Manufacturing Resources Planning (MRP II) and Materials Requirement Planning (MRP)
   f. Automated Inspection.

2. **COMPUTER INTEGRATED MANUFACTURING:**

   Computer integrated manufacturing is characterized by automatic line balancing, machine loading (scheduling and sequencing), automatic inventory control and inspection.

   Robotics
   Laser technology
   Modern maintenance techniques
   Energy technology
   Flexible Manufacturing System (FMS)

EMPLOYEE BASED

- Financial and non-financial incentives at individual and group level.
- Employee promotion.
- Job design, job enlargement, job enrichment and job rotation.
- Worker participation in decision-making
- Quality Circles (QC), Small Group Activities (SGA)
- Personal development.

ATERAL BASED

- Material planning and control
- Purchasing, logistics
- Material storage and retrieval
- Source selection and procurement of quality material
- Waste elimination.

PROCESS BASED

- Methods engineering and work simplification
- Job design evaluation, job safety
- Human factors engineering.

PRODUCT BASED

- Value analysis and value engineering
- Product diversification
- Standardization and simplification
- Reliability engineering
- Product mix and promotion.

B.

TASK BASED

- Management style
- Communication in the organization
- Work culture
- Motivation
- Promotion group activity.

PROCESS-FOCUSED AND PRODUCT-FOCUSED SYSTEM:

In process-focused system the arrangement of facilities is made according to the process layout and in product-focused system the arrangement of facilities is made according to the product layout.

COMPARISON OF PROCESS ORIENTED LAYOUT AND PRODUCT ORIENTED LAYOUT.

S l No	Different Aspects	Process oriented	Product oriented
1	Product	Diversified products using operations, varying rate of output or small batches of many different products	Standardized product, large volume, stable rate of output
2	Workflow	Variable flow depending on nature of job	Identical flow and same sequence of operations for each unit.
3	Human skills	Semiskilled craftsman and able to do various/different categories of work	Highly specialized and able to perform repetitive tasks at fixed place

4	Supporting staffs	Less; scheduling, material handling, production and inventory control	Large; schedule materials and people, monitor and maintain works
5	Material handling	Material handling cost high, handling sometimes duplicated	Less dectble , flow systematized and often automated.
6	Inventory	In process inventory less	In process inventory high
7	Space utilization	Space and capital are tied up by work in process	Less space is occupied by work in transit and for temporary storage.
8	Capital requirement	Comparatively low investment in machines required	Large investment in specialized equipment and processes
9	Production cost	Relatively low fixed cost, high variable cost(for direct labor, material and material handling)	Relatively high fixed cost, low variable cost (for labor and materials)
10	Production time	Through time is larger.	Throughput time is lesser.
11	Flexibility of design change	high	low
12	Effect of breakdown	Break down of any machine doesn't effect much on the final output	Seriously affected; as all are interrelated system

1.4. PRODUCT AND PROCESS DESIGN

PRODUCT DESIGN

Product design is the process of deciding on the unique characteristics and features of the company's product. Process selection is the development of the process necessary to produce the designed product. Product design and process selection are typically made together. Product design must support product manufacturability (the ease with which a product can be made). Product design defines a product's characteristics of

- ✓ Appearance,
- ✓ Materials,
- ✓ Dimensions,
- ✓ Tolerances, And
- ✓ Performance Standards

Service design is unique in that the service and entire service concept are being designed. When a service is designed, the designer must define both the service and service concept

1.5. PRODUCT AND PRODUCT DEVELOPMENT

Economic analysis can only capture those factors that are measurable and have both positive and negative implications that are difficult to quantify. Economic analysis is useful in at least two different circumstances using the following measurable factors to help determine:
Operational design and development decisions – should we outsource to save time? Should we launch the product in four months at a unit cost of 10000 INR or wait for six months, when we can reduce to 8500 INR? -go milestones –should we try to develop a product to address market opportunity? Should we proceed? Should we launch?

If initial feasibility studies are favourable, engineers prepare an initial prototype design. This prototype design should exhibit the basic form, fit and function of the final product, but it will not necessarily be identical to the production model.

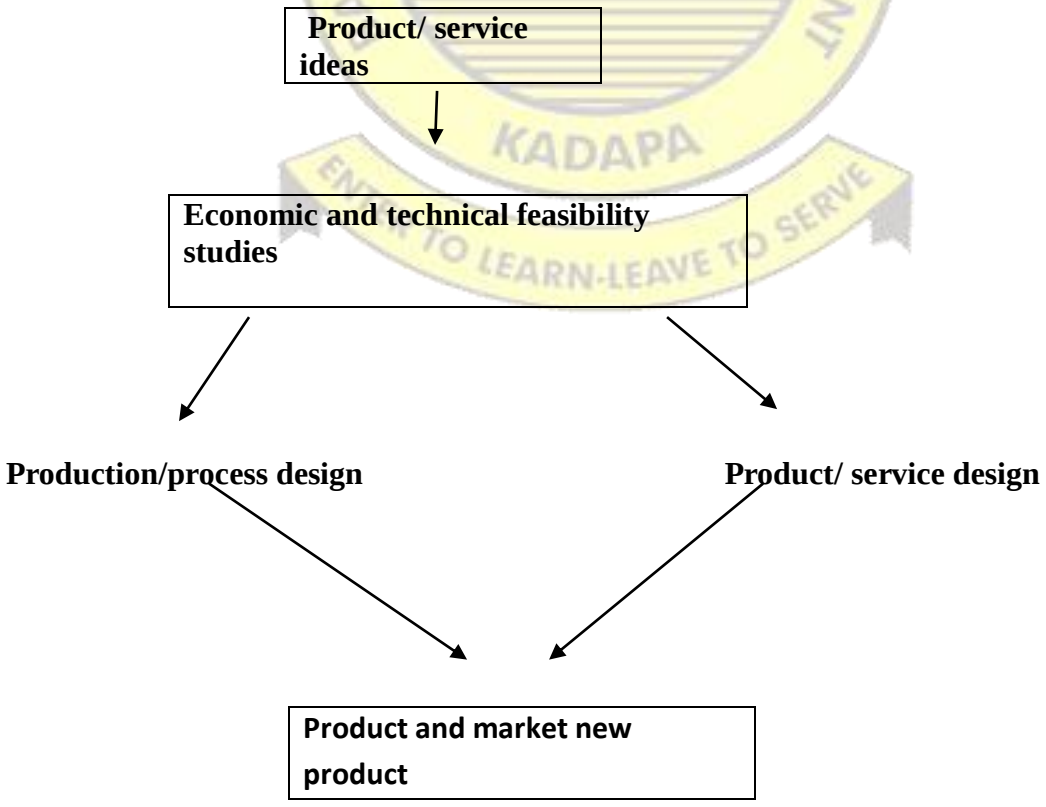

Fig:1.3. Product Development Process

1.6. MANUFACTURING PROCESS TECHNOLOGY

Overcoming the challenges of making company-wide manufacturing operations more customer driven needs to start with a clear definition of what success looks like.

- Having accurate, real-time production visibility improves product quality, order accuracy and customer satisfaction while driving down manufacturing costs at the plant level.
- Keeping manufacturing operations across all locations focused on a common set of goals improves gross margins, reducing the total cost per unit while improving on-time order delivery and perfect order performance.
- The era of Manufacturing Intelligence has arrived, fueled by data from Manufacturing Execution Systems (MES), with manufacturing operations management strategies accelerating adoption company-wide.
- Improving product quality, reducing cycle times, automating manual workflows and streamlining plant floor operations are a few of the many benefits of adopting a company-wide manufacturing operations management strategy.

Production and operations management involve three main types of decisions, typically made at **three different stages:**

1. **Production planning-.** The first decisions facing operations managers come at the planning stage. At this stage, managers decide where, when, and how production will occur. They determine site locations and obtain the necessary resources.
2. **Production control**. -At this stage, the decision-making process focuses on controlling quality and costs, scheduling, and the actual day-to-day operations of running a factory or service facility.
3. **Improving production and operations**.- The final stage of operations management focuses on developing more efficient methods of producing the firm's goods or services.

1.7. CAD/CAM ANALYSIS

CAD (Computer Aided Design) system generate accurately, scaled mathematical models based on user input. Individual models are then integrated as components of an assembly to create the final product

through which exact fit of the parts can be checked. Fully furnished 3D models of parts and whole assemblies for designs can be build using 3-Dimensional CAD software. Even the created designs can be examined virtually from any angle before manufacturing the product.

Computer + Designing software =CAD

Advantages of CAD

- Minimizes the requirement for huge numbers of an expensive draftsman in designing of a product.
- It can be used directly in order to generate cutting data for CNC machines.
- Scaling, re-scaling modification in drawings and models is easier and automatic and accurate.
- Storage and retrieval of models is easier.
- Design data can be shared in computerized manufacturing management systems.
- Precise 3D models can be examined before making expensive materials.
- It increases the speed of production and requires less labour.
- Multiple copies can be stored, printed and shared electronically, which eliminates the need for storing large paper drawings.

Disadvantages of CAD

- Power cuts and viruses can be problematic for the computerized system.
- Industrial versions of the software could be very expensive to buy especially for the startup costs.
- Traditional drafting skills will be lost as they become unnecessary.
- Expensive training would be required to use the software, which can be time-consuming and costly.

CAM (Computer Aided Manufacturing) is evolving as a central element in many productions. It includes a broad range of process to be carried out automatically such as cutting, turning, milling, routing, heat cutting, engraving and even printing of solid materials. After designing and analyzing a product, it is manufactured where computers are involved in manufacturing like to checking whether the product can be made or made by which process, and how much time it is going take.

Manufacturing Tools + Computer = CAM

Advantages of CAM

- Manufacturing requires minimum supervision and can be accomplished during unsocial work hours.
- Manufacture is less labour intensive and saves labour cost.
- Machines are accurate, and manufacturing can be repeated consistently with large batches.
- Error occurrence is negligible, and machines can run continuously.
- Prototype models can be prepared very speedily for elaborated inspection before finalising designs for manufacture.
- Virtual machining can be used to evaluate machining routines and outcomes on the screen.

Disadvantages of CAM

- It requires high initial investment and start-up cost.
- Machine maintenance is also costly.
- May result in loss of a workforce with high-level manual skill.
- To assure proper tooling and set up procedures it needs highly trained operatives and technicians.

UNIT-1

IMPORTANT PREVIOUS QUESTIONS:

1. Explain about process and product design.
2 Briefly describe about CAD/CAM analysis.
3. Define 'production system'. What are the inputs of production system?
4. Explain historical development of POM & trends of POM today.
5. Explain the process of product design used in production and operations management.
6. What are the functions of POM?

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UNIT-2

FACILITIES MANAGEMENT & AGGREGATE PLANNING

2.1. LOCATION OF FACILITY

If the organization can configure the right location for the manufacturing facility, it will have sufficient access to the customers, workers, transportation, etc. For commercial success, and competitive advantage following are the critical factors:

Customer Proximity: Facility locations are selected closer to the customer as to reduce transportation cost and decrease time in reaching the customer.

Business Area: Presence of other similar manufacturing units around makes business area conducive for facility establishment.

Availability of Skill Labor: Education, experience and skill of available labor are another important, which determines facility location.

Free Trade Zone/Agreement: Free-trade zones promote the establishment of manufacturing facility by providing incentives in custom duties and levies. On another hand free trade agreement is among countries providing an incentive to establish business, in particular, country.

Suppliers: Continuous and quality supply of the raw materials is another critical factor in determining the location of manufacturing facility.

Environmental Policy: In current globalized world pollution, control is very important, therefore understanding of environmental policy for the facility location is another critical factor.

2.2. LAYOUT OF FACILITY

A model facility layout should be able to provide an ideal relationship between raw material, equipment, manpower and final product at minimal cost under safe and comfortable environment. An efficient and effective facility layout can cover following objectives:

- To provide optimum space to organize equipment and facilitate movement of goods and to create safe and comfortable work environment.
- To promote order in production towards a single objective
- To reduce movement of workers, raw material and equipment
- To promote safety of plant as well as its workers
- To facilitate extension or change in the layout to accommodate new product line or technology upgradation
- To increase production capacity of the organization

An organization can achieve the above-mentioned objective by ensuring the following:

- Better training of the workers and supervisors.
- Creating awareness about of health hazard and safety standards
- Optimum utilization of workforce and equipment
- Encouraging empowerment and reducing administrative and other indirect work

FACTORS AFFECTING FACILITY LAYOUT

Facility layout designing and implementation is influenced by various factors. These factors vary from industry to industry but influence facility layout. These factors are as follows:

- The design of the facility layout should consider overall objectives set by the organization.
- Optimum space needs to be allocated for process and technology.
- A proper safety measure as to avoid mishaps.
- Overall management policies and future direction of the organization

DESIGN OF FACILITY LAYOUT

Principles which drive design of the facility layout need to take into the consideration objective of facility layout, factors influencing facility layout and constraints of facility layout. These principles are as follows:

- **Flexibility:** Facility layout should provide flexibility for expansion or modification.
- **Space Utilization:** Optimum space utilization reduces the time in material and people movement and promotes safety.
- **Capital:** Capital investment should be minimal when finalizing different models of facility layout.

DESIGN LAYOUT TECHNIQUES

There are three techniques of design layout, and they are as follows:

1. **Two or Three Dimensional Templates:** This technique utilizes development of a scaled-down model based on approved drawings.
2. **Sequence Analysis:** This technique utilizes computer technology in designing the facility layout by sequencing out all activities and then arranging them in circular or in a straight line.
3. **Line Balancing:** This kind of technique is used for assembly line.

TYPES OF FACILITY LAYOUT

There are six types of facility layout, and they are as follows:

- Line Layout
- Functional Layout
- Fixed Position Layout
- Cellular Technology Layout
- Combined Layout, and
- Computerized Relative Allocation of Facility Technique

Process layout design determines the best relative locations of functional work centers. Work centers that interact frequently, with movement of material or people, should be located close together, whereas those that have little interaction can be spatially separated. One approach of designing an efficient functional layout is described below.

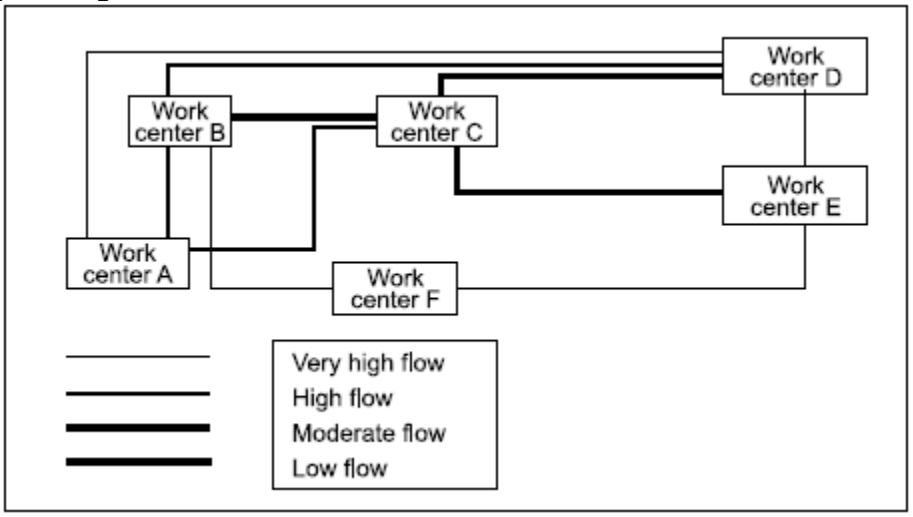
1. List and describe each functional work centre.
2. Obtain a drawing and description of the facility being designed.
3. Identify and estimate the amount of material and personnel flow among work centers
4. Use structured analytical methods to obtain a good general layout.
5. Evaluate and modify the layout, incorporating details such as machine orientation, storage area location, and equipment access.

The first step in the layout process is to identify and describe each work centre. The description should include the primary function of the work centre; drilling, new accounts, or cashier; its major components, including equipment and number of personnel; and the space required. The description should also include any special access needs (such as access to running water or an elevator) or restrictions (it must be in a clean area or away from heat).

For a new facility, the spatial configuration of the work centers and the size and shape of the facility are determined simultaneously. Determining the locations of special structures and fixtures such as elevators, loading docks, and bathrooms becomes part of the layout process.

However, in many cases the facility and its characteristics are a given. In these situations, it is necessary to obtain a drawing of the facility being designed, including shape and dimensions, locations of fixed structures, and restrictions on activities, such as weight limits on certain parts of a floor or foundation.

Relationship flow diagram



2.3. OPTIMIZATION OF PRODUCT/PROCESS LAYOUT

Process layout is recommended for batch production. All machines performing similar type of operations are grouped at one location in the process layout *e.g.*, all lathes, milling machines, etc. are grouped in the shop will be clustered in like groups.

Thus, in process layout the arrangement of facilities are grouped together according to their functions. A typical process layout is shown in the following figure. The flow paths of material through the facilities from one functional area to another vary from product to product. Usually the paths are long and there will be possibility of backtracking.

Process layout is normally used when the production volume is not sufficient to justify a product layout. Typically, job shops employ process layouts due to the variety of products manufactured and their low production volumes.

Process layout

ADVANTAGES

1. In process layout machines are better utilized and fewer machines are required.
2. Flexibility of equipment and personnel is possible in process layout.
3. Lower investment on account of comparatively less number of machines and lower cost of general purpose machines.
4. Higher utilization of production facilities.
5. A high degree of flexibility with regards to work distribution to machineries and workers.
6. The diversity of tasks and variety of job makes the job challenging and interesting.
7. Supervisors will become highly knowledgeable about the functions under their department.

LIMITATIONS

1. Backtracking and long movements may occur in the handling of materials thus, reducing material handling efficiency.
2. Material handling cannot be mechanized which adds to cost.

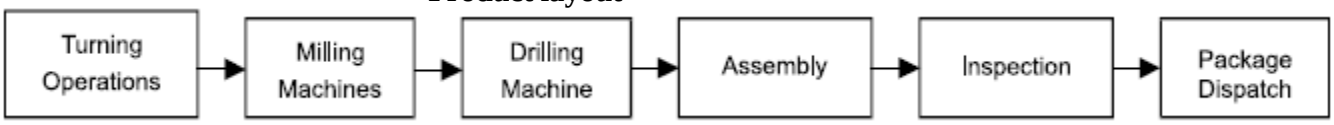
3. Process time is prolonged which reduce the inventory turnover and increases the in- process inventory.
4. Lowered productivity due to number of set-ups.
5. Throughput (time gap between in and out in the process) time is longer.
6. Space and capital are tied up by work-in-process.

PRODUCTLAYOUT:

In this type of layout, machines and auxiliary services are located according to the processing sequence of the product. If the volume of production of one or more products is large, the facilities can be arranged to achieve efficient flow of materials and lower cost per unit. Special purpose machines are used which perform the required function quickly and reliably.

The product layout is selected when the volume of production of a product is high such that a separate production line to manufacture it can be justified. In a strict product layout, machines are not shared by different products. Therefore, the production volume must be sufficient to achieve satisfactory utilization of the equipment.

Product layout



Advantages

1. The flow of product will be smooth and logical in flow lines.
2. In-process inventory is less.
3. Throughput time is less.
4. Minimum material handling cost.
5. Simplified production, planning and control systems are possible.
6. Less space is occupied by work transit and for temporary storage.
7. Reduced material handling cost due to mechanized handling systems and straight flow.
8. Perfect line balancing which eliminates bottlenecks and idle capacity.
9. Manufacturing cycle is short due to uninterrupted flow of materials.
10. Small amount of work-in-process inventory.
11. Unskilled workers can learn and manage the production.

LIMITATIONS

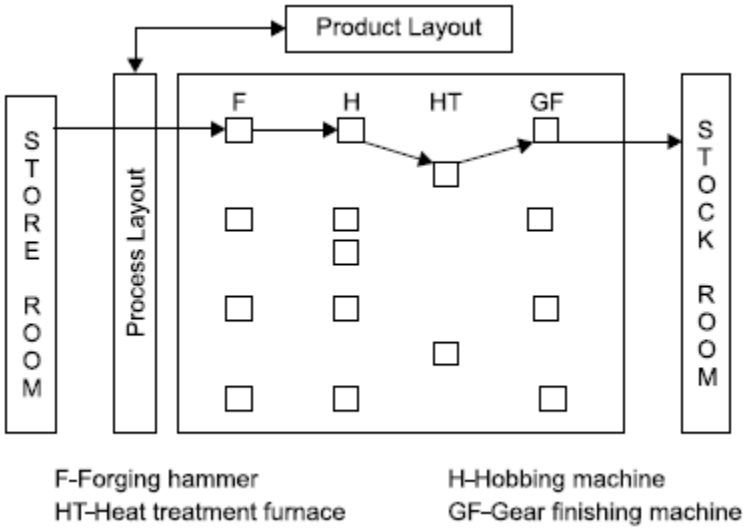
1. A breakdown of one machine in a product line may cause stoppages of machines in the downstream of the line.
2. A change in product design may require major alterations in the layout.
3. The line output is decided by the bottleneck machine.
4. Comparatively high investment in equipments is required.
5. Lack of flexibility. A change in product may require the facility modification.

COMBINATION LAYOUT ADVANTAGES AND DISADVANTAGES

COMBINATIONLAYOUT

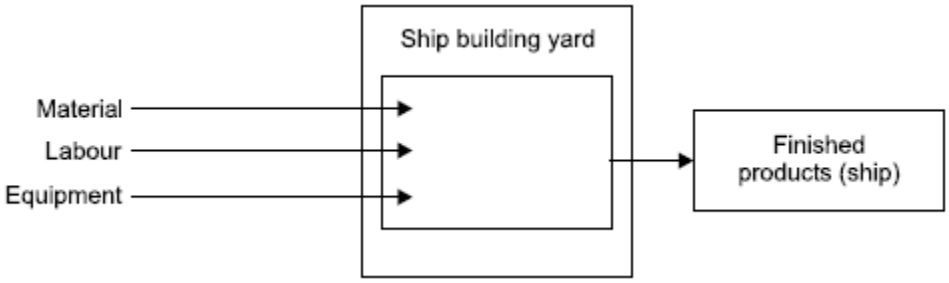
A combination of process and product layouts combines the advantages of both types of layouts. A combination layout is possible where an item is being made in different types and sizes. Here machinery is arranged in a process layout but the process grouping is then arranged in a sequence to manufacture various types and sizes of products. It is to be noted that the sequence of operations remains same with the variety of products and sizes. The following figure shows a combination type of layout for manufacturing different sized gears.

Combination layout for making different types and sizes of gears



Fixed Position Layout-This is also called the **project type** of layout. In this type of layout, the material, or major components remain in a fixed location and tools, machinery, men and other materials are brought to this location. This type of layout is suitable when one or a few pieces of identical heavy products are to be manufactured and when the assembly consists of large number of heavy parts, the cost of transportation of these parts is very high.

Fixed position layout



Advantages

The major advantages of this type of layout are:

1. Helps in job enlargement and upgrades the skills of the operators.
2. The workers identify themselves with a product in which they take interest and pride in doing the job.
3. Greater flexibility with this type of layout.
4. Layout capital investment is lower.

GROUP LAYOUT (OR CELLULAR LAYOUT)

There is a trend now to bring an element of flexibility into manufacturing system as regards to variation in batch sizes and sequence of operations. A grouping of equipment for performing a sequence of operations on family of similar components or products has become all the important.

GROUP TECHNOLOGY LAYOUT IN OPERATION MANAGEMENT

Group technology (GT) is the analysis and comparisons of items to group them into families with similar characteristics. GT can be used to develop a hybrid between pure process

layout and pure flow line (product) layout. This technique is very useful for companies that produce variety of parts in small batches to enable them to take advantage and economics of flow line layout.

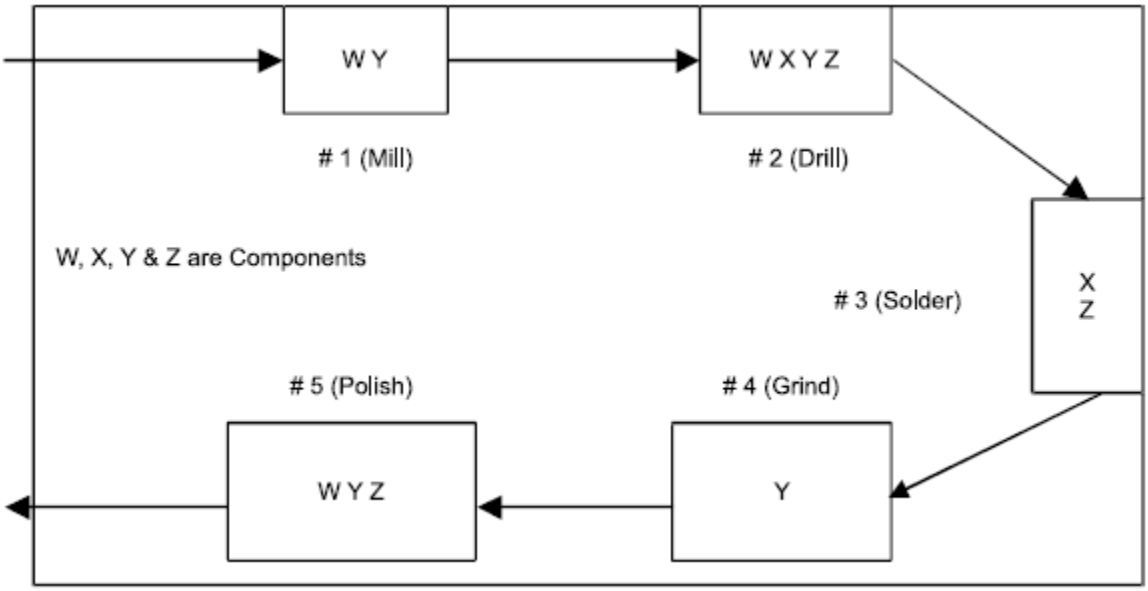
The application of group technology involves two basic steps; first step is to determine component families or groups. The second step in applying group technology is to arrange the plants equipment used to process a particular family of components. This represents small plants within the plants. The group technology reduces production planning time for jobs. It reduces the set-up time.

Thus **group layout** is a combination of the product layout and process layout. It combines the advantages of both layout systems. If there are m-machines and n-components, in a group layout (Group-Technology Layout), the M -machines and n -components will be divided into number of machine-component cells (group) such that all the components assigned to a cell are almost processed within that cell itself. Here, the objective is to minimize the intercell movements.
The basic aim of a group technology layout is to identify families of components that require similar of satisfying all the requirements of the machines are grouped into cells. Each cell is capable of satisfying all the requirements of the component family assigned to it.

The layout design process considers mostly a single objective while designing layouts. In process layout, the objective is to minimize the total cost of materials handling. Because of the nature of the layout, the cost of equipments will be the minimum in this type of layout. In product layout, the cost of materials handling will be at the absolute minimum. But the cost of equipments would not be at the minimum if the equipments are not fully utilized.

In-group technology layout, the objective is to minimize the sum of the cost of transportation and the cost of equipments. So, this is called as multi-objective layout. A typical process layout is shown .

GROUP LAYOUT OR CELLULAR LAYOUT



Group Technology layout can increase

1. Component standardization and rationalization.
2. Reliability of estimates.
3. Effective machine operation and productivity.
4. Customer service.

It can decrease the

1. Paper work and overall production time.
2. Work-in-progress and work movement.
3. Overall cost.

An organization can finalize its business plans on the recommendation of demand forecast. Once business plans are ready, an organization can do backward working from the final sales unit to raw materials required. Thus annual and quarterly plans are broken down into labor, raw material, working capital, etc. requirements over a medium-range period (6 months to 18 months). This process of working out production requirements for a medium range is called aggregate planning.

FACTORS AFFECTING AGGREGATE PLANNING

Aggregate planning is an operational activity critical to the organization as it looks to balance long-term strategic planning with short term production success. Following factors are critical before an aggregate planning process can actually start;

- A complete information is required about available production facility and raw materials.
- A solid demand forecast covering the medium-range period
- Financial planning surrounding the production cost which includes raw material, labor, inventory planning, etc.
- Organization policy around labor management, quality management, etc.

For aggregate planning to be a success, following inputs are required;

- An aggregate demand forecast for the relevant period
- Evaluation of all the available means to manage capacity planning like sub-contracting, outsourcing, etc.
- Existing operational status of workforce (number, skill set, etc.), inventory level and production efficiency

There are three types of aggregate planning strategies available for organization to choose from. They are as follows.

1. **Level Strategy**

   As the name suggests, level strategy looks to maintain a steady production rate and workforce level. In this strategy, organization requires a robust forecast demand as to increase or decrease production in anticipation of lower or higher customer demand. Advantage of level strategy is steady workforce. Disadvantage of level strategy is high inventory and increase back logs.

2. **Chase Strategy**

   As the name suggests, chase strategy looks to dynamically match demand with production. Advantage of chase strategy is lower inventory levels and back logs. Disadvantage is lower productivity, quality and depressed work force.

3. **Hybrid Strategy**

   As the name suggests, hybrid strategy looks to balance between level strategy and chase strategy.

FORECASTING

For an organization to provide customer delight it is important that organization can understand what customer wants and how much does they want. If an organization can gauge future demand that manufacturing plan becomes simpler and cost effective.

The process of analyzing and understanding current and past information to understand the future patterns through a scientific and systemic approach is called forecasting. And **the process of estimating the future demand of product in terms of a unit or monetary value is referred to as demand forecasting**.

The purpose of forecasting is to help the organization manage the present as to prepare for the future by examining the most probable future demand pattern. However, forecasting has its constraint for example we cannot estimate a pattern for technologies and product where there are no existing pattern or data.

BUSINESS FORECASTING

The very objective of business forecasting is to be accurate as possible, so that planning of resources can be done in a very economical manner and therefore, propagate optimum utilization of resources. Business forecasting helps in establishing relationship among many variables, which go into manufacturing of the product. Each forecast situation must be analyzed independently along with forecasting method.

CLASSIFICATION OF BUSINESS FORECASTING

Business forecasting has many dimensions and varieties depending upon the utility and application. The three basic forms are as follows:

Economic Forecasting: these forecasting are related to the broader macro-economic and micro-economic factors prevailing in the current business environment. It includes forecasting of inflation rate, interest rate, GDP, etc. at the macro level and working of particular industry at the micro level.

Demand Forecast: organization conduct analysis on its pre-existing database or conduct market survey as to understand and predict future demands. Operational planning is done based on demand forecasting.

Technology Forecast: this type of forecast is used to forecast future technology upgradation.

Timeline of Business Forecasting

A forecast and its conclusion are valid within specific time frame or horizon. These time horizons are categorized as follows:

Long Term Forecast: This type of forecast is made for a time frame of more than three years. These types of forecast are utilized for long-term strategic planning in terms of capacity planning, expansion planning, etc.

Mid-Term Forecast: This type of forecast is made for a time frame from three months to three years. These types of forecasts are utilized production and layout planning, sales and marketing planning, cash budget planning and capital budget planning.

Short Term Forecast: This type of forecast is made of a time frame from one day to three months. These types of forecasts are utilized for day to day production planning, inventory planning, workforce application planning, etc.

CHARACTERISTICS OF GOOD FORECAST

A good forecast is should provide sufficient time with a fair degree of accuracy and reliability to prepare for future demand. A good forecast should be simple to understand and provide information relevant to production (e.g. units, etc.)

FORECASTING METHODS

Forecasting is divided into two broad categories, techniques and routes. Techniques are further classified into quantitative techniques and qualitative techniques. Quantitative techniques comprise of time series method, regression analysis, etc., where as qualitative methods comprise of Delphi method, expert judgment.

Routes forecasting consist of top-down route and bottom-up route.

CAPACITY UTILIZATION

Capacity utilization is a percentage measure or KPI which indicates the amount of available capacity that is being used to supply current demand.

It is a good indicator of business and market conditions as when times are good most plants are able to run at close to 70-80% capacity utilization and in some cases all the way up to 100%.

Capacity Utilization = Capacity utilized or gross production / Optimum capacity or production level

The use of capacity utilization as a KPI

Capacity utilization is a widely used KPI and operational measure in many industries in the strategic capacity and business planning functions of many organizations. It can be used as a measure which helps determine optimum timing of capacity expansions, entry into new markets, market exits, cost curves for different manufacturers and profitability. **Capacity utilization**, along with other information, can also be used in operations and production management to calculate the average marginal cost of production, the split between fixed and variable costs, inventory , manning, overtime costs, and engineering/maintenance costs.

The Capacity Utilization figure can vary among different industries, inventory, stock building cycles, seasonal demand cycles, and warehousing practices. It is important to set the aim capacity utilization rate with consideration to customer demands first and the other factors mentioned above. It may be that several aim rates will be set for different times in a year or business cycle. When Capacity utilization is at a high level it is important that most gross production is actually saleable production. This means the production process must produce minimal waste, monitor its safety stock levels and be efficient. Lean manufacturing principles are valuable in achieving these required efficiencies, as a lean well run production process will maximize revenue for the business and also cut down customer lead times.

DETERMINATION OF FEASIBLE PRODUCTION ALTERNATIVES

1. Factor rating method
2. Weighted factor rating method
3. Load-distance method
4. Centre of gravity method
5. Break even analysis

FACTOR RATING METHOD

The process of selecting a new facility location involves a series of following steps:

1. Identify the important location factors.
2. Rate each factor according to its relative importance, *i.e.*, higher the ratings is indicative of prominent factor.
3. Assign each location according to the merits of the location for each factor.
4. Calculate the rating for each location by multiplying factor assigned to each location with basic factors considered.
5. Find the sum of product calculated for each factor and select best location having highest total score.

WEIGHTED FACTOR RATING METHOD

In this method to merge quantitative and qualitative factors, factors are assigned weights based on relative importance and weightage score for each site using a preference matrix is calculated. The site with the highest weighted score is selected as the best choice.

LOAD-DISTANCE METHOD

The load-distance method is a mathematical model used to evaluate locations based on proximity factors. The objective is to select a location that minimizes the total weighted loads moving into and out of the facility. The distance between two points is expressed by assigning the points to grid coordinates on a map. An alternative approach is to use time rather than distance.

DISTANCE MEASURES

Suppose that a new warehouse is to be located to serve Delhi. It will receive inbound shipments from several suppliers, including one in Ghaziabad. If the new warehouse were located at Gurgaon, what would be the distance between the two facilities? If shipments travel by truck, the distance depends on the highway system and the specific route taken. Computer software is available for calculating the actual mileage between any two locations in the same county. However, for load-distance method, a rough calculation that is either Euclidean or rectilinear distance measure may be used. Euclidean distance is the straight-line distance, or shortest possible path, between two points.

CENTRE OF GRAVITY

Centre of gravity is based primarily on cost considerations. This method can be used to assist managers in balancing cost and service objectives. The centre of gravity method takes into account the locations of plants and markets, the volume of goods moved, and transportation costs in arriving at the best location for a single intermediate warehouse.

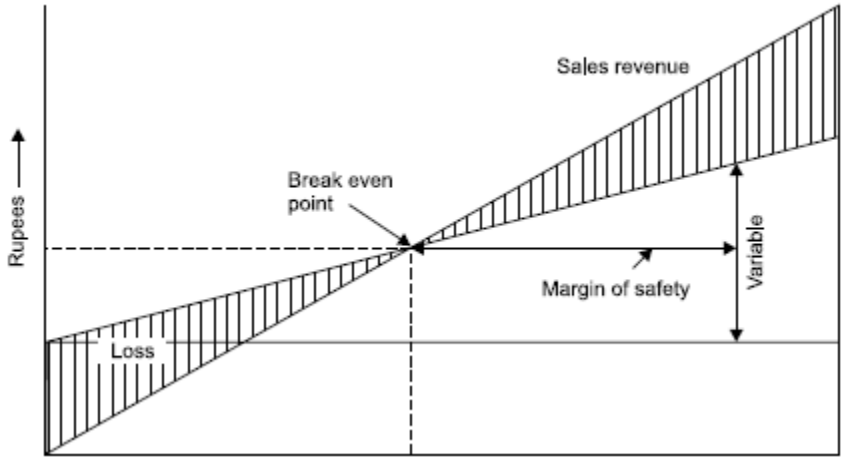
The centre of gravity is defined to be the location that minimizes the weighted distance between the warehouse and its supply and distribution points, where the distance is weighted by the

number of tones supplied or consumed. The first step in this procedure is to place the locations on a coordinate system. The origin of the coordinate system and scale used are arbitrary, just as long as the relative distances are correctly represented.

BREAK EVEN ANALYSIS

Break even analysis implies that at some point in the operations, total revenue equals total cost. Break even analysis is concerned with finding the point at which revenues and costs agree exactly. It is called 'Break-even Point'. Break even point is the volume of output at which neither a profit is made nor a loss is incurred. The Break Even Point (BEP) in units can be calculated by using the relation:

Profit = Total Revenue (TR) – Total Cost (TC)
Profit = Total Revenue (TR) – (Fixed Cost (FC) + Total Variable Costs (TVC)
Breakeven point is a point where no profit no loss
Total costs = Total Revenue



UNIT-2- IMPORTANT PREVIOUS QUESTIONS:

1. Explain the importance of factors in location of facilities.

2. What are the different types of layouts? Explain their merits and demerits.

3. Why is location decision important for a business? What are the factors which are influencing plant location? Explain.

4 Explain the product in planning process in a flexible manufacturing environment.

5. Describe the methods for optimizing the layout of a shop floor in operations. Why is it important?

6. Explain about flexible manufacturing and group technology.

7. What is aggregate planning? How to prepare aggregate demand?

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SYLLABUS

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UNIT-3

SCHEDULING

SCHEDULING IN PRODUCTION AND OPERATION MANAGEMENT

The process of prescribing "When" each operation in a **production** process is to be executed. According to Kimball and Kimball, **Scheduling** is **"The determination of time that is required to perform each operation and also the time required to perform the entire series of operations as routed."**Scheduling can be defined as "prescribing of when and where each operation necessary to manufacture the product is to be performed." It is also defined as "establishing of times at which to begin and complete each event or operation comprising a procedure". The principle aim of scheduling is to plan the sequence of work so that production can be systematically arranged towards the end of completion of all products by due date.

PRINCIPLES OF SCHEDULING

1. **The principle of optimum task size:** Scheduling tends to achieve maximum efficiency when the task sizes are small, and all tasks of same order of magnitude.
2. **Principle of optimum production plan:** The planning should be such that it imposes an equal load on all plants.
3. **Principle of optimum sequence:** Scheduling tends to achieve the maximum efficiency when the work is planned so that work hours are normally used in the same sequence.

INPUTS TO SCHEDULING

1. Performance standards: The information regarding the performance standards (standard times for operations) helps to know the capacity in order to assign required machine hours to the facility.
2. Units in which loading and scheduling is to be expressed.
3. Effective capacity of the work centre.
4. Demand pattern and extent of flexibility to be provided for rush orders.
5. Overlapping of operations.
6. Individual job schedules.

SCHEDULING STRATEGIES

Scheduling strategies vary widely among firms and range from 'no scheduling' to very sophisticated approaches. These strategies are grouped into four classes:

1. **Detailed scheduling:** Detailed scheduling for specific jobs that are arrived from customers is impracticable in actual manufacturing situation. Changes in orders, equipment breakdown, and unforeseen events deviate the plans.
2. **Cumulative scheduling:** Cumulative scheduling of total work load is useful especially for long range planning of capacity needs. This may load the current period excessively and under load future periods. It has some means to control the jobs.
3. **Cumulative detailed:** Cumulative detailed combination is both feasible and practical approach. If master schedule has fixed and flexible portions.
4. **Priority decision rules:** Priority decision rules are scheduling guides that are used independently and in conjunction with one of the above strategies, i.e., first come first serve. These are useful in reducing Work-In-Process (WIP) inventory.

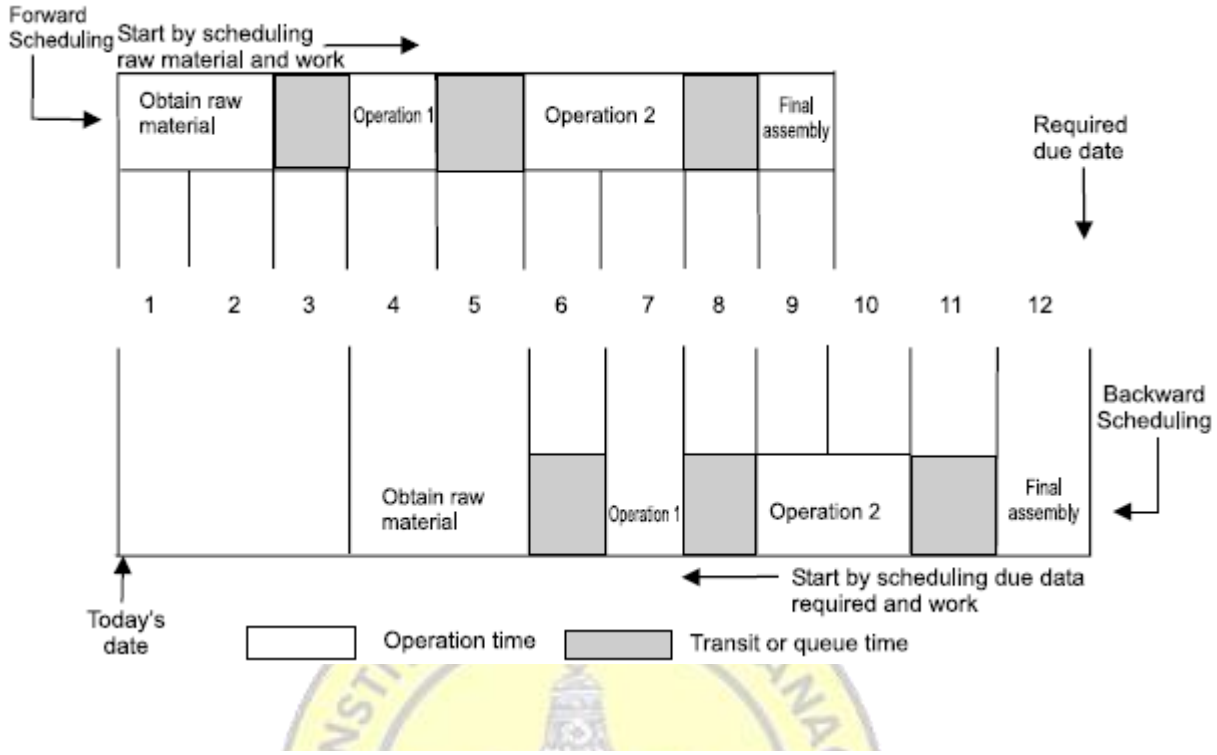
TYPES OF SCHEDULING

Types of scheduling can be categorized as forward scheduling and backward scheduling.

1. **FORWARD SCHEDULING**: is commonly used in job shops where customers place their orders on "needed as soon as possible" basis. Forward scheduling determines start and finish times of next priority job by assigning it the earliest available time slot and from that time, determines when the job will be finished in that work centre. Since the job and its components start as early as possible, they will typically be completed before they are due at the subsequent work centers in the routing. The forward method generates in the process inventory that are needed at subsequent work centers and higher inventory cost. Forward scheduling is simple to use and it gets jobs done in shorter lead times, compared to backward scheduling.

2. **BACKWARD SCHEDULING** is often used in assembly type industries and commit in advance to specific delivery dates. Backward scheduling determines the start and finish times for waiting jobs by assigning them to the latest available time slot that will enable each job to be completed just when it is due, but done before. By assigning jobs as late as possible, backward scheduling minimizes inventories since a job is not completed until it must go directly to the next work centre on its routing. Forward and backward scheduling methods are shown in the following figure.

FORWARD AND BACKWARD SCHEDULING



The scheduling methodology depends upon the type of industry, organization, product, and level of sophistication required. They are:

1. **Charts and boards,**
2. **Priority decision rules, and**
3. **Mathematical programming methods.**

1. GANTT CHARTS AND BOARDS

Gantt charts and associated scheduling boards have been extensively used scheduling devices in the past, although many of the charts are now drawn by computer. Gantt charts are extremely easy to understand and can quickly reveal the current or planned situation to all concerned. They are used in several forms, namely,

a. Scheduling or progress charts, which depicts the sequential schedule;
b. Load charts, which show the work assigned to a group of workers or machines; and
c. Record a chart, which are used to record the actual operating times and delays of workers and machines.

2. PRIORITY DECISION RULES

Priority decision rules are simplified guidelines for determining the sequence in which jobs will be done. In some firms these rules take the place of priority planning systems such as MRP systems. Following are some of the priority rules followed.

Symbol	*Priority rule*
FCFS	First come, first served
EDO	Earliest due date
LS	Least slack (that is, time due less processing time)
SPT	Shortest processing time
LPT	Longest processing time
PCO	Preferred customer order
RS	Random selection

3. MATHEMATICAL PROGRAMMING METHODS

Scheduling is a complex resource allocation problem. Firms process capacity, labor skills, materials and they seek to allocate their use so as to maximize a profit or service objective, or perhaps meet a demand while minimizing costs.

The following are some of the models used in scheduling and production control.

a. Linear programming model:

Here all the constraints and objective functions are formulated as a linear equation and then problem is solved for optimality. *Simplex method, transportation methods* and *assignment method* are major methods used here.

b. PERT/CPM network model:

PERT/CPM network is the network showing the sequence of operations for a project and the precedence relation between the activities to be completed.

Note: Scheduling is done in all the activities of an organization *i.e.*, production, maintenance etc. Therefore, all the methods and techniques of scheduling are used for maintenance management.

SEQUENCING

Sequencing "n" jobs / single machine problem Normally, the total number of jobs exceeds the number of work centers. Therefore, Priority Rules should be developing to determine the sequencing of machining operations. The Priority Rules come into picture when many jobs or operations are chasing for the same capacity. Factors to be considered in setting priorities for jobs include:

a. Customer satisfaction.

b. Order urgency

c. Order profitability

d. Impact on capacity utilization

e. Shop performance

The most popular priority rules are

- **First come fist served (FCFS)**
- **Shortest processing time (SPT)**
- **Earliest due date (EDD)**
- **Least slack (LS).**

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OPERATIONS MANAGEMENT (17E00206)

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3.4. SCHEDULING IN MASS

"Prescribing of when and where each operation necessary to manufacture the product is to be performed". It is also defined as "establishing of times at which to begin and complete each event or operation comprising a procedure".

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1. Performance standards: The information regarding the performance standards (standard times for operations) helps to know the capacity in order to assign required machine hours to the facility.
2. Units in which loading and scheduling is to be expressed
3. Effective capacity of the work centre.
4. Demand pattern and extent of flexibility to be provided for rush orders.
5. Overlapping of operations.
6. Individual job schedules.

TECHNIQUES OF SCHEDULING

(a) Master Scheduling (MS): It shows the dates on which important production items are to be completed. It's a weekly or monthly break-up of the production requirements for each product. Whenever any order is received, it is accommodated first in the MS considering the availability

of the machine and labor. It helps production manager for advance planning & to have check over the production rate and efficiency.

(b) **Shop Manufacturing Schedule:** After preparing the MS, shops schedules (SS) are prepared. It assigns a definite period of time to a particular shop for manufacturing products in required quantity. It shows how many products are to be made, and on what day or week. (c) Backward or Reverse Scheduling: External due date considerations will directly influence activity scheduling in certain structures. The approach adopted in scheduling activities in such cases will often involve a form of reverse scheduling with the use of bar or Gantt charts. A major problem with such reverse or 'due date' scheduling is in estimating the total time to be allowed for each operation, in particular the time to be allowed for waiting or queuing at facilities. Some queuing of jobs (whether items or customers) before facilities is often desirable since, where processing times on facilities are uncertain, high utilization is achieved only by the provision of such queues. Operation times are often available, but queuing times are rarely known initially, the only realistic way in which queuing allowances can be obtained is by experience. Experienced planners will schedule operations, making allowances which they know from past performances to be correct. Such allowances may vary from 50 per cent to 2000 per cent of operation times and can be obtained empirically or by analysis of the progress of previous jobs. It is normally sufficient to obtain and use allowances for groups of similar facilities or for particular departments, since delays depend not so much on the nature of the job, as on the amount of work passing through the departments and the nature of the facilities

3.5. SEQUENCING

Assumptions are generally made in sequencing problems.

1. The processing times on different machines are independent of the order of the job in which they are to be processed.
2. Only one job can be processed on a given machine at a time.
3. The time taken by the jobs in moving from one machine to another is very negligible and is taken as equal to zero.
4. Each job once started on a machine is to be performed up to the completion on that machine.

5. Machines to be used are of different types.
6. All jobs are known and are ready for processing before the period under consideration begins.
7. Processing times are given and do not change.
8. The order of the completion of the jobs has no significance.

3.6. Line of Balance (LOB)

Line of Balance (LOB) is a management control process for collecting, measuring and presenting facts relating to time, cost and accomplishment – all measured against a specific plan. It shows the process, status, background, timing and phasing of the project activities, thus providing management with measuring tools that help:

- Comparing actual progress with a formal objective plan.
- Examining only the deviations from established plans, and gauging their degree of severity with respect to the remainder of the project.
- Receiving timely information concerning trouble areas and indicating areas where appropriate corrective action is required.
- Forecasting future performance.

The LOB itself is a graphic device that enables a manager to see at a single glance which activities of an operation are "in balance" – i.e., whether those which should have been completed at the time of the review actually are completed and whether any activities scheduled for future completion are lagging behind schedule. The LOB chart comprises only one feature of the whole philosophy which includes numerous danger signal controls for all the various levels of management concerned.

To do LOB, the following is needed:

1. A contract schedule, or objective chart;
2. A production plan or lead-time chart for the production process itself;
3. Control points cumulative inventories; and
4. A program status chart on which to plot LOB and the cumulative quantities of units that have passed through the control points of the assembly/production process.

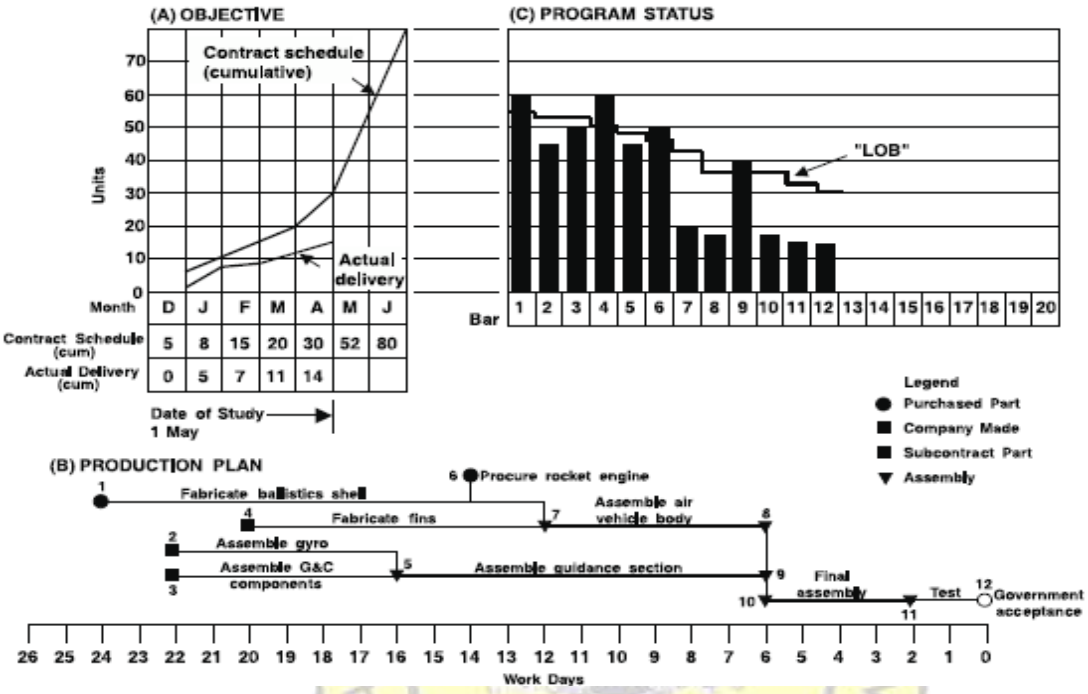

Fig: 3.1. Line of balance

Line Of Balance (LOB) is a management control process for collecting, measuring and presenting facts relating to time, cost and accomplishment - all measured against a specific plan. It shows the process, status, background, timing and phasing of the project activities, thus providing management with measuring tools that help:

1. Comparing actual progress with a formal objective plan.
2. Examining only the deviations from established plans, and gauging their degree of severity with respect to the remainder of the project.
3. Receiving timely information concerning trouble areas and indicating areas where appropriate corrective action is required.
4. Forecasting future performance.

The "Line of Balance" itself is a graphic device that enables a manager to see at a single glance which of many activities comprising a complex operation are "in balance" - i.e., whether those which should have been completed at the time of the review actually are completed and whether any activities scheduled for future completion are lagging behind schedule. The Line of Balance chart comprises only one feature of the whole philosophy which includes numerous danger signal controls for all the various levels of management concerned.

PROJECT SCHEDULING

Types of Projects

PERT techniques is a applied mainly for new project at which you don't have any experience that is why the time estimate for each activity of the project revolves around three time estimate (e.g.) PERT usually applied for the following projects,

- Planning and scheduling of new product.
- Development of missile.
- Development of launching of rockets.

CPM is applied for known projects like

- The construction of building.
- The manufacture and assembly of motors.
- The maintenance project.

Project as already mentioned consists of many activities. The activities are interlinked together to achieve the common objectives like time, cost and standard of performance. CPM and PERT techniques are considered to be project management techniques which enable the project manager to plan and schedule the project. They are also called project network planning and scheduling technique. In the next section you can know about the network planning and scheduling.

3.7. METHODS OF PRODUCTION CONTROL

Production control looks to utilize different type of control techniques to achieve optimum performance out of the production system as to achieve overall production planning targets. Therefore, objectives of production control are as follows:

- Regulate inventory management
- Organize the production schedules
- Optimum utilization of resources and production process

The advantages of robust production control are as follows:

- Ensure a smooth flow of all production processes
- Ensure production cost savings thereby improving the bottom line
- Control wastage of resources
- It maintains standard of quality through the production life cycle.

Production control cannot be same across all the organization. Production control is dependent upon the following factors:

- Nature of production (job oriented, service oriented, etc.)
- Nature of operation
- Size of operation

Production planning and control are essential for customer delight and overall success of an organization.

3.8. WORLD CLASS PRODUCTION/ MANUFACTURING (WCM)

Concept of World Class Production Manufacturing:

World Class Production was originated with RICHARD J. Schonberger. World Class Manufacturing, as one of the most known production systems in the world, is a different set of concepts, principles, policies and techniques for managing and operating a manufacturing company. It is driven by the results achieved by the Japanese manufacturing resurgence following World War II, and adapts many of the ideas used by the Japanese in automotive,

electronics and steel companies to gain a competitive edge. It primary focuses on continual improvement in quality, cost, lead time, flexibility and customer service.

Framework of World Class Manufacturing

The goals of world -Class manufacturing efforts include maintaining market share, improving profitability and improving the firm's ability to complete in a global market place whereas the general principles of improving manufacturing performance are known. But there was a need to develop a conceptual framework to establish the relationship between 'manufacturing performance' and 'business performance' or' world market dominance'. A number of such frameworks developed by number of manufacturing researchers/consultants are described as follows:

1). Hall's Framework of value Added Engineering

2). Schonberger's Framework of World Class Manufacturing

3). Gunn's Model of World Class Manufacturing

4). Maskell's Model of World Class Manufacturing

5).America's Best Plants Model of World Class Manufacturing

IMPORTANT QUESTIONS:

1. Explain about line of balance and its importance in POM.
2. Explain the methods of production control.
3. Explain the advantages and disadvantages of different types of production.
4. Explain the methods of production control.
5. Explain any three rules used for production scheduling with examples.

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SYLLABUS

(17E00206) OPERATIONS MANAGEMENT

The objective of the course is to enable students to understand the production Planning and Controlling aspects of a typical production and operations organization. Study understands the concepts of work study and Quality management.

1. **Introduction:** Overview of production and Operations Management(POM) Function, Historical Development of POM, POM scenario Today, product and process Design Product and Process Development, Manufacturing Process Technology, CAD/CAM analysis

2. **Facilities Management & Aggregate Planning:** Location of Facilities, Layout of Facilities, Optimization of Product/ Process Layout, Flexible Manufacturing and Group Technology: Aggregate Planning – Preparation of Aggregate Demand Forecast, specification of Organizational Policies For Something, Capacity Utilization, Determination of feasible Production Alternatives.

3. **Scheduling:** Scheduling In Job, Shop Type Production, Shop- Loading, Assignment and Sequencing, Scheduling In Mass, Line of Balance, Methods Production Control, World Class Production.

4. **Work Study and Quality Management:** Method Study, Work Measurement, Work Design, Job Design, Work Sampling, Industrial Engineering Techniques. Economics of Quality Assurance Inspection and Quality Control, Acceptance Sampling, Theory of Control Charts, Control Charts for Variables and Control Charts for attributes.

5. **Materials Management:** Introduction, Objectives, Importance of Materials management - Issues in Materials Management - Functions - Activities - Selection of Materials - Advantages of Materials Management.

Text Books:

Production and Operations Management, Aswathappa K - Himalaya Publishing House

"Production and Operations Management" - Dr. K.Sai Kumar, Kalyani Publishers

References:

- Operations Management and Control, Biswajit Banarjee - S.Chand
- Production and Operations Management - Dr.K.C.Arora, 2nd Edition - University Science Press Production and Operations Management, R.Panneerselvam: PHI Learning Private Ltd.
- Production Management, Martand T Telsang - S Chand
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- Operations Management, Mahadevan, Pearson Education, New Delhi
- Production and Operations Management - Text and Cases, Upendra Kachru, Excel Books

UNIT-4

WORK STUDY & QUALITY MANAGEMENT

4.1. METHOD STUDY

Method study enables the industrial engineer to subject each operation to systematic analysis. The main purpose of method study is to eliminate the unnecessary operations and to achieve the best method of performing the operation. Method study is also called **methods engineering or work design.**

Method engineering is used to describe collection of analysis techniques which focus on improving the effectiveness of men and machines.

Fundamentally method study involves the breakdown of an operation or procedure into its component elements and their systematic analysis. In carrying out the method study, the right attitude of mind is important. The method study man should have:

1. The desire and determination to produce results.
2. Ability to achieve results.
3. An understanding of the human factors involved.

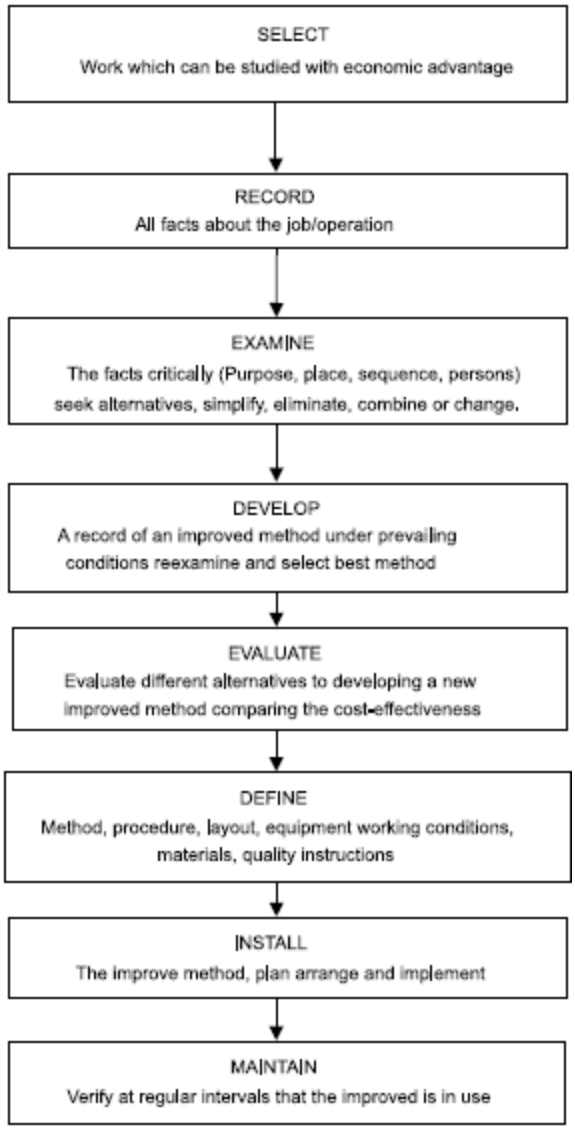


Fig:- 4.1. Method study

The job should be selected for the method study based upon the following considerations:

1. Economic aspect
2. Technical aspect, and
3. Human aspect.

A. **Economic Aspects**

The method study involves cost and time. If sufficient returns are not attained, the whole exercise will go waste. Thus, the money spent should be justified by the savings from it.

The following guidelines can be used for selecting a job:

a. Bottleneck operations which are holding up other production operations.
b. Operations involving excessive labor.
c. Operations producing lot of scrap or defectives.
d. Operations having poor utilization of resources.
e. Backtracking of materials and excessive movement of materials.

B. **Technical Aspects**

the method study man should be careful enough to select a job in which he has the technical knowledge and expertise. A person selecting a job in his area of expertise is going to do full justice.

Other factors which favor selection in technical aspect are:

1. Job having in consistent quality.
2. Operations generating lot of scraps.
3. Frequent complaints from workers regarding the job.

C. Human Considerations

Method study means a change as it is going to affect the way in which the job is done presently and is not fully accepted by workman and the union. Human considerations play a vital role in method study. These are some of the situations where human aspect should be given due importance:

4. Workers complaining about unnecessary and tiring work.
5. More frequency of accidents.
6. Inconsistent earning.

Method study scope lies in improving work methods through process and operation analysis, such as:

1. Manufacturing operations and their sequence.
2. Workmen.
3. Materials, tools and gauges.

4. Layout of physical facilities and work station design.
5. Movement of men and material handling.
6. Work environment.

OBJECTIVES

Method study is essentially concerned with finding better ways of doing things. It adds value and increases the efficiency by eliminating unnecessary operations, avoidable delays and other forms of waste. The improvement in efficiency is achieved through:

1. Improved layout and design of workplace.
2. Improved and efficient work procedures.
3. Effective utilization of men, machines and materials.
4. Improved design or specification of the final product.

The objectives of method study techniques are:

1. Present and analyze true facts concerning the situation.
2. To examine those facts critically.
3. To develop the best answer possible under given circumstances based on critical examination

The scope of method study is not restricted to only manufacturing industries. Method study techniques can be applied effectively in service sector as well. It can be applied in offices, hospitals, banks and other service organizations. The areas to which method study can be applied successfully in manufacturing are:

1. To improve work methods and procedures.
2. To determine the best sequence of doing work.
3. To smoothen material flow with minimum of back tracking and to improve layout.
4. To improve the working conditions and hence to improve labor efficiency.
5. To reduce monotony in the work.
6. To improve plant utilization and material utilization.
7. Elimination of waste and unproductive operations.
8. To reduce the manufacturing costs through reducing cycle time of operations.

The basic approach to method study consists of the following eight steps. The detailed procedure for conducting the method study is shown in the following figure.

1. **SELECT** the work to be studied and define its boundaries.
2. **RECORD** the relevant facts about the job by direct observation and collect such additional data as may be needed from appropriate sources.
3. **EXAMINE** the way the job is being performed and challenge its purpose, place sequence and method of performance.
4. **DEVELOP** the most practical, economic and effective method, drawing on the contributions of those concerned.
5. **EVALUATE** different alternatives to developing a new improved method comparing the cost- effectiveness of the selected new method with the current method with the current method of performance.
6. **DEFINE** the new method, as a result, in a clear manner and present it to those concerned, i.e., management, supervisors and workers.
7. **INSTALL** the new method as a standard practice and train the persons involved in applying it.
8. **MAINTAIN** the new method and introduce control procedures to prevent a drifting back to the previous method of work.

4.2.WORK MEASUREMENT

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.

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.

- **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 analyzing 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.
- **Synthetic data:**

  A work measurement technique for building up the time for a job or pans of the job at a defined level of performance by totaling element times obtained previously from time studies on other jobs containing the elements concerned or from synthetic data.
- **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.
- **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).

- **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.

Techniques	*Applications*	*Unit of measurement*
1. Time study	Short cycle repetitive jobs. Widely used for direct work.	Centiminute (0.01 min)
2. Synthetic Data	Short cycle repetitive jobs.	Centi minutes
3. Working sampling	Long cycle jobs/heterogeneous operations.	Minutes
4. MTM	Manual operations confined to one work centre.	TMU (1 TMU = 0.006 min)
5. Analytical estimation	Short cycle non-repetitive job.	Minutes

Fig:4.2. Work measurement techniques and their application

4.3.WORK DESIGN

Work design is the study and design of a work system in an organizational context. Technologically work is viewed as tools. Techniques and methods used for production of finished goods. The economic concept of work is associated with wages and employment.

Work design seeks to increase productivity by seeking better and less expensive ways to perform the functions tasks. The man material machine combination is the focus of any work problem. This is the part of the entire organization work system work design is a systematic investigation of desired and present work systems to get the ideal work systems and methods.

ASSUMPTIONS OF WORK DESIGN:

1. Work systems try to improve productivity and effectiveness.
2. Work systems are in three states design betterment improvement
3. Work design considers all aspects of the work system

4. Work design integrates abilities and talents
5. Work design goes beyond a set of techniques since work systems need continuous monitoring.

4.4. JOB DESIGN

A well defined job will make the job interesting and satisfying for the employee. The result is increased performance and productivity. If a job fails to appear compelling or interesting and leads to employee dissatisfaction, it means the job has to be redesigned based upon the feedback from the employees.

Broadly speaking the various factors that affect a job design can classified under three heads. They are:

1. Organizational Factors
2. Environmental Factors
3. Behavioural Factors

Organizational factors that affect job design can be work nature or characteristics, work flow, organizational practices and ergonomics.

Work Nature: There are various elements of a job and job design is required to classify various tasks into a job or a coherent set of jobs. The various tasks may be planning, executing, monitoring, controlling etc and all these are to be taken into consideration while designing a job.

Ergonomics: Ergonomics aims at designing jobs in such a way that the physical abilities and individual traits of employees are taken into consideration so as to ensure efficiency and productivity.

Workflow: Product and service type often determines the sequence of work flow. A balance is required between various product or service processes and a job design ensures this.

Culture: Organizational culture determines the way tasks are carried out at the work places. Practices are methods or standards laid out for carrying out a certain task. These practices often affect the job design especially when the practices are not aligned to the interests of the unions.

Environmental Factors

Environmental factors affect the job design to a considerable extent. These factors include both the internal as well as external factors. They include factors like employee skills and abilities, their availability, and their socio economic and cultural prospects.

Employee availability and abilities: Employee skills, abilities and time of availability play a crucial role while designing of the jobs. The above mentioned factors of employees who will actually perform the job are taken into consideration. Designing a job that is more demanding and above their skill set will lead to decreased productivity and employee satisfaction.

Socio economic and cultural expectations: Jobs are nowadays becoming more employee centered rather than process centered. They are therefore designed keeping the employees into consideration. In addition the literacy level among the employees is also on the rise. They now demand jobs that are to their liking and competency and which they can perform the best.

Behavioural Factors

Behavioural factors or human factors are those that pertain to the human need and that need to be satisfied for ensuring productivity at workplace. They include the elements like autonomy, diversity, feedback etc. A brief explanation of some is given below:

Autonomy: Employees should work in an open environment rather than one that contains fear. It promotes creativity, independence and leads to increased efficiency.

Feedback: Feedback should be an integral part of work. Each employee should receive proper feedback about his work performance.

Diversity: Repetitive jobs often make work monotonous which leads to boredom. A job should carry sufficient diversity and variety so that it remains as interesting with every passing day. Job variety / diversity should be given due importance while designing a job.

Use of Skills and abilities: Jobs should be employee rather than process centered. Though due emphasis needs to be given to the latter but jobs should be designed in a manner such that an employee is able to make full use of his abilities and perform the job effectively.

4.5.WORK SAMPLING

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:

1. Work sampling can be used as ratio study
2. Work sampling can be used performance index
3. Work sampling can be used work measurement techniques

4.6.INDUSTRIAL ENGINEERING

Industrial engineering is concerned with the design improvement and installation of integration system of men materials and equipment. It draws upon specialized knowledge and skill in the mathematical physical and social sciences together with the principal and methods of engineering analyses and design to specify predict and evaluate the results to be obtained from such system.

TECHNIQUES OF INDUSTRIAL ENGINEERING:

The main aim of tools and techniques of industrial engineering is to improve the productivity of the organization by optimum utilization of organizations resource like men materials and machines. The major tools and techniques used in industrial engineering are described below:

1. **METHOD STUDY:**

Method study is used to established standard method of performing a job after thorough analysis of the job and to establish the facilities layout at a defined level.

2. WORK MEASUREMENTS:

The application of techniques designed to establish time for a qualified worker to carry out a specified job at a defined of performance.

3. PRINCIPAL OF MOTION ECONOMY:

These rules and principles can be applied to improve the efficiency and reduce tidiness in performing manual work.

4. **JOB ANALYSIS AND INCENTIVES LIKE FINANCIAL OR NON-FINANCIAL:** Job analysis helps to evolve a rational compensation for the efforts of the workers.

5. VALUE ANALYSIS:

It ensures that necessary costs are built into the product and it tries to provide the required function of the minimum cost. Hence helps to enhance the worth of the product.

6. PRODUCTION PLANNING AND CONTROL:

It includes the planning for the resources, proper scheduling and controlling production activities.

7. INVENTORY CONTROL:

It is used to determine the economic lot size and the recorder levels for the items so that it is available to the production center at the right time, in proper qualify to avoid stock out.

8. JOB EVALUATION:

Techniques used to determine the relative worth of jobs of the organization to aid in matching jobs and personal and to evolve sound wage policy.

9. FACILITIES PLAN AND MATERIAL HANDLING:

It is used to systematically plan the materials movement through the plant eliminating back tracking and unnecessary movements.

10. HUMAN FACTORS:

It is concerned with relationship between the man and his working environment to minimize physical and mental stress.

11. SYSTEM ANALYSIS:

System analysis is study or various sub system and elements that make a system their interdependencies in order to design.

12. OPERATION RESEARCH:

Operations research is technical used to obtain optimal solution to the problems based on a set objective and constraints imposed on the problem.

The techniques most often in use are,

- Linear programming
- Simulation
- Network analysis
- Queuing models
- Assignment sequencing and transportation models
- Game theory and dynamic programming

13. CONTINUOUS IMPROVEMENT:

- Organization and methods
- Group technology
- Statistical techniques
- Advances in IT and computer packages etc

4.7. QUALITY CONTROL

Quality Control (QC) 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. It depends on materials, tools, machines, type of labor, working conditions etc. QC is a broad term, it involves inspection at particular stage but mere inspection does not mean QC. As opposed to inspection, in quality control activity emphasis is placed on the quality future production. Quality control aims at prevention of defects at the source, relies on effective feedback system and corrective action procedure. Quality control uses inspection as a valuable tool.

Quality control is defined as

"The operational techniques and the activities which sustain a quality of product or service that will satisfy given needs; also the use of such techniques and activities".

Types of Quality Control

QC is not a function of any single department or a person. It is the primary responsibility of any supervisor to turn out work of acceptable quality. Quality control can be divided into three main sub-areas, those are:

1. Off-line quality control,
2. Statistical process control and
3. Acceptance sampling plans.

1. **Off-line quality control:**
   Its procedure deal with measures to select and choose controllable product and process parameters in such a way that the deviation between the product or process output and the standard will be minimized. Much of this task is accomplished through product and process design.

   Example:
   Taguchi method, principles of experimental design etc.

2. **Statistical process control:**

   SPC involves comparing the output of a process or a service with a standard and taking remedial actions in case of a discrepancy between the two. It also involves determining whether a process can produce a product that meets desired specification or requirements. On-line SPC means that information is gathered about the product, process, or service while it is functional. The corrective action is taken in that operational phase. This is real-time basis.

3. **Acceptance sampling plans:**

A plan that determines the number of items to sample and the acceptance criteria of the lot, based on meeting certain stipulated conditions (such as the risk of rejecting a good lot or accepting a bad lot) is known as an acceptance sampling plan.

Steps in Quality Control

1. Formulate quality policy.
2. Set the standards or specifications on the basis of customer's preference, cost and profit.
3. Select inspection plan and set up procedure for checking.
4. Detect deviations from set standards of specifications.
5. Take corrective actions or necessary changes to achieve standards.
6. Decide on salvage method *i.e.*, to decide how the defective parts are disposed of, entire scrap or rework.
7. Coordination of quality problems.
8. Developing quality consciousness both within and outside the organization.
9. Developing procedures for good vendor-vendee relations.

Objectives of Quality Control

1. To improve the companies income by making the production more acceptable to the
2. customers, *i.e.*, by providing long life, greater usefulness, maintainability etc.
3. To reduce companies cost through reduction of losses due to defects.
4. To achieve interchangeability of manufacture in large scale production.
5. To produce optimal quality at reduced price.
6. To ensure satisfaction of customers with productions or services or high quality level, to build customer goodwill, confidence and reputation of manufacturer.
7. To make inspection prompt to ensure quality control.
8. To check the variation during manufacturing.

9. The broad areas of application of quality control are incoming material control, process control and product control.

Benefits of Quality Control

1. Improving the quality of products and services.
2. Increasing the productivity of manufacturing processes, commercial business, and corporations.
3. Reducing manufacturing and corporate costs.
4. Determining and improving the marketability of products and services.
5. Reducing consumer prices of products and services.
6. Improving and/or assuring on time deliveries and availability.
7. Assisting in the management of an enterprise.

4.8.ACCEPTANCE SAMPLING

Acceptance Sampling is much less expensive than 100 percent inspection.

It is general experience that 100 percent inspection removes only 82 to 95 percent of defective material. Very good 100 percent inspection may remove at the most 99 percent of the defectives, but still cannot reach the level of 100 percent. Due to the effect of inspection fatigue involved in 100 percent inspection, a good sampling plan may actually give better results than that achieved by 100 percent inspection.

Because of its economy, it is possible to carry out sample inspection at various stages. Acceptance number is evaluated using sampling plan and confidence level.

The 100 percent inspection is not possible, where quality can be tested only by destroying the items. In such case, sampling inspection is the only solution

Acceptance Quality Level (AQL):

It is a fraction defective that can be tolerated without serious effect on further processing operation or customer reaction. In other words, AQL is the maximum percent defective that, for

the purpose of sampling inspection, can be considered satisfactory as a process average. AQL can also be termed as maximum number or percentage of defective pieces in a 'good lot'.

Rejectable Quality Level (RQL):

This is also known as 'lot tolerance percent defective (LTPD)'. It represents the percentage defectives in a lot that can be tolerated in only as specified proportion of lots. By adopting a sampling plan that will reject most of the lots offered that would cause too much unfavourable reaction of the customer

This, RQL helps in real protection against unsatisfactory material, reaching the customer. RQL or LTPD can also be expressed by the minimum number or percentage of defective pieces in a "bad lot". This can also be termed as 'Limiting Quality Level' (LQL)

Acceptance sampling solves these problems by testing a representative sample of the product for defects. The process involves first, determining the size of a product lot to be tested, then the number of products to be sampled, and finally the number of defects acceptable within the sample batch.

Products are chosen at random for sampling. The procedure usually occurs at the manufacturing site the plant or factory and just before the products are to be transported. This process allows a company to measure the quality of a batch with a specified degree of statistical certainty without having to test every single unit. Based on the result show many of the predetermined number of samples pass or fail the testing the company decides whether to accept or reject the entire lot.

The statistical reliability of a sample is generally measured by a t-statistic, a type of inferential statistic used to determine if there is a significant difference between two groups that share common features

4.9. THEORY OF CONTROL CHARTS

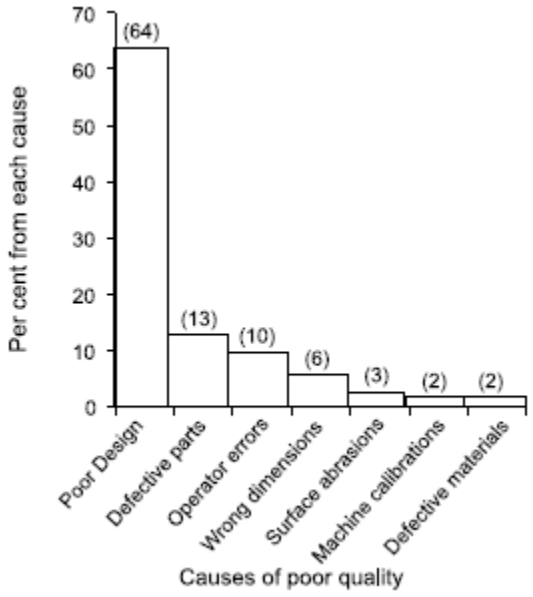
- Pareto charts
- Check sheets
- Cause and effect diagram
- Scatter diagrams
- Histogram

- Graphs or flow charts
- Control charts

1. **PARETO CHARTS**

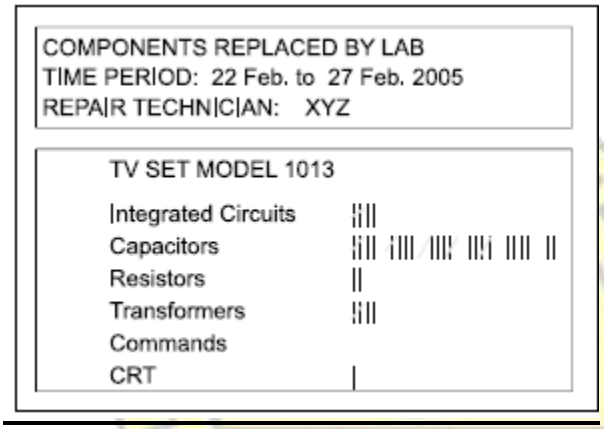
Pareto charts help prioritize by arranging them in decreasing order of importance. In an environment of limited resources these diagrams help companies to decide on the order in which they should address problems. The Pareto analysis can be used to identify the problem in a number of forms.

a. Analysis of losses by material (number or past number).
b. Analysis of losses by process *i.e.*, classification of defects or lot rejections in terms of the process.
c. Analysis of losses by product family.
d. Analysis by supplier across the entire spectrum of purchases.
e. Analysis by cost of the parts.
f. Analysis by failure mode
G. Poor Design
H. Defective Parts
I. Operator Error
J. Wrong Dimensions
K. Surface Abrasion
L. Machine Calibrations
M. Defective Material



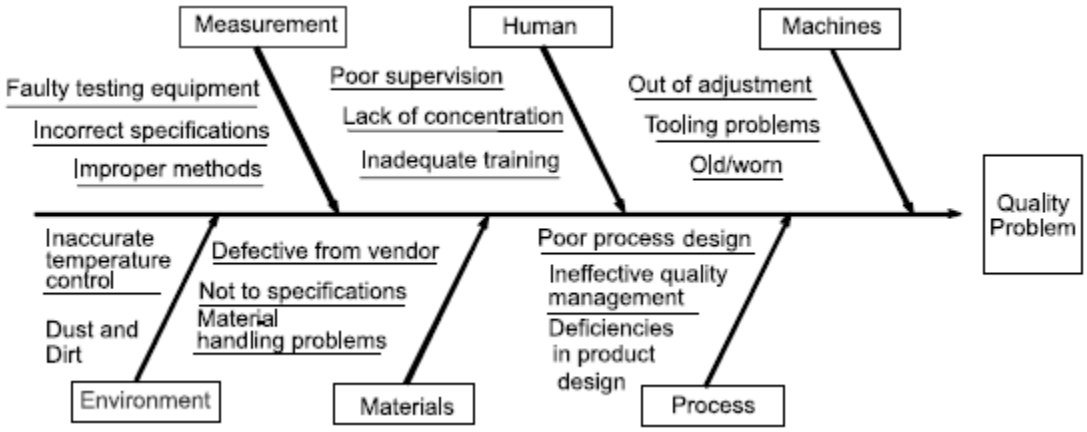
CHECKSHEETS

Check sheets facilitate systematic record keeping or data collection observations are recorded as they happen which reveals patterns or trends. Data collection through the use of a checklist is often the first step in analysis of quality problem. A checklist is a form used to record the frequency of occurrence of certain product or service characteristics related to quality. The characteristics may be measurable on a continuous scale such as weight, diameter, time or length.



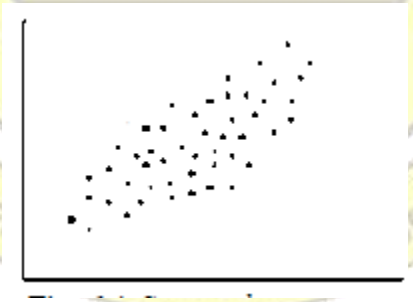
CAUSE AND EFFECT DIAGRAM

It is sometimes called as Fish-bone diagram. It is first developed by Kaorv Ishikawa in 1943 and is sometimes called as Ishikawa diagram. The diameter helps the management trace customer complaints directly to the operations involved. The main quality problem is referred to Fish-head; the major categories of potential cause structural bones and the likely specific causes to ribs. It explores possible causes of problems, with the intention being to discover the root causes. This diagram helps identify possible reasons for a process to go out of control as well as possible effects on the process



SCATTER DIAGRAM (SCATTER PLOTS)

It often indicates the relationship between two variables. They are often used as follow-ups to a cause and effect analysis to determine whether a stated cause truly does impact the quality characteristics.



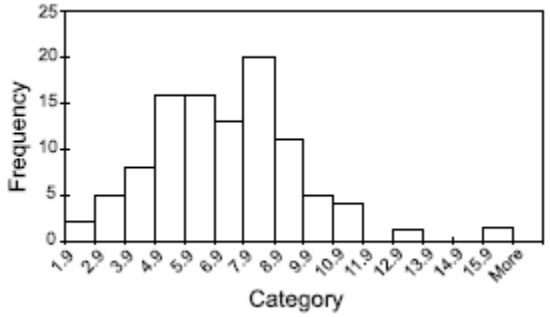
Example:

The plots advertising expenditure against company sales and indicates a strong positive relationship between the two variables. As the level of advertising expenditure increases sales tend to increase.

HISTOGRAM (OR) BAR CHARTS

It displays the large amounts of data that are difficult to interpret in their raw form. A histogram summarizes data measured on a continuous scale showing the frequency

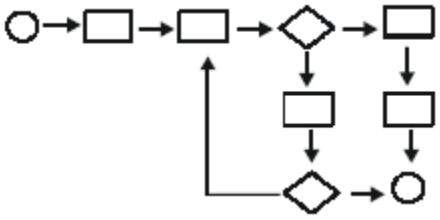
distribution of some quality characteristics (in statistical terms the central tendency and the dispersion of the data).



Often the mean of the data is indicated on the histogram. A bar chart is a series of bare representing the frequency of occurrence of data characteristics, the bar height indicates the number of times a particular quality characteristic was observed.

FLOW CHARTS (OR) GRAPHS

It shows the sequence of events in a process. They are used for manufacturing and service operations. Flow charts are often used to diagram operational procedures to simplify the system. They can identify bottlenecks, redundant steps and non-value added activities. A realistic flow chart can be constructed by using the knowledge of the person who are directly involved in the particular process. The flow chart can be identifies where delays can occur.



CONTROL CHARTS

It distinguishes special causes of variations from common causes of variation. They are used to monitor and control process on an ongoing basis. A typical control chart plots a

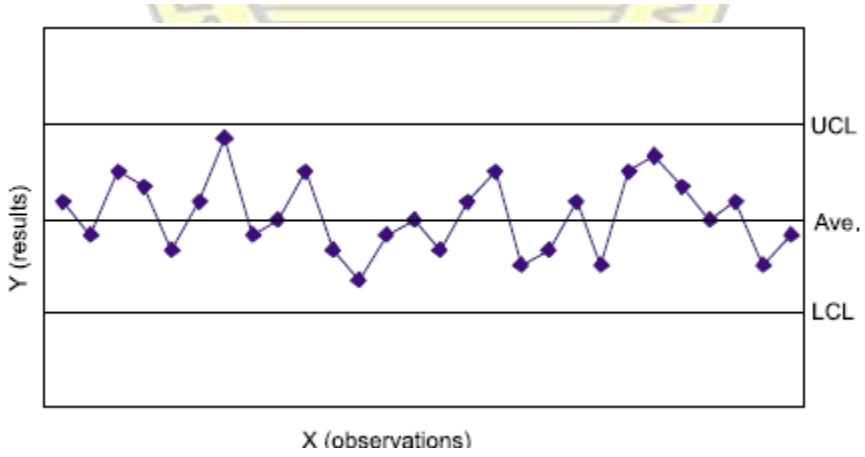
selected quality characteristic found from sub-group of observations as a function of sample number.

Characteristics such as sample average, sample range and sample proportion of non-conforming units are plotted. The centre line on a control chart represents the average value of characteristics being plotted. Two limits know as the upper control limit (UCL) and lower control limit (LCL) are also shown on control charts. These limits are constructed so that if the process is operating under a stable system of chance causes, the problem of an observation falling outside these limits is quite small. The following figure shows a generalized representation of a control chart.

Control chart shows the performance of a process from two points of view.

First, they show a snapshot of the process at the moment the data are collected.

Second, they show the process trend as time progresses. Process trends are important because they help in identifying the out-of-control status if it actually exists. Also, they help to detect variations outside the normal operational limits, and to identify the cause of variations. Fig. shows a generalized representation of a control chart.



CAUSES OF VARIATION IN QUALITY

The variation in the quality of product in any manufacturing process is broadly classified as:

A. Chance causes
B. Assignable causes.

A. **CHANCE CAUSES**

The chance causes are those causes which are inherit in manufacturing process by virtue of operational and constructional features of the equipments involved in a manufacturing process.

1. Machine vibrations
2. Voltage variations
3. Composition variation of material, etc.

They are difficult to trace and difficult to control, even under best condition of production. Even though, it is possible to trace out, it is not economical to eliminate. The chance causes results in only a minute amount of variation in process. Variation in chance causes is due to internal factors only the general pattern of variation under chance causes will follow a stable statistical distribution (normal distribution). Variation within the control limits means only random causes are present

.

B. **ASSIGNABLE CAUSES**

These are the causes which creates ordinary variation in the production quality. Assignable cause's variation can always be traced to a specific quality. They occur due to

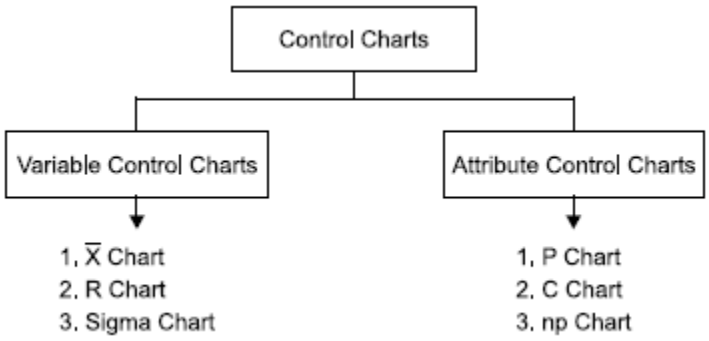
1. Lack of skill in operation
2. Wrong maintenance practice
3. New vendors
4. Error in setting jigs and fixtures
5. Raw material defects

CONTROL CHARTS

SPC is implemented through control charts that are used to monitor the output of the process and indicate the presence of problems requiring further action. Control charts can be used to monitor processes where output is measured as either variables or attributes. There are two types of control charts: Variable control chart and attribute control chart.

1. **Variable control charts:** It is one by which it is possible to measures the quality characteristics of a product. The variable control charts are **X-BAR** chart, **R-BAR** chart, **SIGMA** chart.

2. **Attribute control chart:** It is one in which it is not possible to measures the quality characteristics of a product, i.e., it is based on visual inspection only like good or bad, success or failure, accepted or rejected. The attribute control charts are **p-charts, np-charts, c-charts, u-charts.** It requires only a count of observations on characteristics e.g., the number of nonconforming items in a sample.



CHARACTERISTICS OF CONTROL CHARTS

A control chart is a time-ordered diagram to monitor a quality characteristic, consisting of:

1. A nominal value, or centre line, the average of several past samples.
2. Two control limits used to judge whether action is required, an upper control limit (UCL) and a lower control limit (LCL).
3. Data points, each consisting of the average measurement calculated from a sample taken from the process, ordered overtime. By the Central Limit Theorem, regardless of the distribution of the underlying individual measurements, the distribution of the sample means will follow a normal distribution. The control limits are set based on the sampling distribution of the quality measurement.

BENEFITS OF USING CONTROL CHARTS

A control chart indicates when something may be wrong, so that corrective action can be taken.

1. The patterns of the plot on a control chart diagnosis possible cause and hence indicate possible remedial actions.

2. It can estimate the process capability of process.
3. It provides useful information regarding actions to take for quality improvement.

OBJECTIVES OF CONTROL CHARTS

To secure information to be used in establishing or changing specifications or in determining whether the process can meet specifications or not.

1. To secure information to be used on establishing or changing production procedures.
2. To secure information to be used on establishing or changing inspection procedures or acceptance procedures or both.
3. To provide a basis for current decision during production.
4. To provide a basis for current decisions on acceptance for rejection of manufacturing or purchased product.
5. To familiarize personnel with the use of control chart.

4.10. CONTROL CHARTS FOR VARIABLES

As the name indicates, these charts will use variable data of a process. X chart given an idea of the central tendency of the observations. These charts will reveal the variations between sample observations. R chart gives an idea about the spread (dispersion) of the observations. This chart shows the variations within the samples.

X-Chart and R-Chart: The formulas used to establish various control limits are as follows:

a. Standard Deviation of the Process, σ, Unknown R-Chart: To calculate the range of the data, subtract the smallest from the largest measurement in the sample the control limits:

The control limits are: $UCL_R = D_4 \bar{R}$ and $LCL_R = D_3 \bar{R}$

where $\bar{R}$ = average of several past R values and is the central line of the control chart, and

D_3, D_4 = constants that provide three standard deviation (three-sigma) limits for a given sample size

$\bar{X}$-Chart: The control limits are:

$$UCL_{\bar{X}} = \bar{\bar{X}} + A_2 \bar{R} \text{ and } LCL_{\bar{X}} = \bar{\bar{X}} - A_2 \bar{R}$$

where $\bar{\bar{X}}$ = central line of the chart and the average of past sample mean's, and

A_2 = constant to provide three-sigma limits for the process mean.

b. Standard Deviation of the Process, σ, Known Control charts for variables (with the standard deviation of the process, σ, known) monitor the mean, X , of the process distribution. The control limits are:

$$UCL = \bar{\bar{X}} + 2\sigma_{\bar{X}}$$

and

$$LCL = \bar{\bar{X}} - 2\sigma_{\bar{X}}$$

where $\bar{\bar{X}}$ = centre line of the chart and the average of several past sample means, Z is the standard normal deviate (number of standard deviations from the average),

$\sigma_{\bar{X}} = \sigma / \sqrt{n}$ and is the standard deviation of the distribution of sample means, and n is the sample size

Procedures to construct X-chart and R-chart

1. Identify the process to be controlled.
2. Select the variable of interest.
3. Decide a suitable sample size (n) and number of samples to be collected (k).
4. Collect the specified number of samples over a given time interval.
5. Find the measurement of interest for each piece within the sample.
6. Obtain mean (X) of each sample.
7. Establish control limits for X and R-charts.

Consider that you are evaluating the output from a process. Conceptually, you could evaluate the products in two basic ways. In the first way you would simply classify the products as "conforming" or "non conforming." This produces attribute (discrete) data. In the second way you could measure a key characteristic using a continuous scale. This produces variable (continuous) data.

Variables control charts are used to evaluate variation in a process where the measurement is a variable--i.e. the variable can be measured on a continuous scale (e.g. height, weight, length, concentration). There are two main types of variables control charts. One (e.g. x-bar chart, Delta chart) evaluates variation *between* samples. Non-random patterns (signals) in the data on these charts would indicate a possible change in central tendency from one sampling period to the next. One way of thinking about the use of a variables control chart is that you are testing the hypothesis that a particular sample mean came from the population of sample means represented by the control limits of the process. If the particular sample mean is within the control limits, your concussion is that it does come from that population. If the particular sample mean is outside the control limits, you conclusion is that it may have come from some other distribution (i.e. a distribution with a mean that is higher or lower than this population mean. [NOTE: There are other signals that may indicate an out-of-control signal that will be discussed in the Lesson Six Presentation.]

The other type of variables control chart (e.g. R-chart, S-chart, Moving Range chart) evaluates variation *within* samples. Non-random patterns (signals) in the data on these charts would indicate a possible change in the variation within the samples.

Non-random patterns in the data plotted on the control charts provide evidence of the process being *in-control* (only common cause variation present; predictable) or *out-of-control* (common cause *and* assignable cause variation present; unpredictable). Adjusting a process which is in-control will result in increased variation. Failing to adjust a process which is out-of-control results in a loss of predictability. Control charts help a machine operator or manager to decide when it is appropriate to make an adjustment and when it is better to leave the process alone.

TYPES OF ATTRIBUTES CONTROL CHART:

P Chart

This chart shows the fraction of nonconforming or defective product produced by a manufacturing process. It is also called the control chart for fraction nonconforming.

Np Chart

This chart shows the number of nonconforming. Almost the same as the p chart.

C Chart

This shows the number of defects or nonconformities produced by a manufacturing process.

U Charts

This chart shows the nonconformities per unit produced by a manufacturing process.

4.11. CONTROL CHARTS FOR ATTRIBUTES

P-charts and C-charts are charts will used for attributes. This chart shows the quality characteristics rather than measurements.

P-CHART

A p-chart is a commonly used control chart for attributes, whereby the quality characteristic is counted, rather than measured, and the entire item or service can be declared good or defective. The standard deviation of the proportion defective, p, is:

$\sigma_p = \sqrt{\bar{p}(1-\bar{p})/n}$, where n = sample size, and $\bar{p}$ = average of several past p values and central line on the chart.

Using the normal approximation to the binomial distribution, which is the actual distribution of p,

$$UCL_p = \bar{p} + Z\sigma_p$$

and

$$LCLp = \bar{p} - Z\sigma_p$$

where z is the normal deviate (number of standard deviations from the average).

ILLUSTRATIONS ON X BAR CHART AND R BAR CHART

(*i*) *Standard Deviation of the Process,* Σ*, Unknown*

ILLUSTRATION 1: *Several samples of size n = 8 have been taken from today's production of fence posts. The average post was 3 yards in length and the average sample range was 0.015 yard. Find the 99.73% upper and lower control limits.*

SOLUTION:

$$\overline{\overline{X}} = 3 \text{ yds}$$

$$\overline{R} = 0.015 \text{ yds}$$

$$A_2 = 0.37 \text{ from Statistical Table}$$

$$\text{UCL} = \overline{\overline{X}} + A_2\overline{R} = 3 + 0.37(0.015) = 3.006 \text{ yds}$$

$$\text{LCL} = \overline{\overline{X}} - A_2\overline{R} = 3 - 0.37(0.015) = 2.996 \text{ yds}$$

ILLUSTRATION 2 (*Problem on* $\overline{X}$ *and R Chart*): *The results of inspection of 10 samples with its average and range are tabulated in the following table. Compute the control limit for the* $\overline{\overline{X}}$ *and R-chart and draw the control chart for the data.*

Sample No. (*Sample Size 5*)	$\overline{\overline{X}}$ (*Mean*)	*R* (*Range*)
1	7.0	2
2	7.5	3
3	8.0	2
4	10.0	2
5	9.5	3
6	11.0	4
7	11.5	3
8	4.0	2
9	3.5	3
10	4.0	2
	$\Sigma\overline{\overline{X}} = 76$	$\Sigma R = 26$

SOLUTION:

$$\overline{\overline{X}} = \Sigma \overline{\overline{X}} / \text{No. of samples}$$

$$\overline{R} = \Sigma R / \text{No. of samples}$$

Therefore,

$$\overline{\overline{X}} = \frac{76}{10} = 7.6$$

$$\overline{R} = \frac{26}{10} = 2.6$$

For $\overline{X}$ chart

Upper Control Limit (UCL) $= \overline{\overline{X}} + A_2 \overline{R}$

Lower Control Limit (LCL) $= \overline{\overline{X}} - A_2 \overline{R}$

For $\overline{R}$ chart

Upper Control Limit (UCL) $= D_4 \overline{R}$

Lower Control Limit (LCL) $= D_3 \overline{R}$

The values of various factors (like A_2, D_4 and D_3) based on normal distribution can be found from the following table:

$$A_2 = 0.58,\ D_3 = 0 \text{ and } D_4 = 2.11$$

Thus, for $\overline{\overline{X}}$ chart

$$UCL = 7.6 + (0.58 \times 2.6)$$

$$= 7.6 + 1.51 = \mathbf{9.11}$$

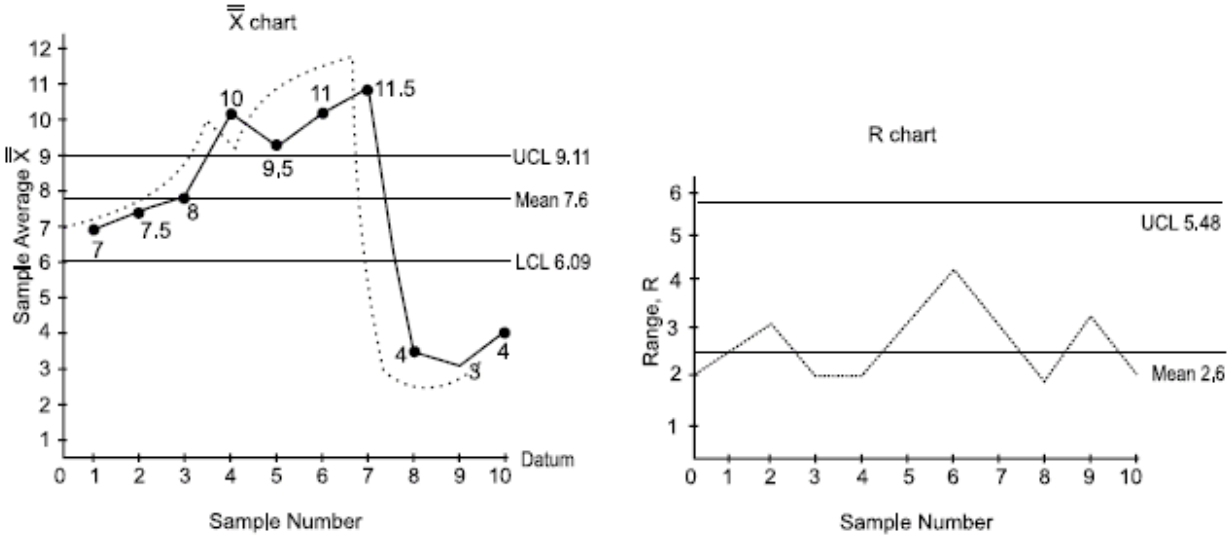
$$\text{LCL} = 7.6 - (0.58 \times 2.6) = \mathbf{6.09}$$

For R chart $$\text{UCL} = 2.11 \times 2.6 = \mathbf{5.48}$$

$$\text{LCL} = D_3 \times \overline{R} = 0 \times \overline{R} = \mathbf{0}$$

These control limits are marked on the graph paper on either side of the mean value (line). $\overline{\overline{X}}$ and R values are plotted on the graph and jointed, thus resulting the control chart.

From the $\overline{\overline{X}}$ chart, it appears that the process became completely out of control for 4th sample over labels.



(ii) Standard Deviation of the Process, σ, known

ILLUSTRATION 3: *Twenty-five engine mounts are sampled each day and found to have an average width of 2 inches, with a standard deviation of 0.1 inche. What are the control limits that include 99.73% of the sample means (z = 3)?*

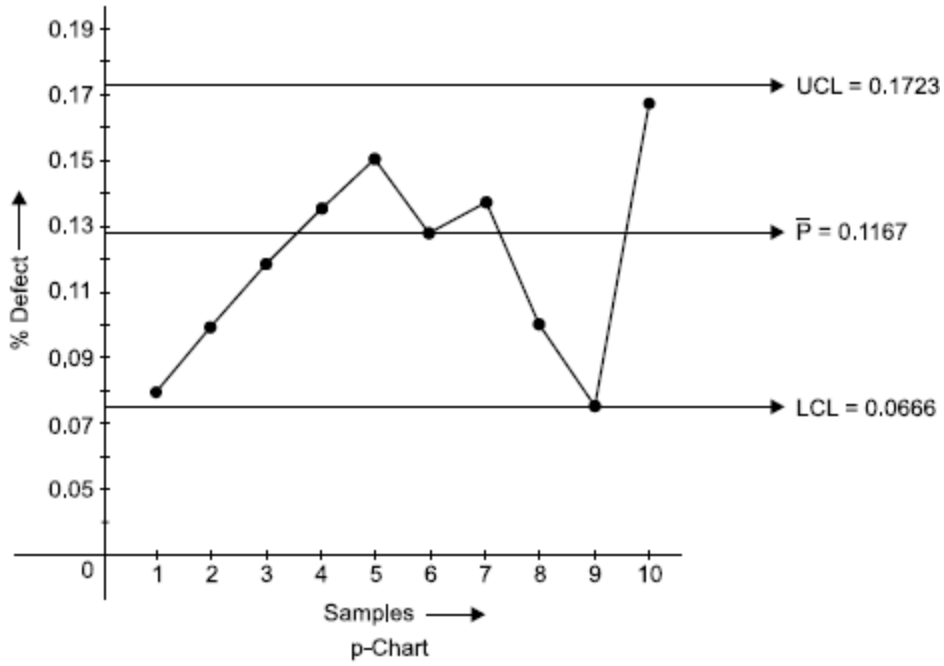
SOLUTION: $$\text{UCL}_{\bar{x}} = \overline{\overline{X}} + Z\sigma_{\bar{x}} = 2 + 3\left(0.1/\sqrt{25}\right) = 2 + 0.06 = 2.06 \text{ inches}$$

$$\text{LCL}_{\bar{x}} = \overline{\overline{X}} - Z\sigma_{\bar{x}} = 2 - 3\left(0.1/\sqrt{25}\right) = 2 - 0.06 = 1.94 \text{ inches}$$

ILLUSTRATION 4 ***(Problem on p-Chart)***: *The following are the inspection results of 10 lots, each lot being 300 items. Number defectives in each lot is 25, 30, 35, 40, 45, 35, 40, 30, 20 and 50. Calculate the average fraction defective and three sigma limit for P-chart and state whether the process is in control.*

SOLUTION:

Date	*Number of pieces inspected* (*a*)	*Number of defective pieces found* (*b*)	*Fraction defective* $p = (b)/(a)$	*% Defective loop*
November 4	300	25	0.0834	8.34
November 5	300	30	0.1000	10.00
November 6	300	35	0.1167	11.67
November 7	300	40	0.1333	13.33
November 8	300	45	0.1500	15.00
November 10	300	35	0.1167	11.67
November 11	300	40	0.1333	13.33
November 12	300	30	0.1000	10.00
November 13	300	20	0.0666	6.66
November 14	300	50	0.1666	16.66
Total Number = 10	3000	350		



Upper Control Limit, UCL $= \bar{p} + 3\sqrt{\dfrac{\overline{P}\left(1-\overline{P}\right)}{n}}$

$$\text{Lower Control Limit, LCL} = \bar{p} - 3\sqrt{\frac{\bar{P}(1-\bar{P})}{n}}$$

where $$\bar{p} = \frac{\text{Total number of defective pieces found}}{\text{Total number of pieces inspected}}$$

$$\bar{p} = \frac{350}{3000} = \mathbf{0.1167}$$

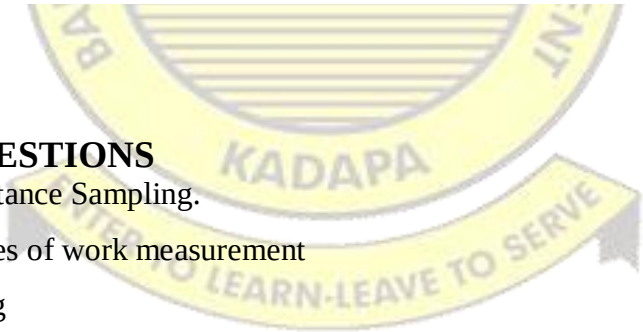
and n = number of pieces inspected every day
$= 300$

Therefore, $$\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = \sqrt{\frac{0.1167 \times (1-0.1167)}{300}}$$

$$= \sqrt{\frac{0.1167 \times 0.8333}{300}} = \mathbf{0.01852}$$

and $$3.\sqrt{\frac{\bar{p}(1-\bar{p})}{n}} = 0.01852 \times 3 = \mathbf{0.05556}$$

Thus, UCL = 0.1167 + 0.05556 = 0.17226 = 0.1723 (Approx.)
LCL = 0.1167 – 0.05566 = 0.06114 = 0.0611 (Approx.)



IMPORTANT QUESTIONS

1. Explain about Acceptance Sampling.
2. Discuss the techniques of work measurement
3. Explain the following

(i) Method Study

(ii) Job Design

(iii) Work Design

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SYLLABUS

(17E00206) OPERATIONS MANAGEMENT

The objective of the course is to enable students to understand the production Planning and Controlling aspects of a typical production and operations organization. Study understands the concepts of work study and Quality management.

1. **Introduction:** Overview of production and Operations Management(POM) Function, Historical Development of POM, POM scenario Today, product and process Design Product and Process Development, Manufacturing Process Technology, CAD/CAM analysis

2. **Facilities Management & Aggregate Planning:** Location of Facilities, Layout of Facilities, Optimization of Product/ Process Layout, Flexible Manufacturing and Group Technology: Aggregate Planning – Preparation of Aggregate Demand Forecast, specification of Organizational Policies For Something, Capacity Utilization, Determination of feasible Production Alternatives.

3. **Scheduling:** Scheduling In Job, Shop Type Production, Shop- Loading, Assignment and Sequencing, Scheduling In Mass, Line of Balance, Methods Production Control, World Class Production.

4. **Work Study and Quality Management:** Method Study, Work Measurement, Work Design, Job Design, Work Sampling, Industrial Engineering Techniques. Economics of Quality Assurance Inspection and Quality Control, Acceptance Sampling, Theory of Control Charts, Control Charts for Variables and Control Charts for attributes.

5. **Materials Management:** Introduction, Objectives, Importance of Materials management - Issues in Materials Management - Functions - Activities - Selection of Materials - Advantages of Materials Management.

Text Books:

Production and Operations Management, Aswathappa K - Himalaya Publishing House

"Production and Operations Management" - Dr. K.Sai Kumar, Kalyani Publishers

References:

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- Production and Operations Management - Text and Cases, Upendra Kachru, Excel Books

UNIT-5

5.1. MEANING OF MATERIAL MANAGEMENT:-

The process of controlling the materials involved in the manaufacting process of a product by a company is called as Material Management. Materials are the most important part of a productive process. The costs of materials used in manufacturing a product from a big part of the cost of finished product, making their management vital to the manufacturing process. So, it can be concluded that proper and orderly material management is very important for a manufacturing concern.

DEFINITION OF MATERIAL MANAGEMENT:-

According to International Federation of Purchasing and Materials Management, "Material Management is a total concept involving an organizational structure unifying into a single responsibility, the systematic flow and control of material from identification of the need through customer delivery".

Hence, Material Management is a term that includes all material related items, (e.g., supply, procurement etc.,) that are virtual for manufacturing a particular product. The forecasting and purchasing of raw material and manifesting equipment with designs and valuation, together with planned procurement of all materials that may include capital goods; packing materials; stock and storage control; material handling and statistical analysis of all supplies.

5.2. OBJECTIVES:

OBJECTIVES OF MATERIAL MANAGEMENT:-

The objective of material management can be divided in two parts:

I. PRIMARY OBJECTIVES:-

The following can be seen as primary purposes of material management:

a. To procure raw materials at the best available price by adhering to predetermined purchases policies.

b. To ensure optimum availability of raw materials so that the organism does not run out of them or end up locking too many funds in storing them.

c. To minimum administration costs and other related activities while procuring materials; and maintain enough stock required to fulfill demand.

d. To avoid running out of supply by continuously maintaining stock of materials.

e. To ensure that materials meet set standards and quality demanded by users.

f. To make sure the workplace is not overstaffed and work is distributed equally among workers.

II. SECONDARY OBJECTIVES:-

a. To work with the designed/ technical department to develop alternatives for raw materials and products. This will increase the profit of a company.

b. To decided whether it will be economic to 'make or buy'

c. To ensure quality of materials at all times.

d. To work towards continuous improvement of final product.

e. To improve cooperative among departments.

f. To follow reliable forecasting methods to calculate demand of materials.

5.3. IMPORTANCE/ADVANTAGES OF MATERIAL MANAGEMENT:

Material management has its own importance, some of them are:

a. Halting in the production process is minimized by ensuring constant supply of materials.

b. Effective management of materials keeps purchasing and transportation costs in control of the firm.

c. Wastage of materials is minimized through optimum stocking and effective control.

d. By checking the quality of materials before purchasing them, the firm can ensure its final product will not be rejected by customers.

e. All inputs are timely available.

f. Factors such as workforce, funds and equipment are used to the

their best.

g. Avoids blockages in stores throughout the production process.

h. Reduction in duplicated orders.

i. Improvements in overall plant availability for production.

j. Improved teamwork and relationship with production departments.

5.4. ISSUES IN MATERIAL MANAGEMENT:

The Challenges before managerial management in industry may be summed up as follows:

1. Scare Capital for investing in material inventory
2. Difficulty in forecasting demand accurately
3. Increasing cost of land and storage space,
4. Selection of appropriate vendors
5. Optimizing time and quantity of demand for products
6. Managing information
7. Changes in Plan/Design
8. Changes in Schedule
9. Inclement weather
10. Lack of Coordination among laborers and site personnel
11. Lack of space to store materials at site
12. Shortage of materials during work
13. Increase in material cost
14. Delay in removal of debris causing inflation
15. Lack of funds for payment
16. Improper design specifications, drawings
17. Lack of space for movement of vehicles for unloading materials
18. Storing materials at wrong places
19. Damage of materials
20. Delay in payment for materials.

5.5. FUNCTIONS AND ACTIVITIES OF MATERIALS MANAGEMENT

Following are the major functions and activities of the material management:

1. MATERIAL PLANNING:

It is one of the basic functions of the material management to predict the future requirement of the materials as per the requirement in the manufacturing department. In order to ensure effective control, a material budget is prepared for various departments and the standard performances are compared with the actual and the deviations are further corrected.

Following are some of the issues that are tackled by material planning

a. The sales forecast of the translated for long term requirement of the materials.

b. Considering the sales figures, a production plan is prepared and the material is ascertained.

c. Arrangement is made for the facilities that are required for managing the materials.

2. **MATERIALS BUDGETING:**

In finalizing material budget, there is notable contribution of the personnel from the material management department. They provide the relevant inputs that are required to frame the budget in a profitable manner. The material budget is influenced by the strategic of the management towards inventory control, policies affecting material quantities, change in the cost structure etc. these functions are universal in nature and exist in almost all type of organizations. On the other hand, certain relationship exists in only specified organizations.

3. **PRODUCTION CONTROL**:

It can be achieved by;

a. Ascertaining the requirement of the material and the components to be procured or manufactured.

b. Preparing schedule for the purchasing and the production process of materials.

c. Placing order with the purchasing department and issue work advice to the manufacturing department.

d. Dispatching the materials to productive department.

4. **MATERIAL PURCHASING**:

They are also responsible for procuring the material of the requisite quality in order to satisfy the specification of the product at the minimum cost. Following are the main activities under purchasing

a. Selecting a supplier and issuing purchase order.

b. To ensure that the delivery meets the requirement of materials.

c. To search for the alternatives to increases the profitability of the company.

5. INVENTORY CONTROL OF MATERIAL:

It denotes a process of ensuring that the components are available to meet the productive on time at the minimum cost. It covers:

a. Placing the order for the material at appropriate time.

b. Maintaining record of the material received, issued, in stock.

c. Deciding about the size that is to be ordered i.e. EOQ.

6. **MATERIAL STOCKING:**

It comprises of the following major functions;

a. Accepted the delivery of the materials that are ordered. Verification of the material with purchase order and inspecting the 'good received note'. After all the compliances are done, forwarding the same to the store department.

b. Proper storage of the material to ensure easy and faster retrieval.

c. Physical verification of the material at periodic interval and correcting the deviations.

7. **MATERIAL DISTRIBUTION**:

It refers to distributing of material out of the department i.e. finished goods and verifying the quantity

a. Receiving finished goods from production department. Verifying the same and storing the same till the time they are distributed properly

b. Packing and labeling of the finished goods and making them ready for the delivery.

c. Preparation of shipping documents like bill of material, packing slip, lorry receipt, railway receipt which are required to be forwarded along with the shipment.

d. Reporting the shipment to the accounts department so that the bill can be issued to the customer and copy can be forwarded to the sales department and the order can be closed.

8. MATERIAL HANDLING:

It includes

a. Handling the material through adequate pallets, trucking, containers etc.

b. Arranging various material handling equipment and other allied items.

9. **TRAFFIC:**

It is basically related with managing the inflow and the outflow of the materials. It initialize with receiving material and after that dispatching the same. In case, the company intends to maintain its own network of the traffic fleet or in case the services are hired as part of routine, there can be altogether a distinct function. It covers:

a. Carrying raw material from the supplier's destination, railway offices and other destinations.

b. Carrying finished goods towards the customers, railway offices and other destinations.

c. Administration of the transport route and fares.

d. Maintaining fleet of the delivery vehicles, if the ownership of the same lies with the company

5.6. SELECTION OF MATERIAL:-

For the selection of material for the product, production manager must have sound knowledge of material and their properties, so that he can select appropriate materials for his product. Research on materials is necessary to find alternatives to satisfy the changing needs of the design in the product and availability of material resumes.

PROCESS IN MATERIALS SELECTION:

Following steps should be taken in the selection of materials for the product:

1. ANALYSIS OF MATERIAL PERFORMANCE REQUIREMENT:

Analysis of material performance requirement can be done by the initial screening technique.

This technique use the critical requirement each part to define the performance requirements of the material. Start with all materials available and narrow down the choices on the basis of the rigid requirements.

2. **CREATING ALTERNATIVE SOLUTIONS AND PROCESS OF SOLUTIONS FOR THE OPTIMUM CONCEPT**:

Having specified the material requirements, the rest of the selection process involves the search for the material that would best meet those requirements.

The starting point is the entire range of engineering materials.

At this stage, it is essential to open up channels in different directions. Steel may be the best material for one design Concept while a plastic is best for a different concept, even though the two designs provide similar functions.

This importance of this phase is that it creates alternatives without much regard to their feasibility.

3. EVALUATION OF ALTERNATIVE SOLUTIONS:

Use soft material requirements to further narrow the field of possible materials a few optimum candidates.

4. DECISION ON THE SELECTION OF OPTIMUM SOLUTION:

Use the optimum materials and matching manufacturing processes to make Detail designs.

Compare alternative combinations taking into account the elements of cost. Select optimum combination of Design – material – manufacturing process.

5.7. ADVANTAGES & FACTORS CONSIDERED IN THE SELECTION OF MATERIALS:

Following factors are considered in the selection of materials:

1. AVAILABILITY: -

The material should be readily available in market in large enough quantities to meet the requirement.

2. COST:-

For every application, there is limiting cost beyond which the designer cannot go. When the limit exceeded the designer has to consider an alternative material. In cost analysis, there are two factors namely cost of material and the cost of processing the material into finished goods. It is likely that the cost of material might be low but the processing may involve costly machining operations.

3. MECHNICAL PROPERTIES:-

The important mechanical properties of material from the consideration design are strength, rigidity, toughness, resilience, shock resistance, wear resistance, creep characteristic, corrosion resistance, frictional properties and hardness. These properties are further explained as

a. Strength: the ability of material to withstand stress without fracture is called its strength.

b. Ductility: the property of a material to undergo deformation under tension without fracture is called ductility.

c. Hardness: the ability of a material to withstanding scratching, wear and abrasion or indentation (penetration) by harder bodies is known as hardness.

d. Toughness: toughness is the amount of energy that a material can absorb before it fractures.

e. Resilience: it is the capacity of a material to absorb or store energy up to elastic limit, and to resist shock and impact.

f. Creep: The slow and progressive deformation of a material with time at constant stress is called creep.

g. Corrosion Resistance: it is the deterioration of a material by chemical reaction with it environment.

h. Brittleness: The property of a material by virtue of which it will be fractured without appreciable deformation is called brittleness.

i. Weldability: It is defined as the ease with which a material can be welded under a given set of conditions.

Manufacturing Consideration: It is important consideration in selection of materials. Sometimes, expensive materials are more economical than low cost material, which difficult to machine.

IMPORTANT QUESTIONS

1. Define Materials Management. What are the Objectives of Materials Management?
2. Discuss the functions and activities of Material Management?
3. Explain the selection of materials. What process is involved in the selection of material?
4. Briefly discuss the factors considered in the selection of materials?
5. Enumerate the advantages of Materials Management?

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