Unit – 2 MANAGEMENT SCIENCE

List of topics/questions in this units:

1) **Principals of Operations Management**
2) **Types of Operations Management**
3) **Inventory – types, system, graph.**
4) **inventory control – techniques, need for inventory control.**
5) **Modern methods of inventory control/inventory management**
6) **Material management – importance / functions**
7) **Purchase process.**
8) **Work Study – method study, work measurement, & Work sampling techniques**
9) **method study – purpose, process, techniques**
10) **work measurement - purpose , techniques**
11) **Work sampling techniques**
12) **Statistical quality control – charts**

1) Principals of Operations Management

It is concerned with converting materials and labor into goods and services as efficiently as possible to maximize the profit of an organization. Operations management attempts to balance costs with revenue to achieve the highest net operating profit possible.

Operations management involves utilizing resources from staff, materials, equipment, and technology. Operations managers acquire, develop, and deliver goods to clients based on client needs and the abilities of the company.

Operations management handles various strategic issues, including determining the size of manufacturing plants and production methods, technology up-gradation, management of inventory levels, work-in-process, raw materials acquisition, quality control, materials handling, and maintenance policies.

Operations management entails studying the use of raw materials and ensuring minimal waste occurs. Operations managers utilize numerous formulas, such as the economic order quantity formula to determine when and how large of an inventory order to process and how much inventory to hold on hand. Operations management is responsible for finding vendors that supply the appropriate goods at reasonable prices and have the ability to deliver the product when needed.

Operations managers are involved in coordinating and developing new processes while reevaluating current structures. Organization and productivity are two key drivers of being an operations manager, and the work often requires versatility and innovation.

Principals of Operations Management

- **Reality.** Operations management should focus on the problem, instead of the techniques, because no tool in itself would present a universal solution.
- **Organization.** Processes in manufacturing are interconnected. All elements have to be predictable and consistent, in order to achieve a similar outcome in profits.
- **Fundamentals.** The Pareto rule is also applicable to operations: 80% of success comes from a strict adherence to precisely maintaining records and disciplines, and only 20% comes from applying new techniques to the processes.

- **Accountability.** Managers are expected to set the rules and the metrics, and define responsibilities of their subordinates, as well as regularly check if the goals are met. Only this way would the workers put in the necessary efforts.
- **Variance.** Variance of processes has to be encouraged, because if managed well, they can be sources of creativity.
- **Causality.** Problems are symptoms: effects of underlying causes. Unless the causes are attacked, the same problems will appear again.
- **Managed passion.** The passion of employees can be a major driver of company growth, and it can be instilled by the managers if not coming naturally.
- **Humility.** Instead of a costly trial and error process, managers should acknowledge their limitations, "get help, and move on."
- **Success.** What is considered success will change over time, but always consider the interest of the customer. In order to keep them, all the other principles have to be revised occasionally.
- **Change.** There will always be new theories and solutions, so you should not stick to one or the other, but embrace the change, and manage for stability in the long term.
- **Team up with customers.** Know what they buy and use, and organize product families accordingly.
- **Continual, rapid improvement.** Aim for non-stop improvement to always deliver the best quality, aim for a quicker response to customer demand, and always offer maximum flexibility. Thus, it gives more value, in a more flexible way.
- **Organize resources.** Set priorities in organizing resources in a way the operations are close to the customer rate of use or demand.
- **Invest in HR.** Offer cross-training options, job rotation, and improvements in work safety and health. Also offer more rewards and recognitions.
- **Maintain equipment.** Always think of improvement of current assets first, instead of a new purchase.
- **Simple "best" equipment.** Keep the equipment as simple and flexible as possible, at a reasonable cost.
- **Minimize human error.** Improve the equipment and keep frontline workers accountable.

2) Types of Operations Management

Operations management is an area of management concerned with designing and controlling the process of production and redesigning business operations in the production of goods or services.[1] It involves the responsibility of ensuring that businessoperations are efficient in terms of using as few resources as needed and effective in terms of meeting customer requirements. Operations management is primarily concerned with planning, organizing and supervising in the contexts of production, manufacturing or the provision of services

TYPES OF PRODUCTION / OPERATIONS MANAGEMENT (or) MANAGER

Operations Management

The operations manager is focused on optimizing general corporate infrastructure by monitoring and changing the work environment, vendor selection, supply chain management, real estate and budgets.

Materials Management

Stores a product through all phases from production to finished goods, shipping between departments, transportation to distribution centers, warehouses, and customers. Materials mangers must insure that the firm has the right item, at the right time, for the right price. This holds for both good and services. For services, the emphasis is on ordering, receiving, storing and distributing any resources required to perform the service. Jobs include: traffic manager, warehouse manager, logistics manager, materials manager.

Purchasing Management Buys the goods and services, raw materials, and supplies required by the firm for its operation. They coordinate the quantity, quality, price, and timing delivery appropriate for the firm's needs. Every firm makes certain purchases each day.

Industrial Production Management

Coordinates the activities of production departments of manufacturing firms. They are responsible for the production scheduling, staffing, quality control, equipment operation and maintenance, inventory control, and coordinating the unit's activities with that of the other departments. Jobs include: line supervisor, manufacturing manager, production planner, production manager.

Operations Research Management

Decides on the best allocation of resources within an organization or system. Resources include time, money, people, space, and raw materials. They might also compare competing research projects to determine what one performs best on time, results, and cost given a fixed set of resources and recommend what project to keep and what project to drop. Jobs include: industrial engineer, systems analyst, office manager, forecaster.

Quality Assurance Management

Works on the prevention of product deficiencies through prevention, detection, and correction. They ensure that production goals and quality are met. They might sample, inspect, and test operations and set standards. With the advent of the Malcolm Baldridge Award many of these manager are part of a firm's total quality management strategic initiatives. Jobs include: quality assurance manager, inspector, technician.

Facilities Management

Designs the physical environment of a company. Work on building design, furniture and associated equipment.

Logistics Management

Responsible for supply chain management in a key area of the corporation. Focused on efficiency and accuracy in receiving and shipping goods. Highly process focued

3) Inventory – types, system, graph

A) INVENTORY – TYPES:

Inventory is defined as a stock or store of goods. These goods are maintained on hand at or near a business's location so that the firm may meet demand and fulfill its reason for existence. If the firm is a retail establishment, a customer may look elsewhere to have his or her needs satisfied if the firm does not have the required item in stock when the customer arrives. If the firm is a manufacturer, it must maintain some inventory of raw materials and work-in-process in order to keep the factory running. In addition, it must maintain some supply of finished goods in order to meetdemand. Generally, inventory types can be grouped into four classifications: raw material, work-in-process, finished goods, and MRO goods.

RAW MATERIALS

Raw materials are inventory items that are used in the manufacturer's conversion process to produce components, subassemblies, or finished products. These inventory items may be commodities or extracted materials that the firm or its subsidiary has produced or extracted. They also may be objects or elements that the firm has purchased from outside the organization.

WORK-IN-PROCESS

Work-in-process (WIP) is made up of all the materials, parts (components), assemblies, and subassemblies that are being processed or are waiting to be processed within the system. This generally includes all material—from raw material that has been released for initial processing up to material that has been completely processed and is awaiting final inspection and acceptance before inclusion in finished goods.

FINISHED GOODS

A finished good is a completed part that is ready for a customer order. Therefore, finished goods inventory is the stock of completed products. These goods have been inspected and have passed final inspection requirements so

that they can be transferred out of work-in-process and into finished goods inventory. From this point, finished goods can be sold directly to their final user, sold to retailers, sold to wholesalers, sent to distribution centers, or held in anticipation of a customer order.

MRO GOODS INVENTORY (SPARE PARAT AND TOOLS)

Maintenance, repair, and operating supplies, or MRO goods, are items that are used to support and maintain the production process and its infrastructure. These goods are usually consumed as a result of the production process but are not directly a part of the finished product. Examples of MRO goods include oils, lubricants, coolants, janitorial supplies, uniforms, gloves, packing material, tools, nuts, bolts, screws, shim stock, and key stock.

B) INVENTORY SYSTEM:

Definition of an Inventory Management System
An inventory management system is the combination of technology (hardware and software) and processes and procedures that oversee the monitoring and maintenance of stocked products, whether those products are company assets, raw materials and supplies, or finished products ready to be sent to vendors or end consumers. A complete inventory management system consists of:

BIN CARD: A BIN Card is a table that records the status of a good held in stock. A typical retailing business with a large stock warehouse will use a BIN card to record a running balance of stock on hand, in addition to information about stock received and notes about problems associated with that stock item.

Barcode scanning: Easily identify and track your products; inventory management software integrates with barcode scanners for instant product identification and labeling.

Stock notifications (Inventory staturs file) : Receive alerts and notifications when there's over- or under-stocking beyond a defined doorstep. This helps you to place orders or offer promotional discounts to clear out extra stock.

Report generation: View sales history in the form of a list of your most popular products. This feature also enables you to manage items in your inventory that have not reached the sales levels you expected, for example, by offering discounts on them.

Material Requirement : inventory into predefined categories and ensure you're always updated about quantities of components and specifications that make up your product stock, and manage their reordering schedules as required.

Purchase order records: Create a single view of purchase order records. You can easily identify which products are in demand, both perpetually and seasonally, and prepare to meet your customers' needs.

Warehouse management: This feature is useful if you need to optimize your warehouse stock and maintain an accurate log of each product's location. It'll give you a single view of where all of your products are stored.

Benefits of Inventory Systems:

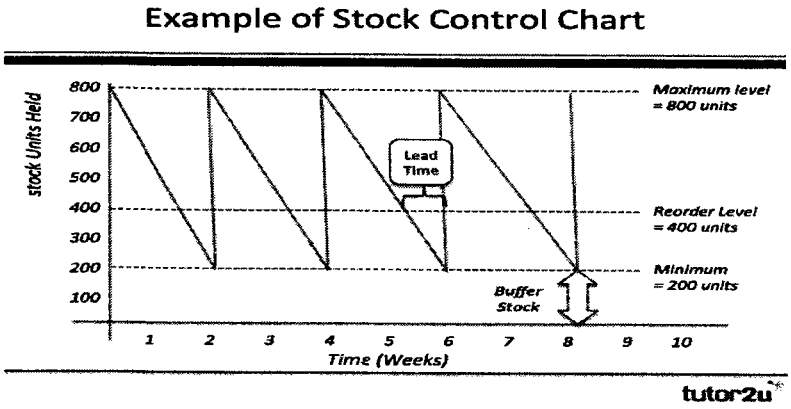
inventory management systems are critical for keeping tabs on current stock levels and understanding what items move quickly and which items are more slow-moving, which in turn enables organizations to determine when it's time to reorder with greater accuracy.

- Improved cash flow
- Better reporting and forecasting capabilities
- Reduction in storage costs (overhead)
- Reduced labor costs
- Reduction in dead stock
- Better organization
- Enhanced transparency
- Improved supplier, vendor, and partner relationships

C) INVENTORY (STOCK) GRAPH/ CHART

The overall objective of inventory (stock) control is to maintain inventory levels to that the total costs of holding stocks is minimise. A popular method of implementing stock control is through the use of inventory (stock) control charts and algorithms that automate the process.

An example of a traditional stock control chart is shown below:



The key parts of the stock control chart are:

Maximum level

- Max level of stock a business can or wants to hold
- Example chart: 800 units

Re-order level

- Acts as a trigger point, so that when stock falls to this level, the next supplier order should be placed
- Example chart: 400 units

Lead time

- Amount of time between placing the order and receiving the stock
- Example chart: just under a week

Minimum stock level

- Minimum amount of product the business would want to hold in stock.
- Assuming the minimum stock level is more than zero, this is known as buffer stock

Buffer stock

- An amount of stock held as a contingency in case of unexpected orders so that such orders can be met and in case of any delays from suppliers

Factors Affecting When / How Much Stock to Re-order

Lead-time from the supplier

- How long it takes for the supplier to deliver the order
- Higher lead times may require a higher re-order level

Implications of running out (stock-outs)

- If stock-outs are very damaging, then have a high re-order level & quantity

---

4) inventory control – A) techniques, B) need for inventory control.

Inventory control meaning :

Maintaining the stock necessary to meet customer's **needs**, delivery in time, reaching quality expectations and to minimize the costs holding **inventory**. The three primary objectives of controlling **inventory** levels, safeguard **inventory** and report it correctly. **Inventory control** or **stock control** can be broadly defined as "the activity of checking stock. However, a more focused not only **verifying inventory but also focusing** on the many related part of **inventory management** (such as forecasting future demand) "within an organisation to meet the demand placed order to suppliers based on economy.

Other side of inventory control include supply chain management, production control, financial flexibility, and customer satisfaction. At the root of inventory control, however, is the inventory control problem, which involves determining when to order, how much to order, and the logistics/Trasportations etc., of those decisions.

A) INVENTRORY CONTROL TECHNIQUES:

Economic Order Quantity – EOQ
Economic order quantity (EOQ) is the ideal order quantity a company should purchase for its inventory given a set cost of production, a certain demand rate, and other variables. This is done to minimize inventory holding costs and order-related costs.

The equation for EOQ also takes into account inventory holding costs such as storage, ordering costs and shortage costs. This production-scheduling model was developed in 1913 by Ford W. Harris and has been refined over time. The formula assumes that demand, ordering, and holding costs all remain constant.

The **Formula** for Economic Order Quantity Is

Q=EOQ units

D=Demand in units (typically on an annual basis)

S=Order cost (per purchase order)

H=Holding costs (per unit, per year)

The goal of the EOQ formula is to identify the optimal number of product units to order so that a company can minimize its costs related to buying, taking delivery of and storing the units.

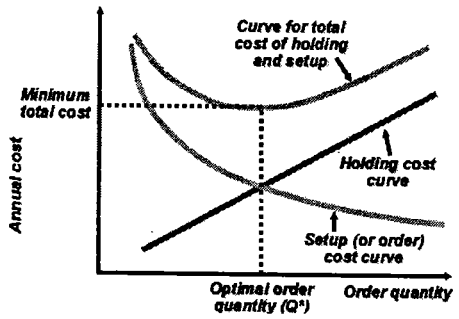
- the EOQ is a company's optimal order quantity that minimizes its total costs related to ordering, receiving and holding the inventory.
- The EOQ formula is best used in situations where demand, ordering, and holding costs remain constant over time.

Assumptions:

- (i) Constant or uniform demand.

- (ii) Independent orders.
- (iii) Instantaneous delivery.
- (iv) Constant ordering costs.
- (v) Constant carrying costs.
- (vi) Constant unit price.

EOQ **GRAPH**



EPQ: IT is quite similar to EOQ. But, small change is that if supplier is out siders, then it is inventory planning is called EOQ. IF supplier is insider, then plan of inventory is called EPQ (Econmic Production Quantity

Re-ordering level:
It is also known as 'ordering level' or 'ordering point' or 'ordering limit'. It is a point at which order for supply of material should be made.

This level is fixed somewhere between the maximum level and the minimum level in such a way that the quantity of materials represented by the difference between the re-ordering level and the minimum level will be sufficient to meet the demands of production till such time as the materials are replenished. Reorder level depends mainly on the maximum rate of consumption and order lead time. When this level is reached, the store keeper will initiate the purchase requisition.

Re-order level =Maximum Rate of consumption x maximum lead time

Maximum Level of inventory:
Maximum level is the level above which stock should never reach. It is also known as 'maximum limit' or 'maximum stock'. The function of maximum level is essential to avoid unnecessary blocking up of capital in inventories, losses on account of deterioration and obsolescence of materials, extra overheads and temptation to thefts etc. This level can be determined with the following formula. Maximum Stock level = Reordering level + Reordering quantity — (Minimum Consumption x Minimum re-ordering period)

Minimum Level of inventory:
It represents the lowest quantity of a particular material below which stock should not be allowed to fall. This level must be maintained at every time so that production is not held up due to shortage of any material.

It is that level of inventories of which a fresh order must be placed to replenish the stock. This level is usually determined through the following formula:

Minimum Level = Re-ordering level — (Normal rate of consumption x Normal delivery period)

Average Stock Level:
Average stock level is determined by averaging the minimum and maximum level of stock. Average level =1/2 (Minimum stock level + Maximum stock level)

Danger Level:
Danger level is that level below which the stock should under no circumstances be allowed to fall. Danger level is slightly below the minimum level and therefore the purchases manager should make special efforts to acquire required materials and stores.

Safety stock :Safety stock is an additional quantity of an item held by a company in inventory in order to reduce the risk that the item will be out of stock. Safety stock acts as **a buffer** in case the sales of an item are greater than planned and/or the company's supplier is unable to deliver additional units at the expected time.

lead time : The lead time is the delay applicable for inventorycontrol purposes. This delay is typically the sum of the supply delay, that is, the time it takes a supplier to deliver the goods once an order is placed, and the reordering delay, which is the time until an ordering opportunity arises again.

ABC analysis is an approach for classifying inventory items based on the items' consumption values. Consumption value is the total value of an item consumed over a specified time period, for example a year. the *ABC analysis* is an inventory categorization technique. ABC analysis divides an inventory into three categories—"A items" with very tight control and accurate records, "B items" with less tightly controlled and good records, and "C items" with the simplest controls possible and minimal records. (NOTES REFER)

HML analysis. An inventory classification scheme **HML** is based on Pareto principle, or 80/20 rule. In ABC **analysis** the items are categories into. H, M, L category based on unit cost. In this **analysis** cut-off-lines are then fixed by the management of the company to classify the inventory items.

VED Analysis :- It attempts to classify the items used into three broad categories, namely Vital, Essential, and Desirable. The **analysis** classifies items on the basis of their criticality for the industry or company.

FSN stands for fast-moving, slow-moving and non-moving items. Essentially, this segments inventory into three classifications. It looks at quantity, consumption rate and how often the item is issued and used. Fast-moving items are items in your inventory stock that are issued or used frequently.

SDE analysis is based upon the availability of items and is very useful in the context of scarcity of supply. * S refers to scarce items, generally imported, and those which are in short supply. * D refers to difficult items, which are available indigenously but are difficult items to procure.

Sos analysis : Seasonality refers to predictable changes that occur over a one-year period in a business or economy based on the seasons including calendar or commercial seasons.Seasonality can be used to help analyze stocks and economic trends. Companies can use seasonality to help determine certain business decisions such as inventories and staffing.

GOLF Classification:-

The letter stands for Government, Ordinary, Local and Foreign. There are mainly imported items which are canalized through the State Trading Corporation (STC) Minerals and Metals Trading Corporation, etc. Indian Drugs and Pharmaceutical Ltd (IDPL), Mica trading corporation etc. These are special procedures of inventory control which may not applicable to ordinary items as they require special procedures.

B) NEED/ IMPORTANCE/ SIGNIFICANCE/ OBJECTIVES OF INVENTORY CONTROL (or) INVENTORY MANAGEMENT

(i) Reducing Risk of Production Shortages:
Firms mostly manufacture goods with hundreds of components. The entire production operation can be halted if any of these are missing. To avoid the shortage of raw material the firm can maintain larger inventories.

(ii) Reducing Order Cost:
Where a firm places an order, it incurs certain expenses. Different forms have to be completed. Approvals have to obtained, and goods that arrive must be accepted, inspected and counted. These costs will vary with the number of orders placed. Smaller the inventories lesser the capital needed to carry inventories.

(iii) Minimise the Blockage of Financial Resources:
The importance of inventory control is to minimise the blockage of financial resources. It reduces the unnecessary tying up of capital in excess inventories. It also improves the liquidity position of the firm.

(iv) Avoiding Lost Sales:
Most firms would lose business without goods on hand. Generally a firm must be prepared to deliver goods on demand. By ensuring timely availability of adequate supply of goods, inventory control helps the firm as well as consumers.

(v) Achieving Efficient Production Scheduling:
The manufacturing process can occur in sufficiently long production runs and with preplanned schedules to achieve efficiencies and economies. By maintaining reasonable level of inventory production scheduling becomes easier for the management.

(vi) Gaining Quantity Discounts:
While making bulk purchases many suppliers will reduce the price of supplies and component supplies will reduce the price of supplies and component parts. The large orders may allow the firm to achieve discounts on regular basis. These discounts in turn reduce the cost of goods and increase the profits.

(vii) Taking the Advantage of Price Fluctuations:
When the prices of the raw materials are low the firm makes purchases in economic lots and maintains continuity of operations. By reducing the cost of raw materials and procuring high prices for its goods the firm maximises profit. This with the help of inventory control the firm takes advantage of price fluctuations.

(viii) Tiding over Demand Fluctuations:
Inventory control also helps the firm in tiding over the demand fluctuation. These are taken care of by keeping a safety stock by the firm. Safety stock refers inventories carried to protect against variations in sales rate, production rate and procurement time. Inventory control aims at keeping the cost of maintaining safety stock minimum.

(ix) Deciding timely Replenishment of Stocks:
Inventory control results in the maintenance of necessary records, which can help in maintaining the stocks within the desired limits. With the help of adequate records the firm can protect itself against thefts, wastes and leakages of inventories. These records also help in deciding about timely replenishment of stocks.

5) Modern methods of inventory control/ inventory management

1) JUST IN TIME (JIT)

The just-in-time (JIT) inventory system is a management planning to **arranges** the raw material orders from suppliers directly to production based on production schedules. Companies use this inventory strategy to **increase efficiency** and **decrease waste** by receiving goods only as they need them for the production process, which **reduces inventory costs**. This method requires producers to **forecast demand** accurately. And also **Providing** raw materials at right time, right palce, at quality, at quantity and at flexible pricing.

It is also known as **just-in-time production** or the Toyota Production System (TPS) Its origin and development was in Japan, largely in the 1960s and 1970s and particularly at Toyota. The success of the JIT production process relies on steady production, high-quality workmanship, no machine breakdowns, and reliable suppliers.

2) MRP (MATERIAL REQUIREMENT PLANNING)

Material requirements planning (MRP) is a system for calculating the materials and components needed to manufacture a product. It consists of three primary steps: taking inventory of the materials and components on hand, identifying which additional ones are needed and then scheduling their production or purchase. An MRP system is intended to simultaneously meet three objectives:

- Ensure materials are available for production and products are available for delivery to customers.
- Maintain the lowest possible material and product levels in store
- Plan manufacturing activities, delivery schedules and purchasing activities.

3) VENDOR RATING

Vendor Rating (also called: supplier rating) is a system used by buying organizations or industry analysts to record, analyze, rank and report the performance of a supplier in terms of a range of predefined criteria, which may include such things as:

- Quality of the Materials
- Delivery performance and Reliability
- Cost, price
- Right time delivery
- Quantity
- Financial support / Provide credit facility

The method includes defining the criteria and the weight each criterion receives in the overall result, development of the questions and questionnaires, actually carrying out the measurements, and finally interpreting the results. If vendor ratings are carried out periodically or even ongoing, the results (per vendor) can be analyzed and compared over time and finally select vendor

4) VALUE ANALYSIS

the systematic identification of **unnecessary costs** in a product or service and efficiently eliminating them without damage its **quality and efficiency.** It can also be defined as a systematic analysis and evaluation of techniques and functions in the various areas of a concern with a view to exploring of **performance improvement** so that the value attached to a particular product may be improved.

Systematic analysis that identifies and selects the best value alternatives for **designs, materials, processes, and systems.** It proceeds by eliminated defects and wastages, without diminishing the effectiveness, required quality, and gain customer satisfaction. It is Also know as value engineering

5) SUPPLY CHAIN MANAGEMENT:

Supply chain management (SCM) is the broad range of activities required to plan, control and execute a product's flow, from acquiring raw materials and production through distribution to the final customer, in the most streamlined and cost-effective way possible. A supply chain starts with the delivery of raw materials from a supplier to a manufacturer and ends with the delivery of the finished product or service to the end consumer.

supply chain which consists of five parts: 1) the plan or strategy, 2) the source (of raw materials or services), 3) manufacturing (focused on productivity and efficiency), 4) delivery and logistics, and 5) the return system (for defective or unwanted products).

the management of the flow of goods and services,[2] involves the movement and storage of raw materials, of work-in-process inventory, and of finished goods from point of origin to point of consumption. Interconnected, interrelated or interlinked networks, channels and node businesses combine in the provision of products and required by end customers in a supply chain. That are distributors, dealers, whole sellers, and retailers.

6) Material management – importance / functions

Materials Management is related to planning, procuring, storing and providingthe appropriate material of right quality, right quantity at right place in right time so as to co-ordinate and schedule the production activity in an integrative way for an industrialundertaking.

Most industries buy materials, transport them in to the plant, change thematerials in to parts, assemble parts in to finished products, sell and transport the productto the customer. All these activities of purchase of materials, flow

of materials, manufacturethem in to the product, supply and sell the product at the market requires various types of materials to manage and control their storage, flow and supply at various places. It is only possible by efficient materials management.

L.J. De Rose: - "Material management is the planning, directing, controlling and co-ordination of all those activities concerned with material and inventory requirements, from the point of their inception to their introduction into manufacturing process."

N.K. Nair: - "the co-ordination of all those activities which are related to the efficient use of materials".

Material management is a service function. It is as important as manufacturing, engineering and finance. The supply of proper quality of materials is essential for manufacturing standard products. The avoidance of material wastage helps in controlling cost of production. Material management is essential for every type of concern.

Functions of Material Management:

1. Production and Material Control:
Production manager prepares schedules of production to be carried in future. The requirements of parts and materials are determined as per production schedules. Production schedules are prepared on the basis of orders received or anticipated demand for goods. It is ensured that every type or part of material is made available so that production is carried on smoothly.

2. Purchasing:
Purchasing department is authorized to make buying arrangements on the basis of requisitions issued by other departments. This department keeps contracts with suppliers and collects quotations etc. at regular intervals. The effort by this department is to purchase proper quality goods at reasonable prices. Purchasing is a managerial activity that goes beyond the simple act of buying and includes the planning and policy activities covering a wide range of related and complementary activities.

3. Non-Production Stores:
Non-production materials like office supplies, perishable tools and maintenance, repair and operating supplies are maintained as per the needs of the business. These stores may not be required daily but their availability in stores is essential. The non-availability of such stores may lead to stoppage of work.

4. Transportation:
The transporting of materials from suppliers is an important function of materials management. The traffic department is responsible for arranging transportation service. The purpose is to arrange cheap and quick transport facilities for incoming materials.

5. Materials Handling:
It is concerned with the movement of materials within a manufacturing establishment and the cost of handling materials is kept under control. It is also seen that there are no wastages or losses of materials during their movement. Special equipment's may be acquired for material handling.

6. Receiving: The receiving department is responsible for the unloading of materials, counting the units, determining their quality and sending them to stores etc. The purchasing department is also informed about the receipt of various materials.

7. Production Control - As production schedules are generated through demand analysis, the materials that are needed are determined. It is important to find readily available materials to make sure that production flows smoothly.

8. Material Requirement Planning (MRP): Material Requirements Planning (MRP) is a computer-based production planning and inventory Control system. MRP is concerned with both production scheduling and inventory control. It is a material control system that attempts to keep adequate inventory levels to assure that required Materials are available when needed. The **major objectives of an MRP system** are to simultaneously:

- Ensure the availability of materials, components, and products for planned production and for Customer delivery,

- Maintain the lowest possible level of inventory,
- Plan manufacturing activities, delivery schedules, and purchasing activities.

9. Material Quality Control: The quality of the finished products manufactured will depend upon the quality of raw material used to manufacture those products. Therefore, the purchase of right quality of materials is indeed very important. The quality of materials can be measured through proper inspection, specification, quality control, simplification and standardization.

10. System Efficiency: This function ascertains the efficiency of the system being used. If the system used for materials management in inept of faulty, the above objectives cannot be met, irrespective of the procedure adopted. For things to be maintained in an effective manner as planned for managing materials, an effective control ought to be there for every single process in the department.

11. Product Design and Development: The product sales can be boosted with its range and functionality. With the help of the advanced technology such as computer such as Computer Aided Design (CAD), the product can be designed different with a variety of options and yet a fast pace. Another technology development in manufacturing is the computer Aided Manufacturing (CAM) that can bring both a variety as well as flexibility to a product.

12. Estimation and Planning: The MRP can be implemented through accurate estimates of sales and demand for products in the industry. Market fluctuations should be given due consideration to make any production control. The materials management department can make use of one of the methods of forecasting that gives productive results to the organization. Predicting the future demand of sales helps in the planning of materials supply.

The importance of material management :

- The material cost content of total cost is kept at a reasonable level. Scientific purchasing helps in acquiring materials at reasonable prices. Proper storing of materials also helps in reducing their wastages. These factors help in controlling cost content of products.
- The cost of indirect materials is kept under check. Sometimes cost of indirect materials also increases total cost of production because there is no proper control over such materials.
- The equipment is properly utilized because there are no break downs due to late supply of materials.
- The loss of direct labour is avoided.
- The wastages of materials at the stage of storage as well as their movement is kept under control.
- The supply of materials is prompt and late delivery instances are only few.
- The investments on materials are kept under control as under and over stocking is avoided.
- Congestion in the stores and at different stages of manufacturing is avoided.

- It helps to minimize loss by obsolescence,deterioration damage etc.
- It helps to protect against thefts, wastages,etc.
- It helps managers in decision making.
- To minimize capital investment in inventory.
- To minimize cost of material purchasing.
- To increase the storing capacity.
- To maintain reasonable stocks of materials.
- To facilitates regular and timely supply tocustomers.

- To ensures smooth production operations.
- To check national wastage.

7) Purchase process

1. Receiving and analysing purchasing requisition:
Purchase requisitions start with the department or person who will be the ultimate user. In the material requirements planning environment, the planner releases a planned order authorising the purchasing department to go ahead and process a purchase order. **The purchase requisition contains, at least, the following information:**

a. Identity of originator, signed approval, and account to which cost is assigned.

b. Material specification.

c. Quantity and unit of measure.

d. Required delivery date and place.

e. Any other supplementary information required.

2. Selecting suppliers:
Identifying and selecting suppliers are important responsibilities of the purchasing department. For routine items or those that have not been purchased in the past, a list of approved suppliers is kept. If the item has not been purchased before or there is no acceptable supplier on file, a search must be made.

3. Requesting quotations:
For major items, it is usually desirable to issue a request for quotation. This is a written inquiry that is sent to many suppliers to ensure that competitive and reliable quotations are received. It is not a sales order. After the suppliers have completed the quotations and returned it to the buyer, the quotations are analysed for price, compliance to specification, terms and conditions of sale, delivery, and payment terms.

4. Determining the right price:
This is the responsibility of the purchasing department and is closely tied to the selection of suppliers. The purchasing department is also **responsible for price negotiation** and will try to obtain the best price from the supplier.

5. Issuing a purchasing order:
A purchase order is a legal offer to purchase. Once accepted by the supplier, it becomes legal contract for delivery of the goods according to the terms and conditions specified in the purchase agreement. The purchase order is prepared from the purchase requisition or the quotations and from any other additional information needed. A **copy is sent to the supplier**; copies are retained by purchasing and are also sent to other departments such as accounting, the originating department, and receiving.

6. Following-up and delivery:
The supplier is responsible for delivering the items ordered on time. The purchasing department is responsible for ensuring that suppliers do deliver on time. If there is doubt that delivery dates can be met, purchasing must find out the problem in time and take corrective action. This might involve **speed up** transportation, alternate sources of supply, working with the supplier to solve its problems, or rescheduling production.

The purchasing department is also responsible for working with the supplier on any changes in delivery requirements. Demand for items changes with time, and it may be necessary to expedite certain items or push delivery back on some others. The buyer must keep the supplier informed of the true requirements so that the supplier is able to provide what is wanted and when.

7. Receiving and accepting goods: When the goods are received, the receiving department inspects the goods to ensure that correct ones have been sent, are in the right quantity, and the bill of lading supplied by the carrier. The receiving department then accepts the goods and writes up a receiving report noting any variance.

8. Approving supplier's invoice for payment:
When the supplier's invoice is received, there are three pieces of information that should agree – the purchase order, the receiving report, and the invoice. The items and the quantities should be the same on all; the prices, and extensions to prices, should be the same on the purchase order and the invoice.

8) Work Study – method study, work measurement, & Work sampling techniques

Introduction to Work Study.

Work Study is systematic **study** of**methods** of **work** in order to improve effective use of its resources and set standards of performance. It can be applied where a set of processes is involved. ...**Work study** helps to reduce waste through standardization of element of the **job**.

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

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

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

the objective of work study is to assist the management to obtain the optimum use of the human and material resources available to the organization for the accomplishment of the work for which, it is engaged.

Advantages of Work Study:

(1) It is direct means of improving productivity.
(2) It results in uniform and improved production flow.
(3) It reduces the manufacturing cost.
(4) With its help fast and accurate delivery dates are possible.
(5) It provides better service and consumer satisfaction.
(6) It improves employee-employer relations.
(7) It provides job satisfaction and job security to workers.
(8) Better working conditions are possible for workers.
(9) It is most important tool of analysis and can help in providing better wages to workers on scientific basis.
(10) Most accurate method and yet provides a sound basis for production planning, control and incentives for man power.
(11) Everyone concerned with industries is benefited from it such as worker, consumer and management of the unit.

Techniques of Work Study:

Basically there are two techniques:
Method study and work measurement as shown in Fig. 17.1.

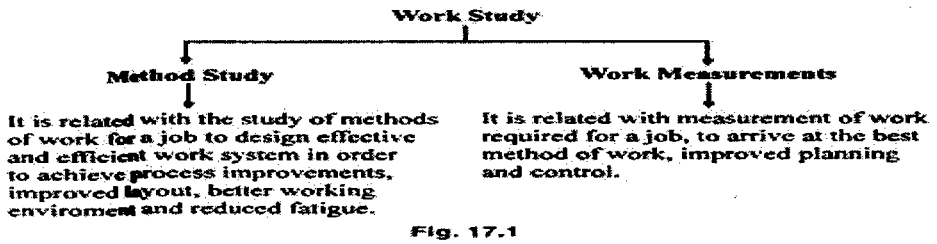


Fig. 17.1

Thus work study is the term used to embrace the techniques of Method Study and Work Measurement which are used to ensure the best utilization of manpower and material resources in carrying out specified activity.(COMBINATION OF NEXT 3 QUESTIONS I.E., 9, 10, 11 Questions REFFER)

9) METHOD STUDY: - A) PURPOSE, B) TECHNIQUES , C) PROCEDURE.

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.

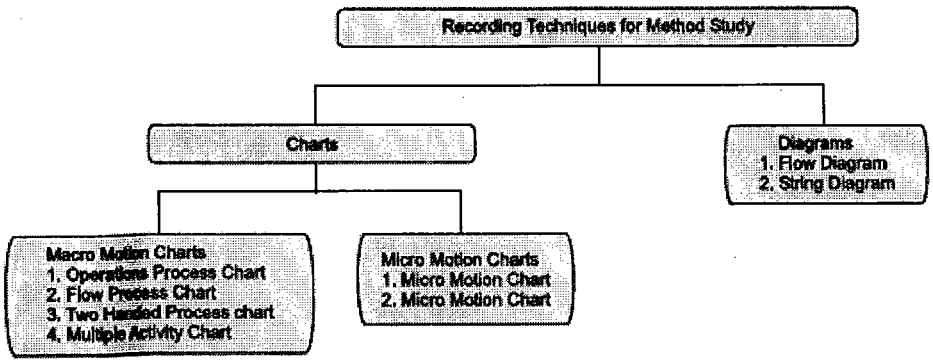
According to British Standards Institution (BS 3138): *"Method study is the systematic recording and critical examination or existing and proposed ways or doing work as a means or developing and applying easier and more effective methods and reducing cost."*

A) METHOD STUDY – PURPOSE/objectives/benifits:

- Better design of plant equipment and buildings.
- Less fatigue or workers by avoiding unnecessary movements of manpower.
- Better working conditions and environment for workers/employees.
- To have more effective utilisation of materials, machines and manpower and money.
- Better Product quality.
- Efficient and fast material handling equipment.
- Leads to standardisation, rationalisation, simplification and specialisation.
- Efficient planning of the section.
- Streamlined working procedures
- Dissatisfaction among the clients/Beneficiaries.
- Escalating operating costs.
- Low morale of the staff.
- Lack of discipline among the employees,visible through late comings,not available during the office hours etc.
- Operating costs-running higher than normal or gradually increasing
- High wastage-poor use of materials, machinery, labour, space and services
- Excessive movement and backtracking ions, handling of materials and men
- Existence of production bottlenecks
- Excessive overtime
- Excessive rejections and reworks
- Complaints about quality
- Complaints from workers-poor working condition of heavy job etc.

B) Method Study - TECHNIQUES

The method study techniques are explained below



CHARTS USED IN METHODS STUDY

This is the most popular method of recording the facts. The activities comprising the jobs are recorded using method study symbols. A great care is to be taken in preparing the charts so that the information it shows is easily understood and recognized. The following information should be given in the chart. These charts are used to measure the movement of operator or work (*i.e.*, in motion study).

a. Adequate description of the activities.
b. Whether the charting is for present or proposed method.
c. Specific reference to when the activities will begin and end.
d. Time and distance scales used wherever necessary.
e. The date of charting and the name of the person who does charting.

Types of Charts

It can be broadly divided into (A) Macro motion charts and (B) Micro motion charts. Macro motion charts are used

MACRO MOTION CHARTS

Following four charts are used under this type:

1. ***Operation Process Chart***
   It is also called outline process chart. An operation process chart gives the bird's eye view of the whole process by recording only the major activities and inspections involved in the process. Operation process chart uses only two symbols, *i.e.*, operation and inspection.
2. ***Flow Process Chart***
   Flow process chart gives the sequence of flow of work of a product or any part of it through the work centre or the department recording the events using appropriate symbols. It is the amplification of the operation process chart in which operations; inspection, storage, delay and transportation are represented. However, process charts are of three types:

   a. Material type— which shows the events that occur to the materials.
   b. Man type—Activities performed by the man.
   c. Equipment type— how equipment is used.

3. ***Two Handed Process Chart***
   A two handed (operator process chart) is the most detailed type of flow chart in which the activities of the workers hands are recorded in relation to one another. The two handed process chart is normally confined to work carried out at a single workplace. This also gives synchronized and graphical representation of the sequence of manual activities of the worker. The application of this charts are:
   - To visualize the complete sequence of activities in a repetitive task.
   - To study the work station layout.

   Multiple Activity Chart

   It is a chart where activities of more than subject (worker or equipment) are each recorded on a common time scale to show their inter-relationship. Multiple activity chart is made:
   - to study idle time of the man and machines,
   - to determine number of machines handled by one operator, and
   - to determine number of operators required in teamwork to perform the given job.

Diagrams Used in Method Study

Flow diagram and

1. String diagram.

1. ***FLOW DIAGRAM***
   Flow diagram is a drawing, of the working area, showing the location of the various activities identified by their numbered symbols and are associated with particular flow process chart either man type or machine type.The routes followed in transport are shown by joining the symbols in sequence by a line which represents as nearly as possible the path or movement of the subject concerned. Following are the procedures to make the flow diagram:

   1. The layout of the workplace is drawn to scale.
   2. Relative positions of the machine tools, work benches, storage, and inspection benches are marked on the scale.
   3. Path followed by the subject under study is tracked by drawing lines.
   4. Each movement is serially numbered and indicated by arrow for direction.
   5. Different colors are used to denote different types of movements.

2. ***STRING DIAGRAM***
   The string diagram is a scale layout drawing on which, length of a string is used to record the extent as well as the pattern of movement of a worker working within a limited area during a certain period of time. The primary function of a string diagram is to produce a record of a existing set of conditions so that the job of seeing what is actually taking place is made as simple as possible.
   Following are the procedures to draw string diagram:

   1. A layout of the work place of factory is drawn to scale on the soft board.
   2. Pins are fixed into boards to mark the locations of work stations, pins are also driven at the turning points of the routes.
   3. A measured length of the thread is taken to trace the movements (path).
   4. The distance covered by the object is obtained by measuring the remaining part of the thread and subtracting it from original length.

MICRO-MOTION STUDY CHART

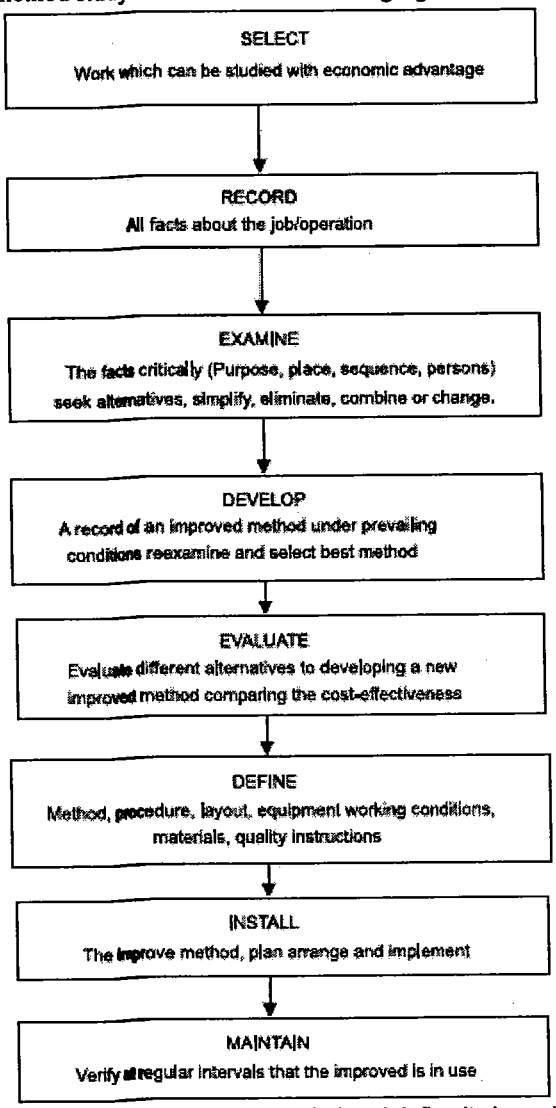
Micro-motion study provides a technique for recording and timing an activity. It is a set of techniques intended to divide the human activities in a groups of movements or micro-motions (called Therbligs) and the study of such movements helps to find for an operator one best pattern
of movements that consumes less time and requires less effort to accomplish the task. Therbligs were suggested by Frank O. Gilbreth, the founder of motion study. Micro-motion study was mainly employed for the job analysis. Its other applications include:

1. As an aid in studying the activities of two or more persons on a group work?
2. As an aid in studying the relationship of the activities of the operator and the machine as a means of timing operations.
3. As an aid in obtaining motion time data for time standards.
4. Acts as permanent record of the method and time of activities of the operator and the machine.

5. **ERGONOMICS (HUMAN ENGINEERING)**
   The word 'Ergonomics' has its origin in two Greek words *Ergon* meaning laws. So it is the study of the man in relation to his work. In USA and other countries it is called by the name 'human engineering or human factors engineering". ILO defines human engineering as, "The application of human biological sciences along with engineering sciences to achieve optimum mutual adjustment of men and his work, the benefits being measured in terms of human efficiency and well-being."

C) PROCEDURE OF METHODS STUDY:

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.

10) WORK MEASUREMENT

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

A) PURPOSE /OBJECTIVES OF WORK MEASUREMENT

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

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

B) TECHNIQUES OF WORK MEASUREMENT

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

Various techniques of work measurement are:

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

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

1. ***Time study***: A work measurement technique for recording the times and rates of working for the elements of a specified job carried out under specified conditions and for 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.
2. ***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.
3. ***Work sampling: (NEXT QUESTION)***
   A technique in which a large number of observations are made over a period of time of one or group of machines, processes or workers. Each observation records what is happening at that instant and the percentage of observations recorded for a particular activity, or delay, is a measure of the percentage of time during which that activities delay occurs.
4. ***Predetermined motion time study (PMTS):***
   A work measurement technique whereby times established for basic human motions (classified according to the nature of the motion and conditions under which it is made) are used to build up the time for a job at the defined level of performance. The most commonly used PMTS is known as Methods Time Measurement (MTM).
5. ***Analytical estimating:***
   A work measurement technique, being a development of estimating, whereby the time required to carry out elements of a job at a defined level of performance is estimated partly from knowledge and practical experience of the elements concerned and partly from synthetic data. The work measurement techniques and their applications are shown in the following table.

6. ***MOTION STUDY:***
Motion study is a systematic way of determining the best method of doing the work by scrutinizing the**motions** made by the worker or the machine. As per Gilbreath it is the science of eliminating the wastefulness due to unnecessary **motions**.

7.**PRODUCTION STUDY**:
Production study is a continuous and lengthy **study** (may be of days), taken with purpose of checking the present or proposed standard time. It may be used to obtain the information affecting the rate of output. So **production study** is not a standard time setting technique but a checking technique.

C) PROCEDURE OF WORK MEASUREMENT:

(i) Divide the selected procedure into small work elements.

(ii) By direct observations record the relevant information regarding the various work elements.

(iii) In the light of relevant information examine the work critically.

(iv) Measure the work content in the terms of time of the work elements involved in method being adopted.

(v) Define and design the new selected method.

(vi) Finally convert the work content time in standard time.

11) WORK SAMPLING TECHNIQUES

Work sampling is the statistical technique for determining the proportion of time spent by workers in various defined categories of activity (e.g. setting up a machine, assembling two parts, idle...etc.).[1] It is as important as all other statistical techniques because it permits quick analysis, recognition, and enhancement of job responsibilities, tasks, performance competencies, and organizational work flows. Other names used for it are 'activity sampling', 'occurrence sampling', and 'ratio delay study'.[2]

In a work sampling study, a large number of observations are made of the workers over an extended period of time. For statistical accuracy, the observations must be taken at random times during the period of study, and the period must be representative of the types of activities performed by the subjects.

One important usage of the work sampling technique is the determination of the standard time for a manual manufacturing task. Similar techniques for calculating the standard time are time study, standard data, and predetermined motion time systems...

Work sampling, also called 'Activity Sampling' or 'Ratio Delay Study', is based on the statistical method first devised by L.H.S. Tippet in 1934. He used this technique firstly, in the British textile industry. Later Morrow carried out several investigations.

WORK SAMPLING TECHNIQUE

1. Random Sampling:
Under this plan, observations are distributed randomly over the day. There are a number of acceptable methods of achieving this. The most suitable and convenient method uses a table of random numbers. The appropriate type of table is one prepared from a rectangular distribution.

2. Systematic Sampling:
To facilitate more productive utilization of the periods between observations, some work engineers adopt the practice of observing at regular intervals say every 15 minutes or 30 minutes or one hour. Such apian of observation schedule is called systematic sampling.

3. Stratified Sampling: Whenever it is known or suspected that probability of occurrence of a given state of activity is appreciably different during different periods of the study or for different portions of the population of men or machines under study, a stratified sampling plan is preferred.

Under this plan total number of observations are divided into groups such that the number of observations in a group is proportional to the fraction of the men/machines and the group represents total population of men/machines.

4. Cluster Sampling:
When the lot submitted for the inspection consists of certain groups of clusters of items, it may be advantageous and economical to select a few clusters of items and then examine all the items in the selected clusters.

5. Two-Stage Sampling:
When the lot submitted for the inspection consists of larger number of packages, each consisting of number of items, it may not be economical to select few packages and inspect all the items in these packages (as in case of duster sampling).

In such cases, the sample is selected in two stages. In first stage a desired number of packages (primary units) are selected at random and in the second stage, the required number of items are chosen at random from the selected primary units. **Here sampling inspection may be carried out as:**(i) Sampling by attributes, and (ii) Sampling by variables.

6. **Single sampling**

A sampling plan in which a decision about the acceptance or rejection of a lot is based on a single sample that has been inspected is known as a single sampling plan.

7. **Double sampling**

A sampling plan in which a decision about the acceptance or rejection of a lot is based on two samples that have been inspected is known as a double sampling plan. The double sampling plan is used when a clear decision about acceptance or rejection of a lot cannot be taken on the basis of a single sample.

8. Multiple Sampling

Multiple Sampling is an extension of the double sampling concept. Multiple sampling is an extension of doublesampling. It involves inspection of 1 to k successive samples as required to reach an ultimate decision. Multiple sampling plans are usually presented in tabular form ...

12 STATISTICAL QUALITY CONTROL – CHARTS (follow notes also)

Statistical quality control. Statistical quality control refers to the use of **statistical** methods in the monitoring and maintaining of the **quality** of products and services. One method, referred to as acceptance sampling, can be used when a decision must be made to accept or reject...

Statistical process control (SPC) is a method of quality control which employs statistical methods to monitor and control a process. This helps to ensure that the process operates efficiently, producing more specification-conforming products with less waste (rework or scrap). SPC can be applied to any process where the "conforming product" (product meeting specifications) output can be measured. Key tools used in SPC include run charts, control charts, a focus on continuous improvement, and the design of experiments. An example of a process where SPC is applied is manufacturing lines.

VARIABLES CHARTS

Variables control charts plot continuous measurement process data, such as length or pressure, in a time-ordered sequence. It is for **measuring quality of each product.** In contrast, attribute control charts plot count data, such as the number of defects or defective units. Variables control charts, like all control charts, help you identify causes of variation to investigate, so that you can adjust your process without over-controlling it.

A number of samples of component coming out of the process are taken over a period of time. Each sample must be taken at random and the size of sample is generally kept as 5 but 10 to 15 units can be taken for charts.

X –Rn CHART

In statistical quality control, the **X chart** is a type of control chart used to monitor variables data when samples are collected at regular intervals from a business or industrial process.[1]

The chart is advantageous in the following situations:

1. The sample size is relatively small **(only 1 defectives)** are typically used for larger sample sizes)
2. The sample size is constant
3. Humans must perform the calculations for the chart

X-R CHART

In statistical quality control, the **X and R chart** is a type of control chart used to monitor variables data when samples are collected at regular intervals from a business or industrial process.[1]

The chart is advantageous in the following situations:[2]

4. The sample size is relatively small **(say, n ≤ 10— or 2 to 10 defectives)** X and R charts are typically used for larger sample sizes)
5. The sample size is constant
6. Humans must perform the calculations for the chart

X-S CHART

In statistical quality control, the **X and s chart** is a type of control chart used to monitor variables data when samples are collected at regular intervals from a business or industrial process.[1]

The chart is advantageous in the following situations:[2]

1. The sample size is relatively large **(say, n > 10—or more than 10 defectives)** X and S charts are typically used for smaller sample sizes)
2. The sample size is variable
3. Computers can be used to ease the burden of calculation

ATTRIBUTE CHARTS:
the inspection results are based on the **classification/features of products** as being defective or not defective, acceptable as good or bad accordingly as that product confirms or fails to confirm the specified specification.

In manufacturing, sometime it is required to control burns, cracks, voids, dents, scratches, missing and wrong components, rust etc. Here, we inspect products only as good or bad but not how much good or how much bad. Furthermore, there are many quality characteristics that come under the category of measurable variables but direct measurement is not taken for reasons of economy.

p-chart

the **p-chart** is a type of control chart used to monitor the proportion of non - conforming units in a sample, where the sample proportion nonconforming is defined as the ratio of the number of nonconforming units to the sample size, n. Simply, features checking of a product, for a particular time of production, varied sample and measuring number of defectives then we use p-chart

The p-chart only accommodates "pass"/"fail"-type inspection as determined by one or more go-no go gauges or tests, effectively applying the specifications to the data *before* they are plotted on the chart. Other types of control charts display the magnitude of the quality characteristic under study, making troubleshooting possible directly from those charts.

np-chart

the **np-chart** is a type of control chart used to monitor the number of nonconforming units in a sample. It is an adaptation of the p-chart and used in situations where personnel find it easier to interpret process performance in terms of concrete numbers of units rather than the somewhat more abstract proportion. Simply, features checking of a product, for a particular time of production, constant sample and measuring number of defectives then we use np-chart

u-chart

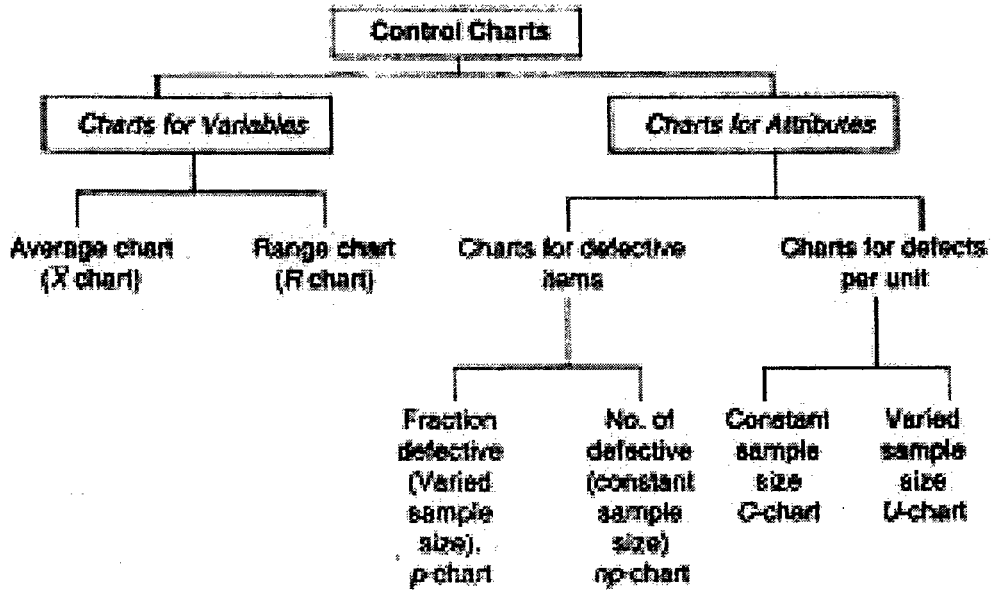
the **u-chart** is a type of control chart used to monitor "count"-type data where the sample size is greater than one, typically the average number of nonconformities per unit.

The u-chart differs from the c-chart in that it accounts for the possibility that the number or size of inspection units for which nonconformities are to be counted may vary. Larger samples may be an economic necessity or may be necessary to increase the area of opportunity in order to track very low nonconformity levels. Simply, features checking of a product, and the lot size varid sample and measuring number of defects then we use u-chart

c-chart

the **c-chart** is a type of control chart used to monitor "count"-type data, typically total number of nonconformities per unit.[1] It is also occasionally used to monitor the total number of events occurring in a given unit of time.

The c-chart differs from the p-chart in that it accounts for the possibility of more than one nonconformity per inspection unit, and that (unlike the p-chart and u-chart) it requires a fixed sample size. The p-chart models "pass"/"fail"-type inspection only, while the c-chart (and u-chart) give the ability to distinguish between (for example) 2 items which fail inspection because of one fault each and the same two items failing inspection with 5 faults each; in the former case, the p-chart will show two non-conformant items, while the c-chart will show 10 faults. Simply, features checking of a product, and the lot size constant sample and measuring number of defects then we use c-chart



- THE END -