BA9221 OPERATIONS MANAGEMENT

UNIT – I INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT

Production Systems – Nature, Importance and organizational function. Characteristics of Modern Production and Operations function. Organisation of Production function. Recent Trends in Production and Operations Management. Role of Operations in Strategic Management. Production and Operations strategy – Elements and Competitive Priorities. Nature of International Operations Management.

UNIT – II FORECASTING, CAPACITY AND AGGREGATE PLANNING 9

Demand Forecasting – Need, Types, Objectives and Steps. Overview of Qualitative and Quantitative methods. Capacity Planning – Long range, Types, Rough cut plan, Capacity Requirements Planning (CRP), Developing capacity alternatives. Aggregate Planning – Approaches, costs, relationship to Master Production schedule. Overview of MRP, MRP II and ERP

UNIT – III DESIGN OF PRODUCT, SERVICE AND WORK SYSTEMS 9

Product Design – Influencing factors, Approaches, Legal, Ethical and Environmental issues. Process – Planning, Selection, Strategy, Major Decisions. Service Operations – Types, Strategies, Scheduling (Multiple resources and cyclical scheduling). Work Study – Objectives, Procedure. Method Study and Motion Study. Work Measurement and Productivity – Measuring Productivity and Methods to improve productivity.

UNIT – IV MATERIALS MANAGEMENT 9

Materials Management – Objectives, Planning, Budgeting and Control. Overview of Materials Management Information Systems (MMIS). Purchasing – Objectives, Functions, Policies, Vendor rating and Value Analysis. Stores Management – Nature, Layout, Classification and Coding. Inventory – Objectives, Costs and control techniques. Overview of JIT.

UNIT – V PROJECT AND FACILITY PLANNING 9

Project Management – Scheduling Techniques, PERT, CPM, Crashing CPM networks – Simple Problems. Facility Location – Theories, Steps in Selection, Location Models – Simple Problems. Facility Layout – Principles, Types, Planning tools and techniques.

Total:45

TEXT BOOKS

1. Aswathappa K and Shridhara Bhat K, Production and Operations Management, Himalaya Publishing House, Revised Second Edition, 2008.
2. Pannerselvam R, Production and Operations Management, Prentice Hall India, Second Edition, 2008.
3. Norman Gaither and Gregory Frazier, Operations Management, South Western Cengage Learning, 2002.

REFERENCES

1. Kanishka Bedi, Production and Operations Management, Oxford University Press, 2004.
2. Russel and Taylor, Operations Management, Wiley, Fifth Edition, 2006.
3. Chary S. N, Production and Operations Management, Tata McGraw Hill, Third Edition, 2008.
4. Chase Jacobs, Aquilano & Agarwal., Operations Management, Tata McGraw Hill, 2006.
5. Mahadevan B, Operations Management Theory and practice, Pearson Education, 2007.

UNIT – I

INTRODUCTION TO PRODUCTION AND OPERATIONS MANAGEMENT

Introduction

Definition: Production/operations management is the process, which combines and transforms various resources used in the Production/operations subsystem of the organization into value added product/services in a controlled manner as per the policies of the organization.

Concept of Production: Production function is that part of an organization with the transformation of a range of inputs into the required outputs (products) having the requisite quality level.

- The set of interrelated management activities, which are involved in manufacturing certain products, is called as production management.
- If the same concept is extended to services management, then the corresponding set of management activities is called as operations management.

Manufacturing Operations Vs Service Operations.

Similarities:

The basic similarities between two are they share the common elements of production system like inputs, outputs, conversion process, and information feedback.

* Both need to predict requirements and adopt policy for managing the stocks of materials in order to be able to meet demand.

* Both need to plan and manage the availability of human resources.

* Both need to have quality control.

Differences:

S. No.	Particulars	Manufacturing	Service
1	Nature	Tangible Eg: automobile	Intangible Eg: hospital
2	Consumption of output	Consumed over a time	Consumed immediately
3	Nature of work	Jobs use less labour and more equipments	More labour and less equipment

4	Degree of customer contract	Little customer contract(customer is not used as a resource)	Direct customer contract and customer is used as one among the resources
5	Customer participation conversion	No participation	Frequent customer participation
6	Measurement of performance	Sophisticated methods for measuring production activity	Elementary methods
7	Holding stock	It is possible	Impossible to hold stock
8	Measurement of customer requirement	Simple	Difficult
9	Resource planning	Simple	Difficult due to unpredictability
10	Defining the authority of production management	Easier	Difficult because the role of operation manager merges into marketing and there is some overlap

Production as a system

Production system model comprises:

1. Production system.
2. Conversion sub-system.
3. Control sub-system.

A system is understood as a whole which cannot be taken apart

a. Production system: A system whose function is to convert a set of inputs into a set of desired outputs.
b. Conversion sub-system: A sub-system of the larger production system where inputs are converted into outputs.

c. Control sub-system: A sub-system of the larger production system where a portion of the output is monitored for feedback signals to provide corrective action if required.

Definfition:

- Production is defined as "the step-by-step conversion of one form of material into another form through chemical or mechanical process to create or enhance the utility of the product to the user." Thus production is a value addition process.
- Edwood Buffa defined production as 'a process by which goods and services are created'. Ex: constructing flats, manufacturing car, bus, radio, television etc.

Production Systems

- Production system receives inputs in the form of materials, personnel, capital utilities and information.
- These inputs are changed in a conversion subsystems into the desired products and services which are called output.
- A portion of the output is monitored in the control subsystem to determine if it is acceptable in terms of quantity, cost and quality.
- If the output is not acceptable, managerial collective action is required.
- The control subsystem ensures system performance by providing feedback so that corrective action can be taken by managers.
- The production system has the following characteristics:

Production is an organized activity, so every production system has an objective.

- The system transforms the various inputs to useful outputs.
- It does not operate in isolation from the other organization system.
- There exists a feedback about the activities, which is essential to control and improve system performance.

Nature of Production

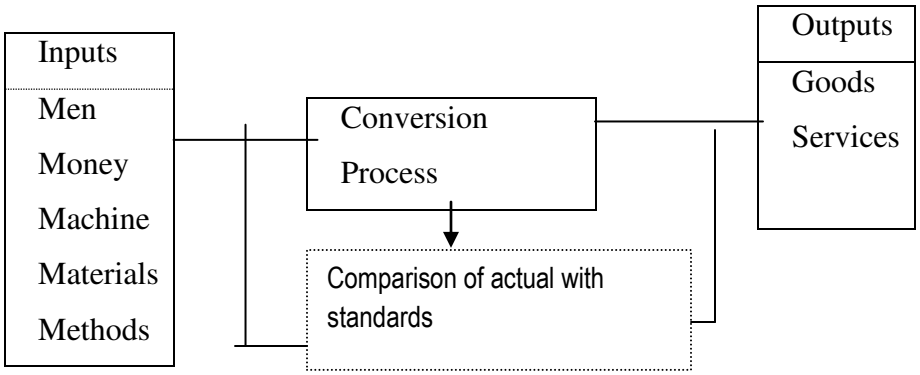
- Production system-A System whose function is to convert a set of inputs into a set of inputs into a set of desired outputs.
- Conversion sub-system- A sub-system of the larger production system where inputs are converted into outputs.

- Control sub-system-A sub-system of the larger production system where a portion of the output is monitored for feedback signals to provide corrective action if required.

Basic elements of production system are

- Inputs-5 m's
- Outputs-Product/service
- Conversion process
- Information feedback- provides information to managers to decide whether organizational activities, need adjustments.
    - Price=cost + profit
- Random fluctuations consists of unplanned (or) uncontrollable influences that cause the actual output to differ from existing output. They can arise from external sources or internal problems.

Random Fluctuation



Importance and Organizational function / Functions of Production manager

1. Production planning:

Planning is a preoperational activity. It aims at anticipating the probable difficulties so that they can be eliminated before they materialize. Production planning aims setting the goals (or) targets and allocating existing resources (4m's).

2. Production Control:

Control is a managing technique which aims to see that the activities are carried out inline with the predetermined standards. PC is a process of planning production in advance of operations, establishing the exact boot of each individual item, setting starting and finishing

data's for each important items and releasing the necessary orders and initiating the required follow-up to affect the smooth functioning of employees. Thus it involves the following elements.

- Routing
- Scheduling
- Dispatching
- Expediting
- Follow-up

Routing- Sequence of operation

Dispatching- Giving orders, to carry out the job

Expediting- monitoring the process

Follow-up- Feedback

3.Factory Building:

Basic consideration falling within the scope of production management. The primary purpose of factory building is to protect the machines, plant services and manufacturing process. It involves the following:

- Type of constructing to own the building.
- Get it on lease whether single storing.
- Multistory.

4. Provision of plant services

Two categories,

- Production services.
- Employee services.

A production service includes storeroom, power room, tool room, material handling, repair services etc.

An employee service includes canteen, recreation room, parking, and toilet.

5. Plant layout:

Arranging various facilities and arrangement in plant.

Deals with the arrangements of machines and plant facilities inside the factory area. The machine should be arranged in such a way, the production plant arranged smoothly. Basic layouts are,

- Production layout
- Process
- Combination
- Fixed- position

6. Physical environment:
    - Lighting: should be sufficient in terms of general lighting and lighting required for a particular process. If possible the use of natural light should be made and the building be constructed according. Otherwise artificial lighting should be used.
    - Fresh air: provision should be made with the help of exhaust fans. The smoke dust, fumes and odour should be removed.
    - Humidity: The moisture content of air is known as humidity. Certain specific degree of moisture is required for production process like spinning and textile industry.
    - Noise: Noise arises due to fast movement of machines. It affects the efficiency of workers. Noise can be eliminated by regular replacement of parts, covering the machines (or) locate such processes at a distant place.
    - Vibration: Vibration arises due to fast movement of giant machines. It affects the precision in processing. Vibration can be reduced by mounting the machines n springs, rubber (or) other shock absorbers.

7. Method study:

Direct function of production management. The standard methods should be devised for performing the repetitive functions efficiently. The unnecessary elements should be eliminated by suitable positioning of workers for different process is developed.

i. Motion Study
ii. Time study

8. Inventory Control:

Inventory control deals with control over raw material, WIP, finished products, store suppliers, tools etc. The management of these items are closely related with

the production. The raw material should be purchased at right quantity/ quality/ source/ time/ place.

9. Quality Control:

* QC is easy in manufacturing and in service it is very difficult.

* QC is everyone's business. The long-run success of the business largely depends on its ability to maintain the quality standards as decided by the management and accepted by customers.

* QC is maintained by testing the methodology.

10. Product Development:

Standardization, simplification,

It is not likely that the product which is accepted today by the customers will be accepted by them forever, in the form same quality. Product development basically considers following aspects,

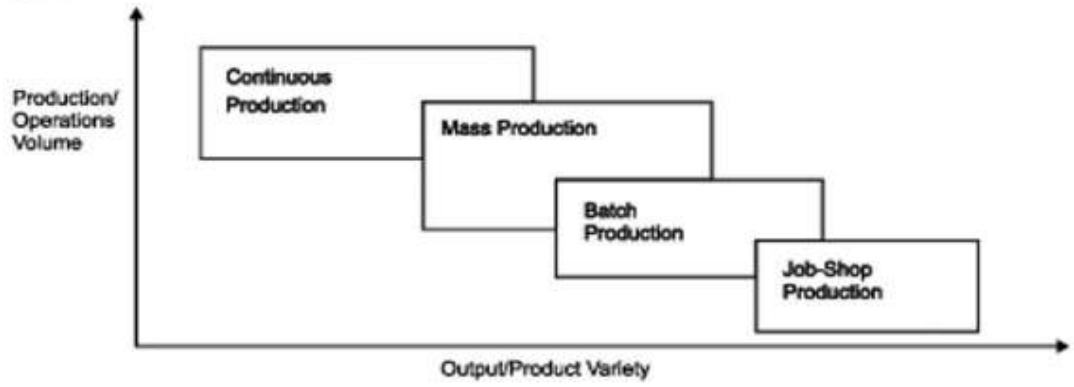
- Diversification
- Improvement in existing product
- Simplification
- Standardization

Types of Production:

1. Intermittent Production:

a. job (or) unit production b. batch (or) quality production

2. Continuous (or) mass production
3. Flexible manufacturing system (FMS)
4. Computer Integrated Manufacturing (CIM)



1. Intermittent Production:

1. Job production/unit

This is the oldest method of production on a very small scale with this the individual requirement met. Each job order stand alone and is not likely to repeat.

This type has lot of flexibility of operation and hence GPMs are required. Factory adopting this type of production is small in size. The layout of such factory is made flexible. So that maximum work can be easily carried out with slight adjustments.

Application:

Used for things for which does not produce on a large scale, and things are highly artistic nature.

Characteristics:

The Job-shop production system is followed when there is:

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

Advantages:

- Only method which can meet the individual requirement.
- There are no managerial problems because of very less no of workers.
- Man working in huge production get an opportunity to produce large type of product and can become expert I very short time.
- This requires very less money and easy starting.
- The risk of loss is less.
- Because of flexibility of factory due to the reduction of demand.

Disadvantage:

- As the purchase of raw material is less, the cost of raw materials is more.
- For handling different types of jobs only skilled workers are needed. Thus labour cost increases.
- Higher cost due to frequent set up changes.

- Higher level of inventory at all levels and hence higher inventory cost.
- Production planning is complicated.
- Larger space requirements.

2. Batch (or) Quantity Production:

Batch production is *a form of manufacturing in which the job passes through the functional departments in lots or batches and each lot may have a different routing* Goods/products produced in small batches. Orders may or may not repeat in the same form.

Few- SPMs (Special purpose Machines)

Large- GPMs (General purpose Machines)

SPMs: Initial investments is costly, efficiency is very high.

Application:

Batch production system is used under the following circumstances:

1. When there is shorter production runs.
2. When plant and machinery are flexible.
3. When plant and machinery set up is used for the production of item in a batch and change of set up is required for processing the next batch.
4. When manufacturing lead time and cost are lower as compared to job order production.

Characteristics:

1. Adopted in medium-sized enterprises
2. Bigger in scale than that of job production and smaller than mass production
3. Some SPMs and others are GPs
4. In this type of production, two or more type of product is manufactured in small small batches (or) lots.

Advantages:

1. While comparing with mass production it requires less capital.
2. If the demand for one product decreases then the production for another product increased. Thus the risk loss is very less.
3. Better utilization of plant and machinery.
4. Promotes functional specialization
5. Cost per unit is lower as compared to job order production

6. Lower investment in plant and machinery
7. Flexibility to accommodate and process number of products
8. Job satisfaction exists for operators

Disadvantages:

1. Comparing to mass production the cost of sales and advertisement per unit is more.
2. Raw materials cost is larger than mass production.
3. Material handling is complex because of irregular and longer flows.
4. Production planning and control is complex.
5. Work in process inventory is higher compared to continuous production.
6. Higher set up costs due to frequent changes in set up.

2. Continuous (or) Mass production:

This method is a large scale production. This type of production requires specially planned layout. It requires more SPMs. Working progress is move from one stage to another with the help of automated devices. Simplification and standardization of product is more.

Characteristics

Mass production is used under the following circumstances:

1. Standardization of product and process sequence.
2. Dedicated special purpose machines having higher production capacities and output rates.
3. Large volume of products.
4. Shorter cycle time of production.
5. Lower in process inventory.
6. Perfectly balanced production lines.
7. Flow of materials, components and parts is continuous and without any back tracking.
8. Production planning and control is easy.
9. Material handling can be completely automatic.

Advantages:

1. Better quality and increased production

2. Wastage is minimum
3. As Raw materials is purchased large no the cost may be less
4. Sales and advertisement cost/unit is less.
5. Only few skilled and rest semi-skilled workers are needed. Hence labour cost is less.
6. Higher rate of production with reduced cycle time.
7. Higher capacity utilization due to line balancing.
8. Less skilled operators are required.
9. Low process inventory.
10. Manufacturing cost per unit is low.

Disadvantage:

1. During the period of less demand less heavy loss on investment
2. This type of production is not changeable with other type because of SPM.
3. Workers feel bore with the repetition of same type of work.
4. It cannot fulfill individual taste.
5. Breakdown of one machine will stop an entire production line.
6. Line layout needs major change with the changes in the product design.
7. High investment in production facilities.
8. The cycle time is determined by the slowest operation.

1. Flexible Manufacturing System:

Need and Importance of FMS:

1. Rigid production system designed for producing high volume lone variety products uneconomical, unresponsive and non-competitive. It is small batch, high variety are market place.
2. Customers are demanding greater variety of products and short-term delivery times.

Definition:

The computer Integrated Process technology suitable for producing a moderate variety of products in moderate volume.

Characteristics:

1. FMS is a computer controlled system
2. It contains several work stations each does different operations
3. The workstation and machine are automated.
4. Automotive material handling equipment move components to the appropriate workstation.
5. Preprogrammed machine select position and activate the specific tool for each job
6. Hundreds of tools options are available.
7. Once the machine has finished one batch the computer signals the next quantity or components and the machine automatically repositions and retools accordingly.
8. The just finished batch is automatically transferred to the next work- station

Advantages

1. production is quick
2. high quality
3. operating cost is less
4. less direct labour cost

Applications:

FMS is generally appropriate when

1. All products are variations of a stable basic design.
2. All products use the same family of components.
3. The no of components is moderate(10-50)
4. The volume of each component is moderate (1000-3000) annually.
5. Manufacturing components that require several machining operations.

4. Computer Integrated Manufacturing (CIM)

CIM is the automated version of the manufacturing process, where the three major manufacturing functions.

1. Product/process design
2. Planning/controlling
3. The manufacturing processes are replaced by the automated technologies. Further, the traditional integration mechanism oral/written communication is replaced by computer technology.

There are 2 aspects of CIM. They are

1. Organizational part

2. Operational part

The various elements of these are listed below.

Organizational part:

It contains corporate services, finance, business planning and marketing.

Operational part:

It Consists of computer Aided Engineering (CAE)

1. Computer Aided Process Planning(CAPP)
2. CAP
3. CAQC
4. CAD
5. CADesign and Drafting
6. MRP(Material Resource Planning)

Computer Aided Manufacturing

1. Flexible Manufacturing system(FMS)
2. Flexible Manufacturing assembly
3. Direct Numerical control (DNC)
4. Data Acquisition System(DAS)

The different types of computers are as follows.

1. Mainframe
2. Mini
3. Micro
4. PC
5. PLC(Programmable logic controllers)
6. Robotic Controllers

Comparisons between Intermittent and Continuous Production:

S.No.	Particulars	Intermittent	Continuous
1	Type of plant layout	Process layout	Product layout
2	Type of machine	More GPMs	More SPMs

3	Type of labour	Highly skilled	Few skilled
4	No of product and product design	While the range of products is manufactured in small quantities the product design changes from batch to batch.	Few standard products are manufactured with large quantities with standard product design.
5	Changes in machine settings	As the specification of each order changes, the machines are set accordingly.	Set up for the machines are changed for the normal period.
6	Nature and size of order	Unrepeated small size of product orders.	Regular and bulk product orders
7	Investment in machines and equipments	It is less because few machines are required and more GPMs are used	More since SPMs are used the machines are arranged according to product layout duplication of machine may occur
8	Investment in inventories	The finished good inventory is less. Waiting and bottleneck slow down of the operating cycle. As a result to the investment and WIP raw materials is increased	Finished good inventory is slightly high But due to the need for sub storing is reduced leads to minimum investments on WIP inventory and raw materials inventory
9	Material Handling Equipments(AMH)	Not feasible to employ mechanized equipments	Mechanized material handling equipments are used
10	Material handling cost/unit	Tends to be high	Low
11	Plant maintenance services	Break down maintenances	Preventive maintenances

12	Line balancing	Not possible	It is must

Classification based on type of strategy used by the manufacturer to serve the customer

1. Made to stock.
2. Made to order
3. Assemble to order

1. Made to stock

Depending on the prediction, of the demand the product was produced and stored as stock. All the characteristics of mass production are applicable to make to stock type.

Characteristics:

1. Constant and predictable demand
2. Few standard product
3. Short-term delivery time expected by the customers
4. Product has higher self- life

Exceptions: All food products, newspaper.

2. Made to order:

Initiation is only after getting the order. Similar to intermittent production.

Characteristics:

1. Customer can wait (or) the expected lead-time is high
2. Seasonable demand
3. Artistic in nature
4. Individual taste and preference can be met
5. Product is not standardized

3. Assemble to order:

Characteristics:

Lead-time is shorter compared to make to order. But it is higher compared to make to stock.

5'ps of production process

Inputs:

People: Both indirect and indirect work force

Plant: Factories (or) service branches when production is carried out

Parts: Materials that go through the system

Process: Includes equipments and steps by which production is accomplished

Planning and Control System:

Includes procedures and information management uses to operate the system.

Types of transformation:

1. Physical transformation in manufacturing
2. Location in transportation
3. Exchange in retailing
4. Storage in warehousing
5. Physiological in health care

Informational in telecommunication

Factors of Production

- To generate a product or service an organisation will need to combine labour, capital, energy, materials and information.
- Labour is the mental and or physical effort of employees and can take a variety of forms including filing, lifting, data processing, decision making, and line management. In fact labour is any effort/task an employee needs to undertake in order to produce the product or service.
- Capital is the machines and tools needed to produce the product or service. This physical capital is purchased through financial capital such as loans, sale of shares in the organisation and use of profit generated by the organisation.
- Energy is provided through the use of gas, electricity, solar power and steam. Energy is needed to heat/light up the premises, make the machinery work and to ensure that the organisation is a comfortable place for the employees to work in.

Categories of operations managers

Strategic, operating and control decisions made by operations managers.

- Strategic decisions: relating to products, processes and manufacturing facilities. These decisions are major ones having strategic importance and long-term significance for the organization.
- Operating decisions: relating to planning production to meet demand. These decisions are necessary in order to ensure that the ongoing production of goods and services meets the market demand and provides reasonable profits for the organization.
- Control decisions: relating to planning and controlling operations. These decisions concern the day-to-day activities of workers, quality of products and services, production and overhead costs and maintenance of machines.

SCOPE OF PRODUCTION AND OPERATIONS MGMT

Commencing with the selection of location, production management covers activities as acquisition of land, constructing buildings, procuring and installing machinery, purchasing and storing raw materials and converting them into saleable products.

CHARACTERISTICS OF PRODUCTION

The system is characterized by four features:

- Manufacturing as competitive Advantage. (TQM, BPRE, JIT, FMS, CIM some techniques which the companies are employing to gain competitive advantage.)
- Services Orientation. :(intangible& perishable nature of services, constant interaction with clients or customers, small volume of production to serve local markets, need to locate facilities to serve local markets)
- Disappearance of Smokestacks: production system was dominated by smokestacks. Protective labor legislation, environment movement has brought total transformation in the production system-factories are aesthetically designed and built, environment friendly.)
- Small has Become Beautiful: (by E.F.Schumacher opposed giant organizations and increased specialization. But industrialists to avail large scale economies of production went in for huge organizations and mass production systems).

Classification based on type of strategy used by the manufacturer to serve the customer

- Made to stock: Depending on the prediction, of the demand the product was produced and stored as stock. All the characteristics of mass production are applicable to make to stock type.
- **Made to order**: Initiation is only after getting the order. Similar to intermittent production.

Characteristics:

- Customer can wait (or) the expected lead-time is high. (A lead time is the latency (delay) between the initiation and execution of a process)
- Seasonable demand
- Artistic in nature
- Individual taste and preference can be met

- **Assemble to order**:

Characteristics: Lead-time is shorter compared to made to order. But it is higher compared to make to stock.

RECENT TRENDS IN PRODUCTION/OPERATIONS MGMT

Some of the recent trends are:

- Global Market Place
- Production/operations Strategy
- Total quality Management (TQM)
- Flexibility
- Time Reduction
- Technology
- Worker Involvement
- Re-engineering: Reengineering could also be interpreted as reverse engineering, in which the characteristics of an already engineered product are identified, such that the product can perhaps be modified or reused.
- Environmental Issues
- Corporate Downsizing (or Right sizing): It has been forced on firms to shed their obesity. It has become necessary due to competition, lowering productivity, need for improved profit and for higher dividend payment to shareholders.
- Supply-chain mgmt

- Lean Production. (use of minimal amounts of resources to produce a high volume of high quality goods with some variety.)

Organization of Production function

Competitive advantage is believed that a firm, strong in competitive advantage, whatever the constraints or restraints.

- Production function can offer competitive advantage to a firm in the following areas:
- Shorter new-product-lead time.
- More inventory turns.
- Shorter manufacturing lead time.
- Greater Flexibility
- Better customer service.
- Reduced Wastage.

Role of Operations in Strategic Management

- A strategy is a way of doing something. It usually includes the formulation of a goal and a set of action plans for accomplishing of the goal.
- Strategic Management: the process of formulating, implementing and evaluating business strategies to achieve organizational objectives.
- A comprehensive definition is "that set of managerial decisions and actions that determines the long-term performance of a corporation. It involves environmental scanning, strategy formulation, strategy implementation, evaluation and control".

STRATEGIC MANAGEMENT

It involves five steps:

1. Select the corporate mission and major corporate goals.
2. Analyze the opportunities and threats or constraints that exist in the external environment. Also analyze the strengths and weaknesses that exist in internal environment.
3. Formulate strategies that will match the organization's strengths and weaknesses that exist in internal environment.
4. Implement the strategies.

5. Evaluate and control activities to ensure that the organization's objectives are achieved.

STEP-1 PROCESS OF STRATEGY MANAGEMENT

- It begins with selecting corporate mission and corporate goals and ends with monitoring the activities of the organization.
- The first step in strategic management process is selecting or crafting corporate mission and corporate goal.
- A mission statement is description or declaration of why a company is in operation (exists), which provides the framework within which strategies are formulated.
- A typical mission statement contains three components:

  *a statement, its reason for existence.

  *a statement of the key values or guiding standards on which the operations takes place.

  *a statement of major goals or objectives.
- A Mission statement is description or declaration of why a company is in operation (exists), which provides the framework within which strategies are formulated.
- A Mission statement contains three components, a statement , its reason for existence; a statement of the key values or guiding standards on which the operations take place and a statement of major goals or objectives.
- A mission statement is a formal, short, written statement of the purpose of a company or organization. The mission statement should guide the actions of the organization, spell out its overall goal, provide a sense of direction, and guide decision-making.
- It provides "the framework or context within which the company's strategies are formulated."
- In simplest terms, the mission is why you exist, and vision is what you want to be.
- McDonalds - "To provide the fast food customer food prepared in the same high-quality manner world-wide that is tasty, reasonably-priced & delivered consistently in a low-key décor and friendly atmosphere

STEP-2 ENVIRONMENTAL SCANNING

- The environment of an organization comprises both external and internal factors.
- Environment needs to be scanned in order to determine trends and projections of factors that will affect fortunes of the organization.

- Scanning must focus on task environment. Scanning helps identify threats and opportunities prevailing in the environment .
- In formulating a strategy , a company seeks to take advantage of the opportunities while minimizing the threats.

STEP-3 STRATEGY FORMULATION

- Strategies are formulated at four levels:

  1.Corporate level: It is formulated by top management to oversee the interests and operations of an organization made up of more than one line of business.

  2.Global level: Companies may be able to increase their profitability.

  3.Business unit level: A Business unit is an organizational subsystem that has a market ,a set of competitors, and a goal distinct from those of the other subsystem in the group and

  4.Functional level: Functional strategies identify the basic courses of action that each of the department must pursue in order to help the business unit to attain its goals.

- Corporate strategy is about the overall business of the firm encompassing things like resource allocation across the business units.
- Business strategy is about how a bit of a business competes within it's own environment (eg for a biotech firm how its biopharma / bioagriculture/biochem divisions operate within the company). Such a strategy must be geared towards success. An organization can achieve high growth and profits by creating a strategy that provides diversity on the cheap (e.g. IKEA).

IKEA is an acronym: Ingvar Kamprad, Elmtaryd, Agunnaryd. Ingvar Kamprad grew up at Elmtaryd in Agunnaryd

IKEA sells household furnishings. Its furniture comes in "knock down" form and has to be assembled by the customer. This saves space in transportation and assembly costs. The cost saving is passed on to the customer, hence prices are cheaper. If customers want their furniture assembled, the various outlets will do that --- for an assembly and transportation charge.

- Operational Strategy is about how an organization delivers on a small scale, "operational level"

Corporate level strategies

1. Growth Strategies- internal growth, Horizontal integration (Horizontal integration occurs when a firm is being taken over by, or merged with, another firm which is in the same industry and in the same stage of production as the merged firm, e.g. a car manufacturer merging with another car manufacturer.), Horizontal related Diversification, Conglomerate diversification (multi-industry company), Vertical integration of related businesses, Vertical integration of unrelated businesses, Mergers, Strategic Alliances.
2. Stability Strategy:
3. Retrenchment Strategies- Turnaround, Divestment, Liquidation.

GLOBAL LEVEL STRATEGY

- Companies may be able to increase profit by producing goods and services in other countries at lower cost or better differentiate their product or service with their competitors.

- Increasing profit through global expansion is possible due to:

- Location economies: Philips, nokia manufactures products in china due to low cost labor.

- Experience curve: It refers to the systematic decrease in production costs that have been observed to occur over the life of a product.

- Transferring distinctive competencies: Toyota's distinctive competencies allow it to produce high quality, well designed cars at a lower cost than any other company in the world.
- Leveraging the skills of global subsidiaries: Global level strategies: international strategy, Multidomestic strategy, Global strategy (as defined in business terms is an organization's strategic guide to globalization) and transnational strategy (The firm seeks to combine the benefits of global-scale efficiencies with the benefits of local responsiveness. Interchange still occurs between the home base and foreign subsidiary and between foreign subsidiaries - a process known as global learning) .

BUSINESS UNIT LEVEL STRATEGY

- A single company that operates within one industry is also considered a business unit.
- For Example: An independent company that builds and sell swimming pools is considered a business unit. Siyaram Silk Mills(4%-5% mkt share.), Govind Rubber (focus on exports), Balakrishna Industries (Auto parts to be export).

STRATEGY IMPLEMENTATION

STEP-4

- Strategies formulated need to be implemented.
- Implementation is the logical step to formulation, the two differ in two ways:
- Strategy Formulation:
  - It is primarily an intellectual process.
  - Requires good intuitions and analytical skills.
  - Requires co-ordination among a few individuals
- Strategy Implementation:
  - Is positioning forces before action.
  - Is managing forces during the action.
  - Focuses on effectiveness.
  - Focuses on efficiency.
  - Requires special motivation and leadership skills.
  - Requires co-ordination among many persons.

IMPLEMENTING STRATEGIES

It requires actions such as altering sales territories, adding new departments, closing facilities, hiring new employees, changing an organizing's pricing strategy, developing financial budgets, formulating new employees benefits, establishing cost-control procedures, changing advertising strategies, building new facilities, training new employees, transferring managers among divisions and building better computer information system etc.

STRATEGY EVALUATION

STEP-5

- Strategy evaluation helps determine the extent to which the company's strategies are successful in attaining its objectives.
- Basic activities in strategy evaluation:
- Establishing performance targets, standards and tolerance limits for the objectives, strategies and implementation plans.
- Measuring the performance in relation to the targets at a given time. If outcomes are outside the limits, inform managers to take action.
- Analyze deviations from acceptable tolerance limits.

- Business strategy: refers to the aggregated strategies of single business firm or a strategic business unit (SBU) in a diversified corporation.
- According to Michael Porter, a firm must formulate a business strategy that incorporates cost leadership, differentiation, or focus to achieve a sustainable competitive advantage and long-term success.
- Alternatively, according to W. Chan Kim, an organization can achieve high growth and profits by creating a Blue Ocean Strategy that breaks the previous value-cost trade off by simultaneously pursuing both differentiation and low cost.
- Functional strategies: include marketing strategies, new product development strategies, human resource strategies, financial strategies, legal strategies, supply-chain strategies, and information technology management strategies. The emphasis is on short and medium term plans and is limited to the domain of each department's functional responsibility. Each functional department attempts to do its part in meeting overall corporate objectives.

ELEMENTS OF PRODUCTION/OPERATIONS STRATEGY

Operations strategy comprises six components:

1. Positioning the production system
2. Focus of factories and service facilities
3. Product/service design and development.
4. Allocation of resources to strategic alternatives, and
5. Facility planning, Capacity, location and layout

6. Technology selection and process development

BUILDING COMPETITIVE PRIORITIES:

- Strategy Formulation is a key element of business strategy and production strategy.
- Quality based strategies focus on satisfying the customer by integrating quality into all phases of the firm.
- Time-based strategies focus on reducing the time required to complete various activities (for .e.g. develop new products or services and market them, respond to change in customer demand or deliver a product or a service).
- By reducing time, costs are also reduced, productivity is increased, quality tends to be better, innovative products are launched to the market and customer service is improved.

COMPETITIVE PRIORITIES:

- The companies have positioned themselves to compete on cost, quality, flexibility and speed.
- Competing on cost : low cost.
- Competing on Quality : High Performance design, High Quality, Consistent Quality.
- Competing on Flexibility : Variety, Volume.
- Competing on Speed : Rapid Delivery, On-time delivery.

STRATEGY FORMULATION

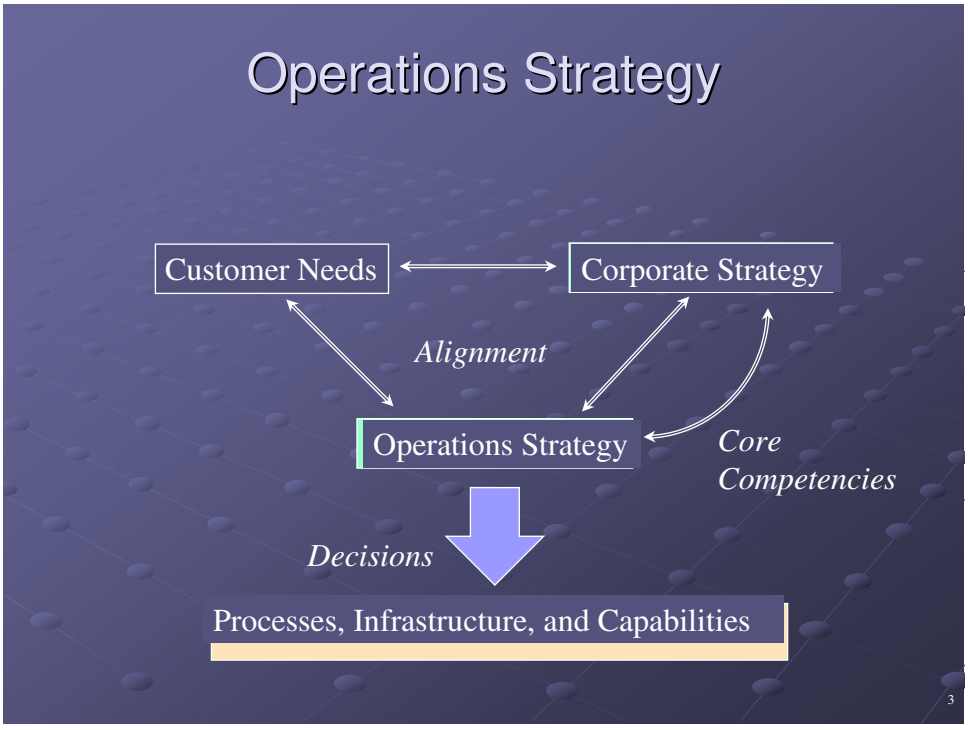
- Strategy Formulation is a key element of business strategy and production strategy.
- Quality based strategies focus on satisfying the customer by integrating quality into all phases of the firm.
- Time-based strategies focus on reducing the time required to complete various activities (for .e.g. develop new products or services and market them, respond to change in customer demand or deliver a product or a service).
- By reducing time, costs are also reduced, productivity is increased, quality tends to be better, innovative are launched to the market and customer service is improved.

Production and Operations strategy:

According to Slack and Lewis, operations strategy holds the following definition: "is the total pattern of decisions which shape the long-term capabilities of any type of operations and their contribution to the overall strategy, through the reconciliation of market requirements with operations resources".

Operations strategy is the tool that helps to define the methods of producing goods or a service offered to the customer.

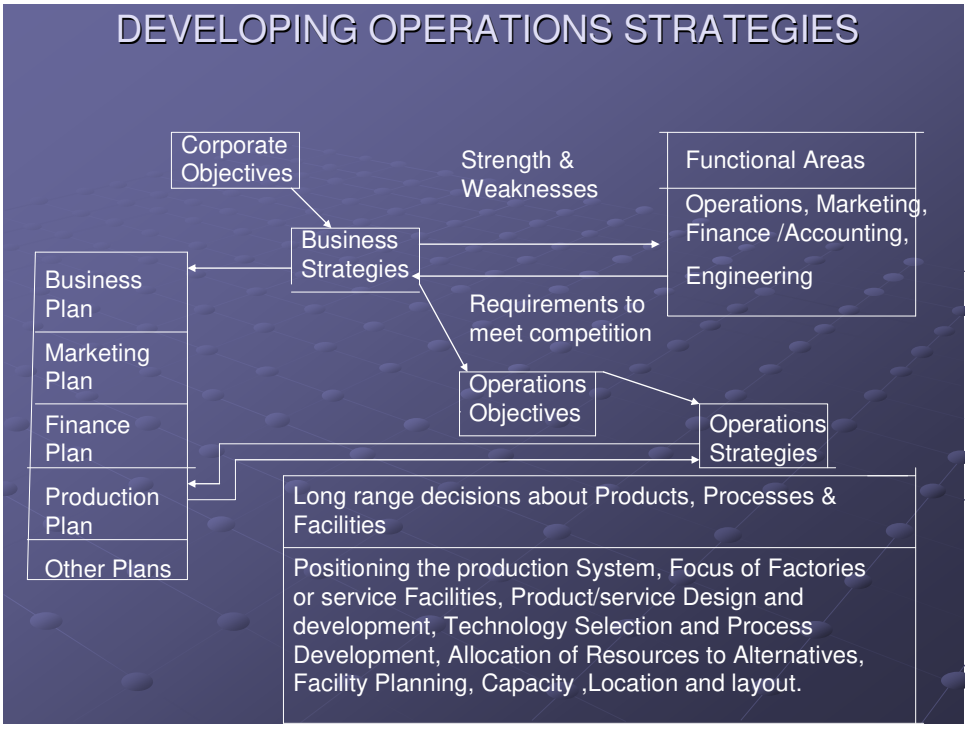
CORPORATE STRATEGY "is the direction an organization takes with the objective of achieving business success in the long term. Recent approaches have focused on the need for companies to adapt to and anticipate changes in the business environment, i.e. a flexible strategy".



Production and Operations strategy :

- The production and operation strategy is derived from the business strategy that relates to products, processes, methods, operating resources, quality, costs, lead times and scheduling.

- Production strategy must be consistent with the business strategy and formulated to support the goals of the business organization.
- Production and operations strategy may have a major influence on the competitiveness of an organization.
- A core competency is fundamental knowledge, ability, or expertise in a specific subject area or skill set.
- Companies with specific strengths in the marketplace, such as data storage or the development of accounting applications, can be said to have a core competency in that area.
- The core part of the term indicates that the individual has a strong basis from which to gain the additional competence to do a specific job or that a company has a strong basis from which to develop additional products.



IMPORTANCE/BENEFITS OF STRATEGIC MANAGEMENT

- Strategic management offers both financial as well as non-financial benefits to an organization:
  - It allows for identification, prioritization and exploitation of opportunities.
  - It provides an objective view of management problems.
  - It represents a framework for improved co-ordination and control of activities.

- It allows more effective allocation of time and resources to identified opportunities.
- It creates a framework for internal communications among personnel.
- It gives encouragement to forward thinking.
- It gives encouragement to forward thinking.

Competitive priorities / OM's Emergence as a field

In the late 1950s and early 1960s scholars began to deal specifically with operations management as opposed to industrial engineering or operations research. Writers such as Edward Bowman and Robert Fetter (*Analysis for production and operations management* [1957]) and Elwood S.Buffa (*Modern production management [1961])* noted the commonality of problems faced by all productive systems and emphasized the importance of viewing production operations as a system. They also stressed the useful applications of waiting-line theory, simulation, and linear programming, which are now standard topics in the field. In 1973, chase and Aquilano's first edition of this book stressed the need "to put the management back into operations management' and suggested the need 'to put the management back into operations management' and suggested the lifecycle as a means of organizing the subject.

Computers and the MRP Crusade

The major development of the 1970s was the broad use of computers in operations problems. For manufacturers, the big breakthrough was the application of materials requirements planning (MRP) to production control. This approach ties together in a computer program all the parts that go into complicated products. This program then enables production planners to quickly adjust production schedules and inventory purchases to meet changing demands for final products. Clearly, the massive data manipulation required for changing schedules on products with thousands of parts would be impossible without such programs and the computer capacity to run them. The promotion of this approach (pioneered by Joseph Orlicky of IBM and consultant Oliver Wight) by the American production and Inventory Control Society (APICS) has been termed the MRP Crusade.

JIT TQC and Factory Automation

The 1980s saw a revolution in the management philosophies and the technologies by which production is carried out. Just In Time (JIT) production is the major break-through in manufacturing philosophy. Pioneered by the Japanese, JIT is an integrated set of activities designed to achieve high-volume production using minimal inventories of parts that arrive at the workstation just in time. This philosophy coupled with total quality control (TQC), which aggressively seeks to eliminate causes of production defects is now a corner stone in many manufacturer's production practices.

As profound as JIT's impact has been factory automation in its various forms promises to have even greater impact on operations management in coming decades. Such as computer integrated manufacturing (CIM), flexible manufacturing systems (FMS), and factory of the future (FOF) are already familiar to many and are becoming everyday concepts to OM practitioners.

Manufacturing Strategy Paradigm:

The late 1970s and early 1980s saw the development of the Manufacturing Strategy Paradigm by researches at the Harvard Business School. This work by professors William Abernathy, kim Clark, Robert Hayes, and Steven Wheelwright (built on earlier efforts by Wickham Skinner) emphasized how manufacturing executives could use their factories capabilities as strategic competitive weapons. The paradigm itself identified how what we call the five P's of production management can be analyzed as strategic and tactical decision variables. Central to their thinking was the notion of factory focus and manufacturing trade-offs. They argued that because a factory cannot excel on all performance measures, its management must derive a focused strategy, creating a focused factory that does a limited set of tasks extremely ell. This raised the need for making trade-offs among such performance measures as low cost, high quality, and high flexibility in designing and managing factories.

Service Quality and Productivity

The great diversity of service industries- ranging from airlines to zoos, with about 2,000 different types in between- precludes identifying any single pioneer or developer that has made a major impact across the board in these areas. However, one service company's- cDonald's-unique approach to quality and productivity has been so successful that it stands as a reference point in thinking about how to deliver high-volume

standardized services. In fact, McDonald's operating system is so successful that the president of Chaparral Steel used it as model in planning the company's highly efficient minimills.

Total Quality Management and Quality Certification:

The unquestioned major development in the field of operations management, as well as in management practice in general, is total quality management (TQM). Though practiced by many companies in the 1980s, TQM became truly pervasive in the 1990s. All operations executives are aware of the quality message put forth by the so-called quality gurus-W.edards Deming, Joseph M. Juran, and Philip Crosby Helping the quality movement along is the Baldrige National Quality Award, which as started in 196 under the direction of the American Society of Quality Control and the National Institute of Standards and Technology. The Baldrige Award recognizes up to five companies a year for outstanding quality management systems.

The ISO 9000 certification standards put forth by the International Organization for Standardization now play a major role in setting quality standards for global manufacturers in particular Man Europeans companies require that vendors meet these standards as a condition for obtaining contracts.

Business Process Reengineering:

The need to become lean to remain competitive in the global economic recession in the 1990s pushed companies to seek major innovations in the processes by which they run their operations. The flavor of business process reengineering (BPR) is conveyed in the title of Michael Hammer's influential article "Reengineering Work: Don't Automate, Obliterate." The approach seeks to make revolutionary changes as opposed to evolutionary changes (which are commonly advocated in TQM). It does this by taking a fresh look at what the organization is trying to do in all its business processes, and then eliminating nonvalue-added steps and computerizing the remaining ones to achieve the desired outcome.

Electronic Enterprise:

The recent quick adoption of the Internet and the World Wide Web during the late 1990s is amazing. Electronic enterprise refers to the use of the Internet as an essential element of business activity. The Internet is an outgrowth of a government network called

the ARPANET, which was created in 1969 by the Defense Department of the United States government. The use of Web pages, forms, and interactive search engines is changing the way people collect information, shop, and communicate. Even today, connections to the Internet are relatively inexpensive, and Microsoft and Netscape have led the way by making the "Web browsing" software virtually free.

Supply Chain Management:

The idea is to apply a total system approach to managing the flow of information, materials, and services from raw material suppliers through factories and warehouses to the end customer. Recent trends such as outsourcing and mass customization are forcing companies to find flexible ways to meet customer demand The focus is on optimizing those core activities to maximize the speed of response to changes in customer expectations.

Computer Integrated Manufacturing

CIM is an umbrella term for the total integration of product design and engineering, process planning and manufacturing by means of complex computer systems. It is a computerized system for production planning, inventory control, or scheduling is often considered part of CIM. By using these powerful computer systems to integrate all phases of manufacturing, from initial customer order to final shipment, firms hope to increase productivity, improve quality, meet customer needs faster, and offer more flexibility. CIM is an important aspect of technology in manufacturing, but it is just one set of tools that helps many manufacturing firms, even those with high wages, remain competitive in the global market place. In the following sections we describe these tools and their potential benefits.

Computer Aided Design and Manufacturing

CAD is an electronic system for designing new parts or products or altering existing ones, replacing drafting traditionally done by hand. The heart of CAD is a powerful desktop computer and graphics software that allow a designer to manipulate geometric shapes. The designer can create drawings and view them from any angle on a display monitor. The computer can also simulate the reaction of a part to strengthen and stress tests. Using the design data stored in the computer's memory, manufacturing engineers and other users can quickly obtain printouts of plans and specifications for a part or product.

CAD cuts the cost of product development and sharply reduces the time to market for new products. Analysts can use CAD to store, retrieve and classify data about various parts. This information is useful in creating families of parts to be manufactured by the same group of machines. Computer-aided design saves time by enabling designers to access and modify old designs quickly rather than start from scratch.

The component of CIM that deals directly with manufacturing operations is called Computer-aided Manufacturing (CAM). CAM systems are used to design production process and to control machine tools and materials pass through programmable automation. For example, researchers at the Technology/Clothing Technology Corporation are developing a concept to enable clothing manufacturers to create "custom" clothing. The concept involves using a computer scan of a customer's body and a computer- driven machine cut the fabric to fit the customer perfectly. Automated custom clothing goes against established apparel industry procedures, whereby companies cut down dozens of layers of cloth at the same time to hold down labor costs. It has also the advantage of fostering customization and speedy delivery as competitive priorities.

A CAD/CAM system integrates the design and manufacturing function by translating final design specifications into detailed machine instructions for manufacturing an item. CAD/CAM is quicker, less error prone than humans, and eliminates duplication between engineering and manufacturing. CAD/CAM systems allow engineers to see how the various parts of a design interact with each other without having to build a prototype.

Numerically Controlled Machines

Numerically controlled (NC) machines are large machine tools programmed to produce small to medium-sized batches of intricate parts. Following a preprogrammed sequence of instructions, NC machines drill, turn, bore, or mill many different parts in various sizes and shapes. Currently, NC machines are the most commonly used form of flexible (programmable) automation. Early models received their instructions from a punched tape or card. Computerized numerically controlled (CNC) machines are usually stand-alone pieces of equipment, each controlled by its own microcomputer.

Industrial Robots

Robots are glamorous than NC workhorses. The first industrial robot joined the GM production line in 1961. Industrial robots are versatile, computer-controlled machines

programmed to perform various tasks. These “steel-collar” workers operate independently of human control. Most are stationary and are mounted on the floor with an arm that can reach into difficult locations.

The robot’s “hand” sometimes called an *end effector or tool,* actually does the work. The has (not shown) can be changed to perform different tasks, including materials handling, spot welding, spray painting, assembly, and inspection and testing. Second-generation robots equipped with sensors that simulate touch and sight have spawned new applications. For example, robots can wash windows, pick fruit from trees, mix chemicals in laboratories, and handle radioactive materials.

The initial cost of a robot depends on its size and function. Other potential costs include modifying both product and process to accommodate the robot, preparing the worksite, installing and debugging the robot, and retraining and relocating workers. Benefits from robot installation include less waste materials, more consistent quality, and labor savings. Robots are the drudges of the work force, performing highly repetitive tasks without tiring, taking a lunch break, or complaining.

Automated Material Handling

In both manufacturing and service industries, the choice of how, when, and by whom materials are handled is an important technological decision. Materials handling covers the process of moving, packaging, and storing a product. Moving, handling, and storing materials costs time and money but adds o value to the product. Therefore operations managers are always looking for ways to reduce costs by automating the flow of materials to and from an operation.

Whether materials handling automation is justifiable depends on flow strategy. When operations have a flexile flow strategy, job paths vary and there is little repeatability in material handling. Such variability means that workers must move materials and equipment in open-top containers, carts, or lift trucks. However, when operations have a line flow strategy and repeatability is high, handling can be automated. In addition, other types of flexible automation are now available for firms with flow strategies that fall between these two extremes. Let’s look at two such technologies: automated guided vehicles and automated storage and retrieval systems.

AGVs

An automated guided vehicle(AGV) is a small, driverless, battery-driven truck that moves materials between operations, following instructions from either an onboard or a central computer. Most older models follow a cable installed below the floor, but the newest generation follows optical paths that can go anywhere with aisle space and a relatively smooth floor.

The AGV's ability to route around problems such as production bottlenecks and transportation blockages helps production avoid expensive, unpredictable shutdowns. Furthermore, AGVs enable operations managers to deliver parts as they are needed, thus reducing stockpiles of expensive inventories throughout the plant. The automotive industry now uses AGVs in some plants as mobile assembly stands primarily for heavy loads.

AS/RS

An automated storage and retrieval system (AS/RS) is a computer-controlled method of storing and retrieving materials and tools using racks, bins, and stackers. With support from AGVs, an AS/RS can receive and deliver materials without the aid of human hands.

FLEXIBLE MANUFACTURING SYSTEM

A flexible manufacturing system (FMS) is a configuration of computer-controlled, semi-independent workstations where are automatically handled and machine loaded. An FMS is a type of flexible automation system that builds on the programmable automation of NC and CNC machines. Programs and tooling setups can be changed with almost no loss of production time for moving from production of one product to the next. Such systems require a large initial investment($5 million to $20 million) but little direct labor to operate. An FMS system has three key components:

1. several computer-controlled workstations, such as CNC machines or robots, that perform a series of operations;
2. computer-controlled transport system for moving materials and parts from one machine to another and in an out of the system; and
3. loading and unloading stations.

Workers bring raw materials for a part family to the loading points, where the FMS takes over. Computer-controlled transporters deliver the materials to various workstations where they pass through a specific sequence of operations unique to each part. The route is determined by the central computer. The goal of using FMS systems is to synchronize

activities and maximize the system's utilization. Because automation makes it possible to switch tools quickly, setup times for machines are short. This flexibility often allows one machine to perform an operation when another is down for maintenance and avoids bottlenecks by routing parts to another machine when one is busy.

Specific characteristics of this FMS include the following.

- ✓ The computer control room houses the main computer, which controls the transporter and sequence of operations.
- ✓ CNC machines, each with its own microprocessor, control the details of the machining process.
- ✓ AGVs, which travel around and move materials on pallets to and from the CNCs. When the AGVs batteries run low, the central computer directs them to certain spots on the track for recharging.
- ✓ Indexing tables lie between each CNC ad the track. Inbound pallets from an AGV are automatically transferred to the right side of the table, and outbound pallets holding finished parts are transferred to the left side for pickup.
- ✓ A tool changer loads and unloads tool magazines. Each magazine holds an assortment of tools. A machine automatically selects tools for the next specific operation.
- ✓ An automatic AS/RS (upper right) stores finished parts. The AGV transfers parts on its pallet to an indexing table, which then transfers them to the AS/RS. The process is reversed when parts are needed for assembly into finished products elsewhere in the plant.

This particular system fits an intermediate flow strategy involving medium-level variety (5 to 100 parts) and volume (annual production rates of 40 to 200 units per part). The system can simultaneously handle small batches of many products. In addition, an FMS can be used a second way: At any given time, an FMS can produce low-variety, high-volume products in much the same way that fixed manufacturing systems do. However, when these products reach the end of their life cycles, the FMS can be reprogrammed to accommodate a different product. This flexibility makes FMS very appealing, especially to operations using a line flow strategy where life cycles are short.

A much more popular version of flexible automation is the flexible manufacturing cell (FMC), which is a scaled-down version of FMS that consists of one or a very small group of NC machines that may or may not be linked to a materials handling system controlled by a computer, which moves parts to the appropriate machines, as does the more sophisticated FMS.

Nature of International Operations Management / World Class Manufacturing:

The concern for improving performance continuously and rapidly in line with the increasing global competition is gathering momentum. If a system fails to give desirable results then the fault is not with the culture or the level of technology or labour. It is due to ineffective and incorrect performance measures used. Hence identification and definition of right type of performance measures are to be given a top most priority. World Class Manufacturing concept is of the recent origin following the attributes of World Class Manufacturing aim to fulfill the customer demands.

1. Products with high quality
2. Products at competitive price.
3. Products with several enhance features.
4. Products in a wider variety.
5. Products deliver with shorter time.
6. Products delivered on time.
7. Flexibility in fulfilling the product demand.

These performance measures are external to the manufacturing system but highly essential for the success of the company. These can be measured internally. Companies must set up the performance measure in these lines, so that the product will have the high level of acceptance at customer points.

The success of the company in the face of stiff competition is a direct consequence of its manufacturing function having a superior performance measurement system over its competitors. Under World Class Manufacturing, the companies' product should have a specification closer to the customer needs than those made by any competitor, they should

reach the customer error free, get deliver in a need time faster than any other competitor and should always be delivered at the promised due dates.

ISSUES IN INTERNATIONAL OPERATIONS MANAGEMENT

1. Sourcing and vertical integration.
2. Facilities location.
3. Standardization of production facilities.
4. Contract manufacturing.
5. Supply chain management.
6. Managing service operations.
7. International quality standards.
8. Internationalization of R&D and,
9. Managing technology transfers.

SOURCING AND VERTICAL INTEGRATION

- Sourcing refers to series of steps and processes a firm uses to acquire the required components to produce goods and service. It is called as 'procuring'.
- The required components / inputs may be manufactured in-house (or) may be outsourced.
- Make or buy decisions are the important factors in operations strategies.
- Backward integration: When a firm decides to make all the components in-house.
- Forward integration: A firm that owns and controls all distribution channels of the firm's products.
- Outsourcing is the act of moving some of a firm's internal activities and decision responsibility to external providers.

FACILITIES LOCATION

- Facility location problem is faced by both new and existing business and its solution is critical to a firm's eventual success.
- For the firm contemplating to locate operations in foreign countries.

- Factors to be considered are:

1. Country factors.
2. Technology Factors.
3. Product factors.
4. Government Policies.

STANDARDIZATION OF PRODUCTION FACILITIES

- Another strategic issue relates to Standardization of production facilities.
- Standardization of production facilities is one of the issues of internal operations management.
- Companies use same method of production, degree of capital invested, plant layout, control system and the like in all their subsidiaries located in different countries.
- A Few firms seek to customize their facilities to suit local conditions.

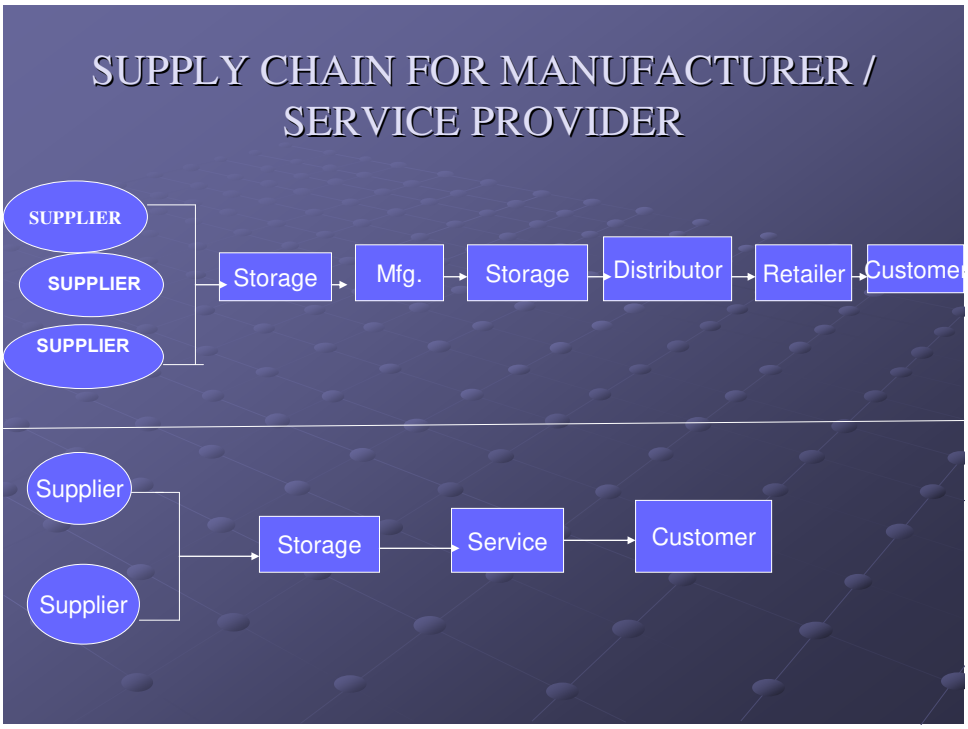
CONTRACT MANUFACTURING

- Contract manufacturing is an arrangement where an international business, places order with local manufacture companies for producing products, that are expected to sell locally or exported to foreign countries.
- The aerospace, defense, computer, semiconductor, energy, medical, food manufacturing, personal care, pharmaceutical
- and automotive fields. Some types of contract manufacturing include CNC machining, complex assembly, aluminum die casting, grinding, broaching, gears, and forging.

SUPPLY CHAIN MANAGEMENT

- A Supply chain is a sequence of an organization's facilities, functions and activities that are involved in producing and delivering a product / service.
- The sequence begins with basic raw materials supplies and extends all the way to the final customers.
- The elements are

- Customer service requirements.
- Plant and distribution centre network design
- Inventory management
- Outsourcing
- Key customer and supplier relationships
- Business processes
- Information systems
- Organizational designs and training Programmes
- Performance metrics
- Performance goals.



MANAGING SERVICE OPERATIONS

- The service sectors, called the tertiary sector, is becoming increasingly important in the developed countries and trend is visible in developing countries.
- An international services business is a firm that transforms resources into an intangible output that creates utility for its customers.

- Eg: British Airways
- Capacity Planning: Deciding how many customers the firm will be able to serve at a time.
- It is crucial in service providing as purchasing of any service involves close customer participation.

INTERNATIONAL QUALITY STANDARDS:

- Quality refers to the ability of a product / service to consistently meet or exceed customer expectations.
- Quality should first and foremost be perceived from the customer point of view.

Dimensions of quality are:

- Reliability
- Serviceability
- Durability
- Appearance
- Customer service and
- Safety.

Any company that distinguishes its product based on any one of the dimensions of quality or group, helps in gaining competitive advantage.

INTERNATIONALISATION OF R&D :

- Research and development (R&D) refers to an organized efforts, which are directed towards increasing scientific knowledge and product/ process innovation.
- Basic Research has the objective of enriching knowledge, without any short-term expectation of commercial applications.
- Applied research has the objective of achieving consumed applications. It has a problem solving emphasis i.e. ,it is conducted to reveal answers to specific problems.
- Development is the conversion of the results applied research into useful commercial applications.

- R&D benefits helps of firm's in gaining competitive advantage by bringing new product or service to the market that is different from competitors.

MANAGING TECHNOLOGY TRANSFERS:

- Management of technology transfers is the final strategic issue in international operations management.
- Technology transfer is the transfer of systematic knowledge of the manufacturer of a product, for the application of process or for the rendering of a service and does not extend to the mere sale or lease of goods.
- Transfer of technology from an MNC to its foreign plant is complex, because it is time-consuming, and costly process. The process ranges from R&D to product planning and design.
- It includes training of personnel, quality control, management practices, marketing skills and service supports.
- Successful transfer of technology needs cooperation and communication between the transferring and the transfers firm's and their respective countries.

Vertical Integration: This type of strategy can be a good one if the company has a strong competitive position in a growing, attractive industry.

A company can grow by taking over functions earlier in the value chain that were previously provided by suppliers or other organizations ("backward integration"). This strategy can have advantages, e.g., in cost, stability and quality of components, and making operations more difficult for competitors. However, it also reduces flexibility, raises exit barriers for the company to leave that industry, and prevents the company from seeking the best and latest components from suppliers competing for their business.

A company also can grow by taking over functions forward in the value chain previously provided by final manufacturers, distributors, or retailers ("forward integration"). This strategy provides more control over such things as final

products/services and distribution, but may involve new critical success factors that the parent company may not be able to master and deliver. For example, being a world-class manufacturer does not make a company an effective retailer.

Some writers claim that backward integration is usually more profitable than forward integration, although this does not have general support. In any case, many companies have moved toward less vertical integration (especially backward, but also forward) during the last decade or so, replacing significant amounts of previous vertical integration with outsourcing and various forms of strategic alliances.

UNIT-II

FORECASTING, CAPACITY AND AGGREGATE PLANNING

DEMAND FORECASTING:

- Forecast: A statement about the future.
- Forecasting: Estimating the future demand for products/services and the resources necessary to produce these outputs.
- Forecasting defined: Forecasting is the first step in planning. It is defined as estimating the future demand for products and services and the resources necessary to produce these outputs.
- Estimates of the future demand for products or services are the starting point for the entire sales forecasts

DEMAND FORECAST:

- According to Fayol, “Forecasting is the essence of management. Its techniques are used in every type of organization may it be government or private, production or service and social or religious”.
- According to McFarland, “Forecasts are predictions or estimates of the changes if any in characteristic economic phenomena, which affect one’s business plan”.
- Forecasting is the study of internal and external forces that shape demand and supply.

CHARACTERISTICS:

1. It is the basis of planning, production program.
2. It is an estimate of sales in the future.
3. The basis of forecasting is past trends and present economic conditions.
4. Forecasting is done for a particular period.
5. It can be in the shape of money or in the shape of a unit of a commodity.
6. It depends on market planning, economic, or other factors.
7. It tries to find-out lines of profitable investment.
8. It helps the firm in planning for trained manpower.
9. It tries to arrange appropriate promotional efforts such as advertisement, sales campaign etc.

NEED OF DEMAND FORECASTING:

Demand forecasting is needed for:

New facility Planning:

Designing and building a new facility (factory) or designing and implementing a new production process, and long-range forecasts of demand for existing. Designing and building a new facility (factory) or designing and implementing a new production process may take as long as five years or even more.

- These strategic activities are based on long-range forecasts of demand for existing and new products to allow the needed lead time for production and operations managers for plant location, plant layout, installation of machinery and equipments to produce the products and services to meet the demand.

Production Planning:

The rate of producing the products must be matched with the demand which may be fluctuating over the time period in the future.

- Work force scheduling: The forecasts of monthly demand may further be broken down to weekly demands and the workforce may have to be adjusted to meet these weekly demands.

Financial Planning:

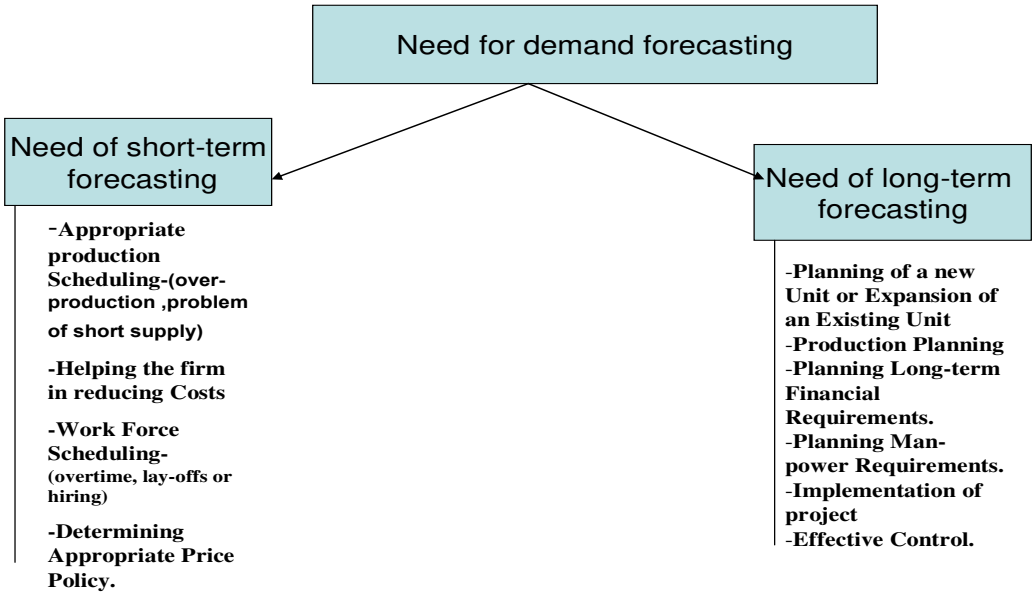
Sales Forecasting are the driving force in budgeting. Sales forecasts provide the timing of cash inflows (sales revenues) and also provide a basis for budgeting the requirements of cash outflow for purchasing materials, payments to employees and to meet other expenses of power and utilities etc.

- Hence, sales forecasts help finance manager to prepare budgets taking into consideration the cash inflows and cash outflows.

Workforce Scheduling:

- The forecasts of monthly demand may further be broken down to weekly demands and the workforce may have to be adjusted to meet these weekly demands.
- This may be done through reassignment of jobs to workforce, allowing overtime work, layoffs or hiring in order to match the weekly production rates with the weekly demands.
- Hence, short-range forecasts are needed to enable managers to have the necessary lead time to fine tune the workforce changes to meet the weekly production demands.

NEED FOR DEMAND FORECASTING



TYPES OF FORECAST:

1. Technological Forecasts: Concerned with rates of technological progress. It will provide changes will provide many companies with new products and materials to offer for sale.
2. Economic forecasts: Statements of expected future business conditions published by governmental agencies.
3. Demand Forecasts: Projections of demand for a company's products or services throughout some future period, it provides the basis for the company's planning and control decisions.

These forecast drive a company's production capacity and scheduling systems and serve as inputs to financial, marketing and human resource (manpower) planning.

FORECASTING TIME HORIZONS:

- (i) Short-range forecast: This forecast has a time span of upto one year, but is generally less than three months.
- It can be even for monthly or weekly forecasts.

- It is used for planning purchasing, job-scheduling, workforce levels, job assignments and production levels.
- (ii) Medium-range forecast (or intermediate range):
- A Medium range or intermediate range forecast generally spans from 3 months to 3 years.
- It is used in sales planning, production planning and budgeting (quarterly/yearly), cash budgeting and analyzing various operating plans.

(iii) Long-range forecast:

- Generally 3 years or more in time span, long range forecasts are used in new product planning and development, capital expenditure planning and planning for facility location or expansion and research and development.

TYPES AND CHARACTERISTICS OF FORECASTS BASED ON TIME HORIZON:

Forecast Horizon	Applications	Characteristics	Forecast Methods
Long-range(3 to 5 yrs. or more)	Business planning, Product planning, Capital Planning, Facility planning, Location planning	Broad, general, often only qualitative	Technological, Economic, Demographic, Marketing studies, Judgment.
Medium or intermediate(3 to 3 years)	Aggregate Planning, Capital and cash Budgets, Production Planning and budgeting, inventory planning and budgeting.	Numerical, not necessarily at the item level. Estimate of reliability needed.	Collective opinion, Time series / Regression analysis, judgment.
Short-range(1week to 3 months)	Short run adjustment of production and personal levels,	May be at the item level for planning of activity level, should be at the item level	Exponential, Smoothing.

	purchasing, job scheduling, capacity changes by over time, lay offs etc.	for purchasing and inventory control.	

ELEMENTS / REQUIREMENTS OF A GOOD FORECAST:

The forecast should be timely. This means that the forecasting horizon must have the time necessary to implement possible changes in production capacity, financial needs etc.

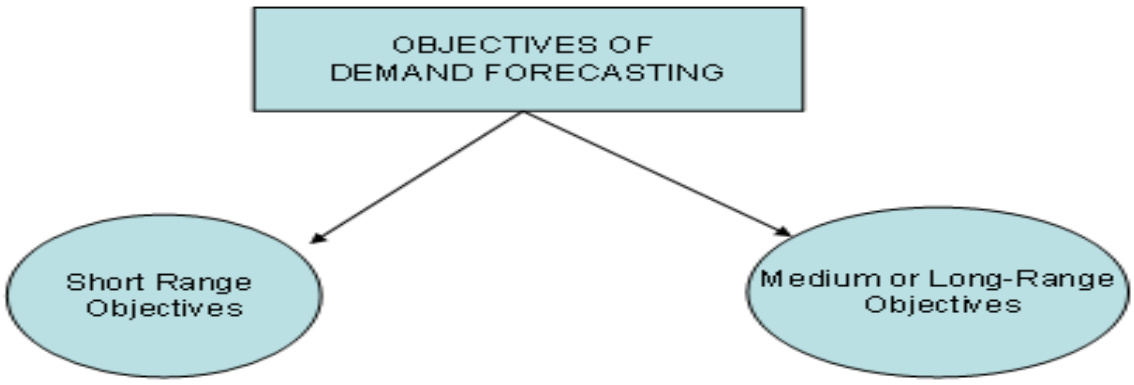
(ii) The forecast should be accurate and the degree of accuracy should be known.

(iii) The forecast should be reliable.

(iv) The forecast should be expressed in meaningful units such as rupees, units of products, machines and skills needed.

(v) Techniques should be simple.

(vi) The forecast should be in the written form to permit an objective basis for evaluating the forecast once the actual results are known.



SHORT RANGE OBJECTIVES:

- Objectives are:

1. Formulation of production strategy and policy: To Bridge the gap betn demand and supply of a product offered by the firm and to ensure.- The requirements of materials to be purchased on a regular basis.-Optimum utilization of plant and equipments.- Planning the availability of labor on a regular basis.

2. Formulation of pricing policy: Demand forecasts enable management to formulate a suitable mechanism for fixing the prices for products to be sold.
3. Planning and control of sales: Demand Forecasts facilitate territory design and determination of sales quotas to be assigned to sales people.
4. Financial planning: Demand Forecasts Facilities estimating cash inflows and cash outflows for the products which forecasts are made.

MEDIUM OR LONG-RANGE OBJECTIVES:

Long-range planning for production capacity: The installed capacity of the plant is usually based on long-term demand forecasts.

(ii) Labor requirements (Employment levels): Employment levels are based on reliable medium /long term demand forecasts so as to optimize the cost of production over the long term planning horizon.

(iii) Restructuring the capital structure: Long term forecasts facilitate planning for long term finance requirements at reasonable finanacial coasts and other terms and conditions for obtaining finance from lending institutions as well as planning for internal finanacial resources to meet the long-term financial needs.

STEPS IN DEMAND FORECASTING:

1. Understand the objective of forecasting
2. Integrate demand planning and forecasting throughout the supply chain
3. Understand and identify customer segments.
4. Identify Major factors that influence the demand forecast.
5. Determine the appropriate forecasting technique.
6. Establish performance and Error Measures for forecast.

STEPS IN FORECASTING PROCESS:

(i) Determine the purpose (objectives) of the forecast: details required in the forecast ,the amount of resources (manpower, computer time, rupees etc.)

(ii) Select the items for which forecasts are needed: Determine whether the forecast needed for a single product or for a group of products (Product -line).

(iii) Determine the time horizon for the forecast: Short-term, medium term, long term./ monthly, quarterly, or Yearly.

(iv) Select the forecasting model (method or technique): Quantitative- Moving Averages, exponential Smoothing and regression analysis. Qualitative techniques such as judgmental or market research method.

(v) Gather and analyze the data needed for the forecast:

(vi) Prepare the forecast: Using the Selected method.

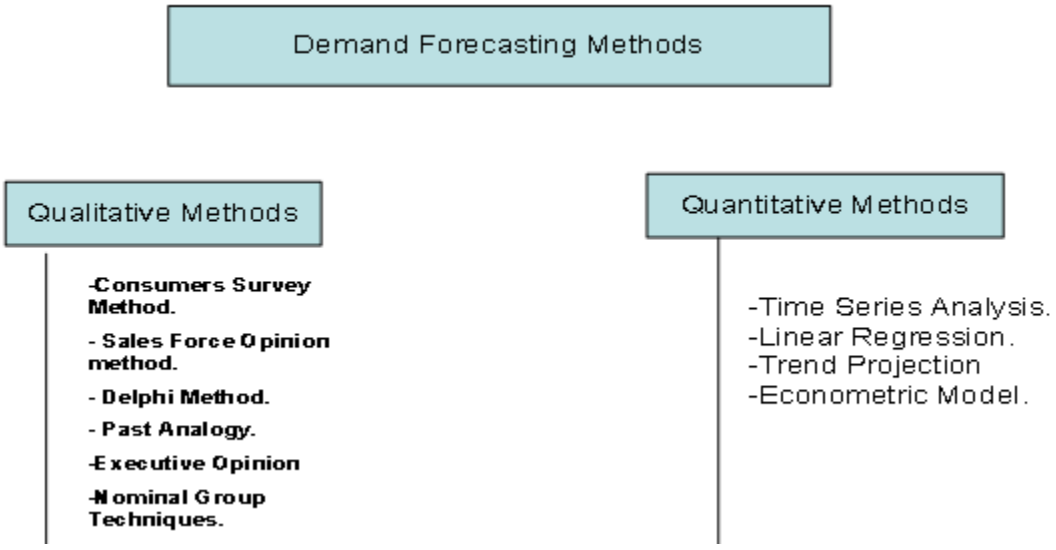
(vii) Monitor the forecast: Monitor the forecast to determine whether it is performed satisfactorily. If not, review the method, assumptions, validity of data and modify the forecast if needed and prepare a revised forecast.

FORECASTING APPROACHES:

The two approaches to forecasting are:

(i) Qualitative: It consists mainly of subjective inputs, often of non-numerical description.

(ii) Quantitative: It involves either projection of historical data or the development of association models which attempt to use causal variables.



QUALITATIVE METHODS:

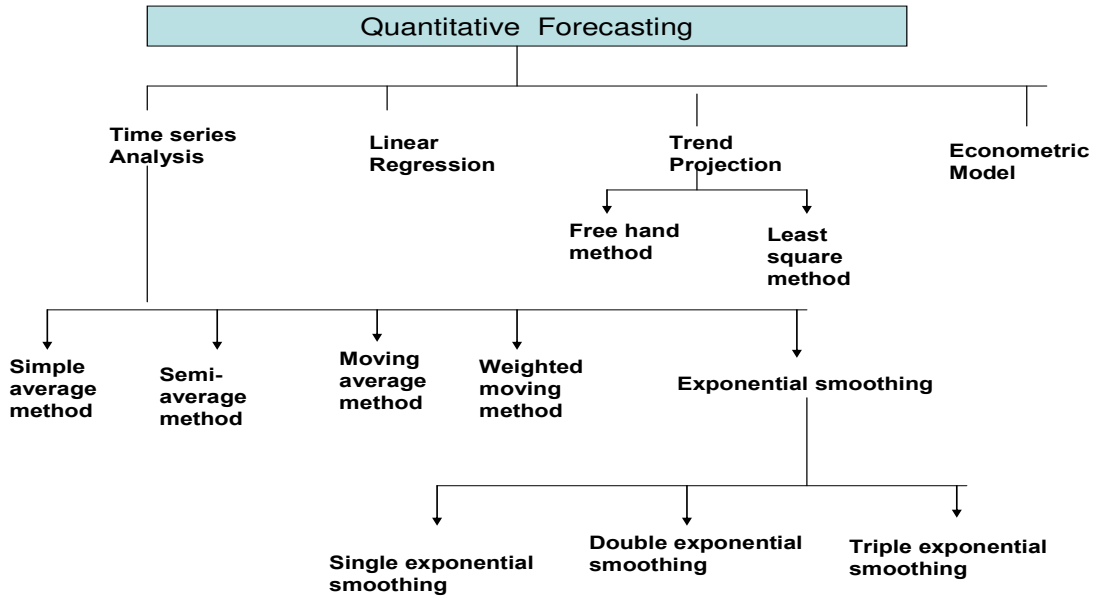
Methods of Qualitative Forecasting:

1. Consumers Survey Method:
   - Complete Enumeration Survey.
   - Sample Survey And test marketing.
   - End-use Method.
2. Sales Force Opinion Method:
3. Delphi Technique:
4. Past Analogy.
5. Executive Opinion-
6. Nominal Group Technique- problem solving& decision making method.

QUANTITATIVE DEMAND FORECASTING METHOD:

- Quantitative/ statistical methods are considered to be superior techniques of demand estimation because:

1. The element of subjectivity in this method is minimum.
2. Method of estimation is scientific.
3. Estimation is based on the theoretical relationship between the dependents and independents variables.
4. Estimates are relatively more reliable, and
5. Estimates involves smaller cost.



TIME SERIES:

- Time series forecasting methods are based on analysis of historical data (time series; a set of observations measured at successive times or over successive periods.)
- They make the assumption that past patterns in data can be used to forecast future data points.
- According to Morris Hamburg, "A time series is a set of observations arranged in chronological order".
- According to Kenny And keeping, " A Set of data depending on the time is called time series".

METHODS OF TIME SERIES ANALYSIS

- TIME SERIES Analysis can be done by two methods:

1. Simple Average Method: In this model, the arithmetic average of the actual sales for a specific number of recent past time periods is taken as the forecast for the next time period.

$$\text{Simple Average} = \frac{\text{Sum of demands for all past periods}}{\text{Number of demand periods}}$$

Semi-Average Method

- In this method, the original data is divided into two equal parts and averages are calculated for both the parts.
- These averages are called semi-averages.

Moving- Average Method:

- Moving Average method is a simple device of reducing fluctuations and obtaining trend values with a fair degree of accuracy.
- In this method, the average value of a number of years (months, weeks or days) is taken as the trend value for thee middle point of the period of moving average.
- The process of averaging smoothes the curve and reduces the fluctuations.

Weighted Moving Average Method

- Sometimes trend values are determined by using weighted moving average.
- In this method, the moving totals are multiplied by the weights assigned to them and the weighted moving average is obtained by dividing this product by the sum of the weights.

Exponential Smoothing

- Exponential smoothing models are well known and often used in operations management. The reasons for their popularity are two:

(i) They are readily available in standard computer software packages.

(ii) They require relatively little data storage and computation.

TYPES OF EXPONENTIAL SMOOTHING:

i) Single Exponential Smoothing: The equation for creating a new or updated forecast uses two pieces of information:

a) Actual demand for the most recent period, and

b) The most recent demand forecast.

As each time period expires, a new forecast is made:

Forecast of next period's demand = α (Actual demand for most recent period) +
(1- α)(Demand forecast for most recent period).

Exponential Smoothing with trends (Double-Exponential Smoothing):

- An Exponential Smoothing over an already smoothed time series is called double-exponential smoothing.
- Double-exponential smoothing allows forecasting data with trends.
- This method is better at handling trends that are not stationary.

iii) Triple-Exponential Smoothing:

- In the case of non-linear trends, it might be necessary to extend it even to a triple-exponential smoothing.
- Triple-exponential smoothing is better at handling parabola trends and is normally used for such data.

OVERVIEW OF QUALITATIVE METHODS:

1. Jury of Executive Opinion.
2. Sales force Composite Method
3. Market Research Method (or Consumer Survey Method)
4. Other Judge mental Methods: Delphi Method

JURY OF EXECUTIVE OPINION:

- It is a forecasting technique in which the opinions of a small group of high-level executives (managers) are taken, based on which a group demand is obtained as the forecast.
- Advantages:
- Can be used for technological forecasting.
- Can be used to modify an existing forecast to account for unusual circumstances.
- Disadvantages:
- Executive opinion can be costly because it takes valuable executive time.
- It sometimes gets out of control or gets delayed.

SALES FORCE COMPOSITE METHOD:

- This is also called as " Pooled sales force estimate" method.
- It is based on estimate of expected sales by sales persons.
- Advantages:

- The sales force is the group closest to the customers
- Sales territories often are divided into districts or regions and forecast will be useful in inventory management, distribution and sales force staffing.
- Disadvantages:
- Individual biases of sales people may affect the sales forecast (some are optimistic, some are pessimistic.)

MARKET RESEARCH METHOD OR CONSUMER SURVEY METHOD:

- This is a systematic approach to determine consumer interest in a product or service by conducting a consumer survey and sample consumer opinions.
- This method may be used to forecast demand for the short, medium and long-term.

OTHER JUDGE MENTAL METHODS: DELPHI METHOD:

- In this method, opinions are solicited from a number of other managers and staff personnel.
- The decision makers consist of a group of 5 to 10 experts who will be making the actual forecast.
- The staff personnel assist decision makers by preparing, distributing, collecting and summarizing a series of questionnaires and survey results.

It is a judgmental method which uses a group process that allows experts to make forecasts.

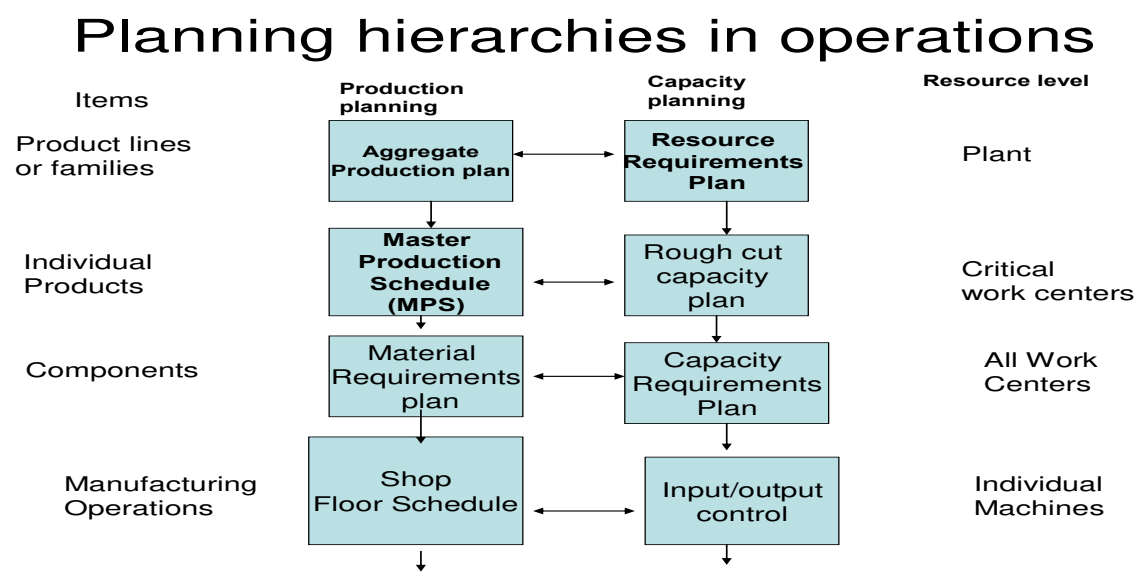
Quantitative Forecasting	Qualitative Forecasting
1) Quantitative forecasting methods use mathematical models to represent relationships among relevant variables based on historical data and / or known relationships.	In contrast, qualitative forecasting methods rely on one or more individuals to generate forecast without using mathematical models alone; e.g., a sales manager may predict future sales for the division based on informal discussions with some customers.
2) Quantitative forecasting models are used in conjunction with historical data to forecast demands (or some other quantity).	Qualitative forecasting incorporates the forecaster's experiences, intuition, values and personal biases into the forecast.

3) These methods are sometimes referred to as objective forecasting methods because the underlying assumptions of the forecasting model and the data used can be stated precisely, independent of the user. Thus, if two individuals use the same model and same data, they should get the same forecasts.	These are considered subjective forecasting methods because there is no way to determine exactly what information is being used by the forecaster and how. Such forecasts are specific to the forecaster and cannot be duplicated by others. For ex: If two individuals attempt to predict the market penetration of a new product, their forecasts will be different because the are Drawing on different experiences and are likely to weight the importance of those experiences differently.

CAPACITY PLANNING:

- Meaning: Capacity is the rate of productive capacity of a facility.
- Capacity is expressed as volume of output per time period.
- Operations manager are concerned with the capacity for reasons:

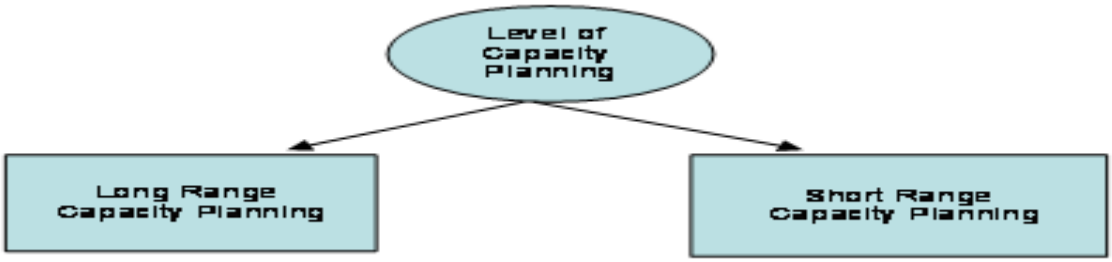
1. They want sufficient capacity to meet customer demand in time.
2. Capacity affects cost efficiency of operations, the ease or difficulty of scheduling output and the costs of maintaining the facility.
3. Capacity requires an investment of capital.



Definition of Capacity planning

- According to APICS, " Capacity planning or capacity requirements' planning is the function of establishing, measuring and adjusting limits or levels of capacity."
- The term 'capacity Requirements Planning' in this context is the process of determining how much labor and machine resource is required to accomplish the tasks of production".
- It is also defined as "Capacity Planning is the study of the level of capacity the organization provides at each stage of the production or service delivery system to meet its objective."
- Capacity Planning is the process used to determine how much capacity is needed in order to manufacture greater product or begin production of a new product.

Long Range Capacity Planning



LONG RANGE CAPACITY PLANNING:

- Over the long term,capcity planning relates primarily to strategic issues involving the firm's major production facilities.
- Technology and transferability of the process to other products is also intertwined with the long term capacity planning.
- Long term capacity planning may evolve when short term changes in capacity are insufficient.
- For ex: If the firm's Addition of a third shifts to its current two-shift plan still does not produce enough output, and subcontracting arrangements cannot be made, One feasible alternative is to add capital equipment and modify the layout of the plant (long term actions).
- It may even be desirable to add additional plant space or to construct a new facility (long-term alternatives).

SHORT RANGE CAPACITY PLANNING:

- In short term, capacity planning concerns issues of scheduling, labor shifts and balancing resource capabilities.
- The goal of short-term capacity planning is to handle unexpected shifts in demand in an efficient economic manner.
- The time frame for short-term capacity planning is frequently only a few days but may run as long as six months.

OBJECTIVES OF CAPACITY PLANNING:

The decisions taken by operations managers in devising their capacity plans will affect several different aspects of performance:

- Costs: capacity levels in excess of demand could mean under-utilization of capacity and therefore high unit cost.
- Revenues: It is also affected by the balance between capacity and demand.
- Working Capital: It will be affected if an operation decides to build up finished goods inventory prior to demand.
- Quality: By hiring temporary staff.-disruption to the routine working of the operation.
- Speed: By the deliberate provision of surplus capacity to avoid queuing.

- Dependability:- how close demand levels are to capacity.
- Flexibility:-volume flexibility will be enhanced by surplus capacity.

TYPES OF CAPACITY PLANNING: There are two types of capacity planning:

1. Rough-cut capacity Planning (RCCP).
2. Capacity Requirements Planning (CRP).

Rough-cut capacity Planning (RCCP):

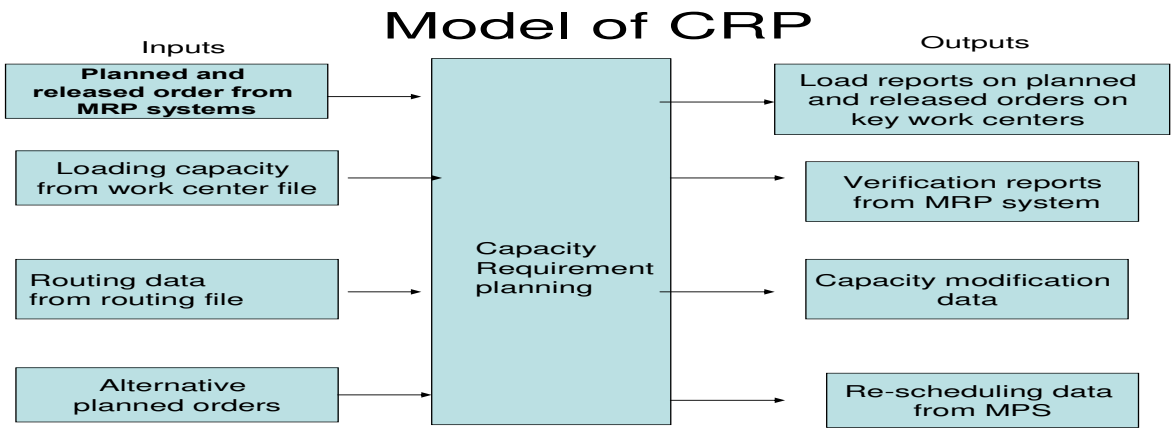
- Rough-cut capacity Planning (RCCP) is very important plan in capacity planning of firm.
- It takes capacity planning to the next level of detail.
- The Master Production Schedule (MPS) is the primary source of information for RCCP.
- RCCP is a medium-range planning aid and is used to verify whether enough available capacity exists at critical resources to accomplish a projected master production schedule.
- The purpose of RCCP is to check the feasibility of the MPS, provide warnings of any bottlenecks, ensure utilization of work centers, and advise vendors of capacity requirements.
- RCCP provides aggregate information to top management far enough in advance to permit management to make changes in capacity (i.e. hire more people, buy more equipment) to accomplish a given MPS.

Capacity Requirements Planning (CRP):

- Capacity Requirements Planning (CRP) occurs at the level of the material requirements plan.
- It is the process of determining in detail the amount of labor and machine resources needed to achieve the required production.
- Planned orders from the MRP and open shop orders (scheduled receipts) are converted into demand for the time in each work centers accordingly.
- CRP is the last level of capacity analysis. it is planning and control of the resources needed to produce the requirements generated by the MRP system.

Basis of difference	RCCP	CRP

1)What	1)Projected gross capacity 2) Requirements for key resources.	Projected net capacity Requirements for each work center.
2) How	Explode production plan or MPS through resource profiles.	Explode MPS and MRP I planned orders through detailed routings combine with current WIP status from shop floor control.
3) When	As required for simulation	Weekly, monthly
4) Why	pre-MRP I evaluation of MPS. Intermediate to long range planning.	1)Post-MRP I detailed analysis
5) Precision	Aggregate or gross key resources only.	Detailed- considers inventory, lot sizing WIP completions, Work center lead times
6) Complexity	Much less than CRP	Usually exceeds MRP I.
7) Planning Horizon	Production plan limits	MRP I Horizon
8) Implementation	Short	Requires work centers, routings, MPS< MRP I and WIP status of SFC.



Capacity Alternatives:

1. Short-term Responses: For short-term periods of up to one year, fundamental capcity is fixed.

- Major facilities are seldom opened or closed on a regular monthly or yearly basis.
- Short term capacity can be modified by operating these facilities more or less intensively than normal.

➢ The cost of setting up, changing over, and maintaining facilities, procuring raw materials and manpower, managing inventory, and scheduling can all be modified be such capacity changes.

Temporary capacity changes:

TYPE	ACTION
inventories	Stock pile finished goods during slack periods to meet later demand.
Backlogs	During peak demand periods, ask willing customers to wait time before receiving their product. File their order and fulfill it after the peak demand period.
Employment levels	Hire additional employees or lay off employees as demand for output increases and decreases.
Work force utilization	Have employees work overtime during peaks and be idle or work fewer hours during slack demand periods.

Employee training	Instead of having each employee specialize in one task, train each in several tasks, then as skill requirements changes, rotate employees among different tasks.
Process design	Change the current job content workstation to increase productivity. Use work methods analysis to redesign jobs.
Subcontracting	During peak periods, hire other firms temporarily to make the product or some of its subcomponents.
Maintenance	Temporarily discontinue routine preventive maintenance on facilities and equipment so that during peak periods the facility can be operated when it would otherwise be idle.

Long-term Response:

- Long-term consideration relates to overall level of capacity, such as facility size. It requires forecasting demand over a time horizon and then converting those forecast into capacity requirement. Following strategies are:

1. Long-term Capacity Expansion.
2. Long-term Capacity Reduction.

Evaluating Capacity Alternatives:

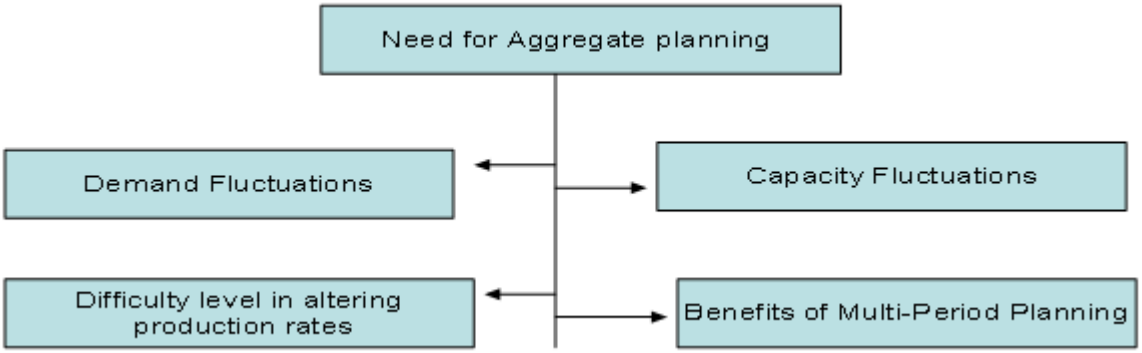
- Models available to assist in capacity planning as follows:

1. Present Value Analysis: (time value of capital investment.)
2. Break-even Analysis: (min. break even volume for project cost and revenue.)
3. Linear Programming: (the model focuses on short run question of ways to use existing capacity in order to optimize the utilization of resources.)
4. Decision Tree Analysis: (for the analysis of capacity expansion decisions, decision tree analysis is often used.)

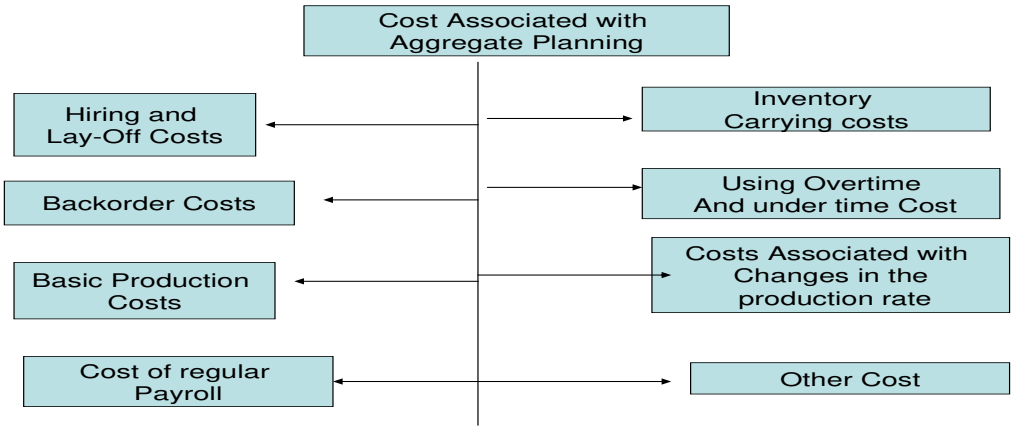
AGGREGATE PLANNING:

- Aggregate planning is the process of developing, analyzing and maintaining a preliminary, approximate schedule of the overall operations of an organization.
- The Aggregate plan contains sales forecasts, production levels, inventory levels, and customer backlogs.
- In simple terms, aggregate planning is an attempt to balance capacity and demand in such a way that costs are minimized.

- The term "Aggregate" is used because planning at this level includes all resources " in the aggregate" e.g. as a product line or family.
- Aggregate resources could be total number of workers, hours of machine time, or tonnes of raw materials.



Aggregate Planning associated Cost



APPROACHES OF AGGREGATE PLANNING:

- An aggregate plan takes into consideration the overall level of output and the capacity i.e. required to produce it.
- These are two basic approaches to estimating the capacity that will be required to produce an aggregation or grouping of a company's products, which are as follows.
- Top-down Approach
- Bottom-up Approach

Top-down Approach:

- It involves development of the entire plan by working only at the highest level of consolidation of products.
- It consolidates the products into an average product and then develops one overall plan.
- This plan is disaggregated to allocate capacity to product families and individual products.
- This approach rests on the assumption that if the proper amount of total capacity is available, the right amount of capacity for all of the parts will be available.
- This top-down approach is performed in terms of a pseudo-product which is a fictitious product that represents the average characteristics of the entire product line to be planned.

Bottom-up Approach:

- It is also known as sub-plan consolidation approach.
- It involves development of plans for major products and product families at some lower level, within the product line.
- These sub-plans are then consolidated to arrive at the aggregate plan, which gives the overall output and the capacity required to produce it.
- This approach starts with plans for major products or product families and aggregate (sums) the impact that these plans have on the capacity of the company.
- If the capacity requirements for individual plans appear to sum-up to a satisfactory overall use of the company's resources the plans are accepted to be implemented strategically. If not, some of the individual plans are revised to improve the overall impact of the aggregate plan.
- This is also called "resource requirement planning" and "rough-cut capacity planning.

AGGREGATE PLANNING PROCESS:

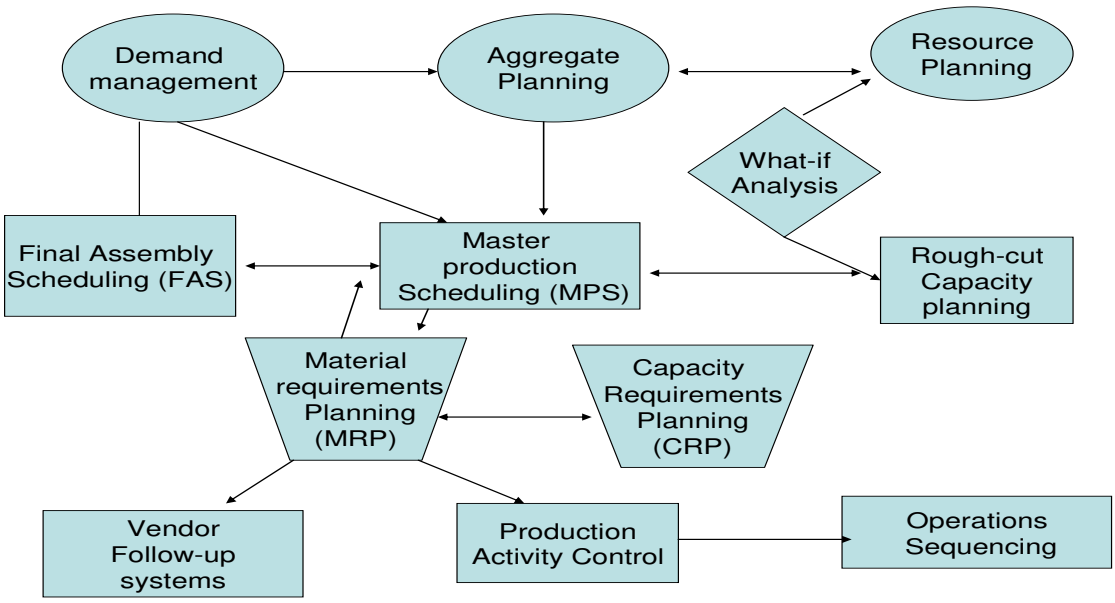
- The process for basic considerations as follows:

1. Concept of Aggregation
2. Goals for Aggregate Planning
3. Aggregate Demand forecasts
4. Interrelationships among decisions

RELATIONSHIP TO MASTER PRODUCTION SCHEDULE

- Aggregate Planning (AP) and Master Production Scheduling (MPS) are two important functions in Manufacturing Resource Planning Proper interfaces between the two functions will greatly enhance the effectiveness of the whole Manufacturing Planning and Control (MPC) system.
- Aggregate Planning (AP) and Master Production Scheduling (MPS) is the front end of most production and operations planning and control systems.
- In aggregate production planning, management is concerned with determining the aggregate levels of production, inventory, and workforce to respond to fluctuating demands in the future.
- The aggregate plan provides an overall guideline for master production scheduling, which specifies the timing and volume of the production of individual products.
- The master scheduler takes the aggregate decisions as targets and tries to achieve them as much as possible.
- Ideally, the sum of production (and inventory) quantities in the master schedule over a time period should equal the aggregate production (and inventory) quantities for that time period.

- However, deviations may occur due to factors such as capacity limitations at critical work-centers.
- The feedback from actual master scheduling performance provides information for improving future aggregate plans.
- To be feasible and acceptable, a master production schedule should meet the resource constraints at critical work centers.
- This feasibility check is called ""resource requirement planning" (RRP) or "rough-cut capacity planning (RCP).



O

verview of MRP, MRP II and ERP

- MATERIAL REQUIREMENT PLANNING (MRP).
- MANUFACTURING RESOURCES PLANNING (MRPII).
- ENTERPRISE RESOURCE PLANNING (ERP).

MATERIAL REQUIREMENT PLANNING(MRP)

- According to American Production and Inventory Control Society (APICS), " MRP constitutes a set of techniques that use bill of material, inventory data, and the master production schedule to calculate the requirements for materials."

OBJECTIVES OF MRP

1. Inventory Reduction
2. Reduction in production and delivery lead times
3. Realistic Commitments
4. Increased Efficiency

NEED FOR MRP

1. Forces the planner to determine the total material
2. Helps in development of procedure and systems
3. Focuses on control parameters
4. Classification for inventory item

5. Fixing of norms for shelf life
6. Arranging items of correct specifications.

INPUT /OUTPUT OF MRP SYSTEM

- An MRP system translates the demand for end products into raw materials and three components requirements to all available variants of MRP systems are:

1. Inputs
2. MRP processing (material flow in MRP).
3. Outputs.

Inputs to MRP

- MRP is a processor which processes inputs (relating data) to give a time phased detailed schedule for raw materials and components.
- These inputs are:

1. Master production Schedule (MPS).
2. Bill of materials (BOM)
3. Inventory status file (ISF)- information such as- Inventory status, replenishment lead times, and manufacturing lead time.

MANUFACTURING RESOURCES PLANNING (MRPII):

- According to APICS,MRP II is defined as a "a method for effective planning of all the resources of manufacturing company.
- Ideally it addresses operational planning in units, financial planning in dollars and has a simulation capability to answer ' what –if" questions .
- It is made up of variety of functions each linked together; business planning, production planning, master production scheduling, material requirements planning, capacity requirements planning and the execution system for capacity and priority.

BENEFITS OF MRPII:

1. Effective Inventory Management and control
2. Improved Capacity Planning
3. Better Priority

4. Enhanced Customer Service
5. Improved Management
6. Enhanced employee Morals
7. Effective Long-range Planning Tool

ENTERPRISE RESOURCE PLANNING (ERP):

- "ERP System is defined as Configurable information systems packages that integrate information and information-based processes within and across functional areas in an organization".

FEATURES OF ERP:

1. Accommodating Variety
2. Integrated Management Information
3. Seamless Integration
4. Supply Chain management
5. Resource Management
6. Integrated Data model

SCOPE OF ERP:

1. Financials
2. Logistics
3. Human resources
4. Workflow

ERP SYSTEMS

PROBLEMS AND SOLUTIONS

12 (a) The past data about the load on a stamping centre are as follow:

Month	Load, Machine hours
May 2009	584

June 2009	610
July 2009	655
August 2009	747
September 2009	862
October 2009	913
November 2009	963

i) Find an exponential smoothing forecast for the month of December 2009. Take ($\alpha = 0.33$)

ii) Compare your answer with a five month moving average forecast.

May / June 2010

Solution

a)

i) Since the forecast demand for June or any month is not give. Using naïve approach the forecast for June is considered to be the 584 machine hours. $\alpha = 0.33$.

The formula for exponential smoothing is

$$F_t = F_{t-1} + \alpha (D_{t-1} - F_{t-1})$$

Where

F_t = Smoothed average forecast for period t.

F_{t-1} = previous period forecast.

α = smoothing constant

D_{t-1} = previous period demand

Month	Demand	Forecast	$(D_{t-1} - F_{t-1})$	Correction $\alpha (D_{t-1} - F_{t-1})$	New Forecast $F_{t-1} + \alpha (D_{t-1} - F_{t-1})$
June	610	584	26	8.58	592.58
July	655	593	62.42	20.60	613.60
August	747	614	133	43.89	658
September	862	658	204	67.32	725
October	913	725	188	62.04	787
November	963	787	176	58.08	845.08

The forecasted demand for the month of December 2009 under exponential smoothing is 845 machine hours.

(ii) 5 months moving average method.

The method in which the past month average is taken to forecast the machine hours for future period.

Months	Load Machine hours	5 Months moving average Total	Average
May	584		
June	610		
July	655		
August	747		
September	862	3458	691.6
October	913	3787	757.4
November	963	4140	828

The forecasted machine hours for December 2009 using moving average method is 828 machine hours.

These are difference of 17 machine hours between the two methods.

12. (b) From the data given below forecast monthly demand if $\alpha = 0.2$. Assume that actual demand in the first month is the same as the forecasted demand and the initial level and the trend for month 1 are 10. From these results, forecast the demand for period 8.

Month	1	2	3	4	5	6
Demand	20	30	35	30	50	55

Find the tracking signal for the above data?

May / June 2006

Solution

MONTH	DEMAND	FORECAST

1	20	10
2	30	14
3	35	18.2
4	30	20.56
5	50	26.448
6	55	32.16

NEWBARE = 2 (NEW DEMAND + (1-.2) 10

= .2 (30) + (1-.2) 10

2M = 6+8=14

3 MONTH = . 2 (35) + 1-.2 (14)

= 7 + 11.2

= 18.2

4^{TH} MONTH =. 2(30) + (1-.2) (18.2)

6 + 14.56 = 20.56

5^{TH} MONTH = .2(50) + (1-.2) (20.56)

10 + 16.448

= 26.448

6^{TH} MONTH = .2 (55) + (1-.2) (26.448)

-11 + 21.16 = 32.16

COMPUTATION OF ABSOLUTE PERCENTAGE ERROR

MONTH	DEMAND	FORECAST	ERROR	SUM OF ERROR
1	20	10	10	10
2	30	14	16	26
3	35	18.2	16.8	42.8

4	30	20.56	9.44	52.24
5	50	26.448	23.552	75.792
6	55	32.16	22.9	98.6

ABSOLUTE DEVIATION	CLEAN DEVIATION	MAD	PRACKING	SIGNAL
10	10	10	10/1	1
16	26	13	26/13	2
16.8	42.8	14.27	42.8/14.27	3
9.44	52.24	13.06	52.24/13.06	4
23.552	75.792	15.16	75.792/15.16	5
22.9	98.6	16.4	98.6/16.4	6

AVERAGE ERROR = $\frac{10+16+16.8+9.44+23.552+22.9}{6}$

= 6.45

MAD = 16.45

TRACKING SIGNAL = $\frac{\text{SUM OF FORECAST ERROR}}{\text{MEAN ABSDUTE DEVIATION}}$

13 (b) A firm believes that its annual profits depends on its expenditures for research. The information for the preceding six years is given below. Estimate the profit when the expenditure is 6 lakhs.

Year	1	2	3	4	5	6
Expenditure for research in lakhs of rupees	2	3	5	4	11	5
Annual profit n lakhs of rupees	20	25	34	30	40	31

Nov. / Dec. 2008

Solution

Year	X	Y	XY	X^2

1	2	20	40	4
2	3	25	75	9
3	5	34	170	25
4	4	30	120	16
5	11	40	440	121
6	5	31	155	25
Total(∑)	30	180	1000	200

$\overline{X}$ =30/6 = 5 $\overline{Y}$ =180/6 = 30

$$b = \frac{\sum XY - n\overline{X}\overline{Y}}{\sum \overline{X}^2 - n\overline{X}^2}$$

=1000-6*5*30 / 200-6*5*5 = 1000-900 / 200-150 = 2

Q= $\overline{Y}$ - b $\overline{X}$

= 30-2*5 =20

Model is y = a+bx = 20+2x

Profit when expenses is 6 units

Y=20+2*6

=20+12 =32 units of rupees

13. (b) The sales particular of a company for 13 years of operation is furnished below.

Year	1	2	3	4	5	6	7
Units Sold	96	116	119	127	146	145	153
Year	8	9	10	11	12	13	
Units Sold	158	160	165	177	190	205	

(i) Fit a simple regression for the above data.

(ii) Forecast the sales for the 14th year of operation.

Nov. / Dec. 2007

Solution

X(year)	Y(sales)	X=X-7	XY	X^2
1	96	-6	-576	36
2	116	-5	-580	25
3	119	-4	-476	16
4	127	-3	-381	9
5	146	-2	-292	4
6	145	-1	-145	1
7	153	0	0	0
8	158	1	158	1
9	160	2	320	4
10	165	3	495	9
11	177	4	708	16
12	190	5	950	25
13	205	6	1230	36
	1957	0	1411	182

$\overline{X} = \frac{0}{13} = 0$

$\overline{Y} = \frac{1957}{13} = 150.53$

$$b = \frac{\sum xy - n\overline{X}\overline{Y}}{\sum X^2 - n\overline{X}^2}$$

$= \frac{1411 - 0}{182 - 0} = 7.75$

$a = \overline{Y} - b\overline{X}$

$= 150.5 - 7.75 * 0$

$= 150.5$

y=a + bX

= 150.5+7.75X

Forecast for sale of 14th year

y = a+ b(X-7)

= a+b(14-7)

= 204.76

13. (b) A company has the following sales pattern. Compute the sales forecast for the year 2007 using linear regression

Year	2000	2001	2002	2003	2004	2005	2006
Sales (In lakhs):	6	8	11	23	29	34	40

May / June 2007

Solution

X(year)	Y(sales)	X=X-2003	XY	X^2
2000	6	-3	-18	9
2001	8	-2	-16	4
2002	11	-1	-11	1
2003	23	0	0	0
2004	29	1	29	1
2005	34	2	68	4
2006	40	3	120	9
	151	0	172	28

$\overline{X} = \frac{0}{7} = 0$

$\overline{Y} = \frac{151}{7} = 21.57$

$$b = \frac{\sum xy - n\overline{X}\overline{Y}}{\sum X^2 - n\overline{X}^2}$$

$= \frac{172 - 7*0*21.57}{182 - 7*0*0} = 6.142$

$a = \overline{Y} - b\overline{X}$

$= 21.57 - 6.142 * 0$

$= 21.57$

$y = a + bX$

$= 21.57 + 6.142(2007 - 2003) = 21.57 + 6.142*4 = \underline{46.13 \text{ units}}$

12. (b) Consider an item that has projected requirements as shown in table. The beginning inventory of 30 units. The economic order quantity is 65 units and the lead time to assemble the item is one week. Develop the MRP table for the item.

Projected Requirements

Week	0	1	2	3	4	5	6	7	8	9	10	11	12
Projected Requirement	-	30	50	40	-	15	20	20	-	10	-	15	50

Nov. / Dec. 2007

Solution

Lead time=1 EOQ=65

Work	0	1	2	3	4	5	6	7	8	9	10	11	12
Project requirement	-	30	50	40	-	15	20	20	-	10	-	15	50
Receipts	-	-	65	65				65					65

Stock on hand	30		15	40	40	25	55	50	50	40	40	25	40
Planned release		65	65	-	-	-	65	-	-	-	-	65	-

UNIT – III

DESIGN OF PRODUCT, SERVICE AND WORK SYSTEMS

INTRODUCTION:

Product is anything that can be offered to a market that might satisfy a want or need.

- Two concepts are:
- Narrow concept- A product is a bundle of physical or chemical properties which has some utility.
- Wide concepts- All the brands, all the colors all the packaging or all the designs of a product is taken to be different products.
- According to W. Alderson, "A product is a bundle of utilities consisting of various features and accompanying services".
- According to Philip Kotler, "A Product is a bundle of physical services and symbolic particulars expected to yield satisfaction or benefits to the buyer".

MEANING, DEFINITION- PRODUCT DESIGN:

- Design is the conversion of knowledge and requirement into a form, convenient and suitable for use for manufacture.
- It is observed that inputs of the organizations resource resulting properly designed product and service known as outputs satisfying the customer's desire.
- According to C.S.Deverell, " Product design in its broadest sense includes the whole development of the product through all the preliminary stages until actual manufacturing begins".
- In other words, design means determination of shape, standard and pattern of the product.

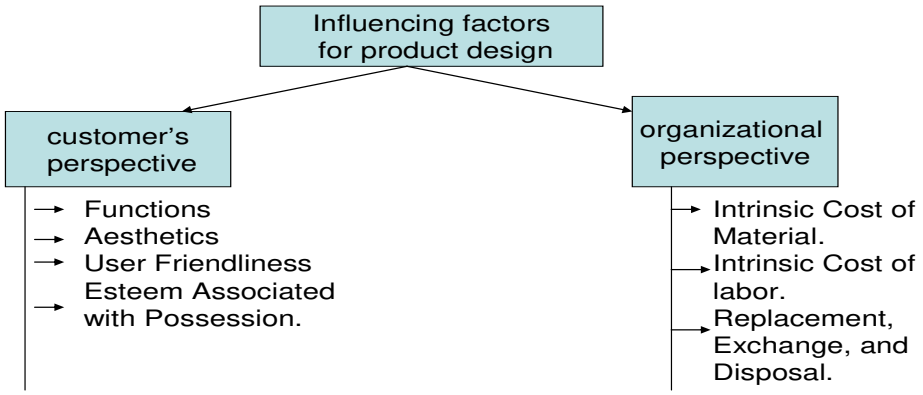
OBJECTIVES OF PRODUCT DESIGN:

- The objects of designing the product may be summarized as follows:

1. The first object of designing is to create attention in product for increasing the sale potentials.
2. To enlarge the importance of product from customer's point of view.
3. To make the product more effective and create more utility in the product for the consumer.
4. To produce better quality at the lowest possible price.

Influencing factors

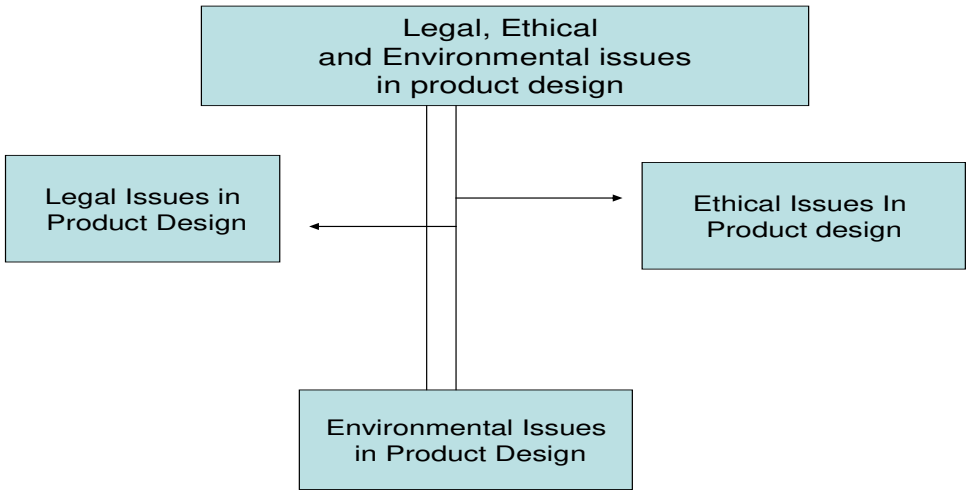
- The factors influencing product design are from the customer's perspective or from the organizational perspective.



Approaches/ Elements

1. Research and Development
2. Reverse Engineering
3. Manufacturability
4. Standardization
5. Modular Design
6. Robust Design
7. Concurrent Engineering
8. Computer-aided Design
9. Life-cycle Of a Product

Designers must be careful to take into account a wide array of legal and ethical considerations. If there is a potential to harm the environment, then those issues also become important.



LEGAL ISSUES IN PRODUCT DESIGN:

- The legal issues play a crucial role in the design process. They are as follows:

i) Product Liability:

ii) Intellectual Property: It refers to property of the mind or intellect. IP is legally protected and a designer must be aware of this.

Protecting IP is essential if research and development is to remain the property of the designer.

It is a means to ensure that the financial gain from the design goes to the creator of the intellectual property.

ETHICAL ISSUES IN PRODUCT DESIGN:

- That influence designers They include:

i) Assessing the Impact of the Design on Consumer

ii) Protection of intellectual property.

iii) Privacy.

iv) Exposure to the Undesirable.

v) Advertising Of Designs.

vi) Right to Alter Natural Orders.

vii) Whether designs should be tested on Animals and Human.

viii) Environmental Impact

ix) Sustainable Technology.

x) Minority Groups.

ENVIRONMENTAL ISSUES IN PRODUCT DESIGN

i) Greenhouse Effect or Global Warning

ii) Ozone Layer

iii) Tropical Deforestation

iv) Waste

v) Water Pollution

vi) Resource Consumption

PROCESS – PLANNING & DESIGN:

- Process Meaning: A process is any part of an organization that takes inputs and transforms them into outputs.
- The value the process generates is the difference between what the final product is worth to the customer and its initial value.
- The objective of the process is to provide the maximum overall value to the customer in the product.

PROCESS PLANNING:

- Production Planning organizes the resources needed to make a product.
- Most products can be made by a number of different processes.
- For e.g: a table can be hand-built by craftsman's, it can be assembled from bought-in parts by semi-skilled people; it can be made automatically by machines on an assembly line; So, operations manager have to design a process that will make a product with the features described in the product plans.

Functions of process planning:

1. The process describes the operations used to make a product.
2. Process Planning makes the decisions about a process. It designs a process that make a product as effectively and efficiently as possible.

Steps in process planning:

1. Analyze the part print to get an overall picture of what is wanted.
2. Make recommendations to or consult with the product engineer on product design changes.
3. List the basic operations required to produce the part to the drawing or specifications.
4. Determine the most practical and economical manufacturing methods and the form of tooling required for each operation.
5. Devise the best way to combine the operations and put them in sequence.
6. Specify the gauging required for process.

Process Selection:

- Process Selection refers to the way an organization chooses to product its good or services.
- It takes into account selection of technology, capacity planning, layout of facilities, and design of work systems.
- Process selection is a natural extension after selection of new products or services.
- An organization Process strategy include:

1. Make-or-Buy Decisions:
2. Capital Intensity:
3. Process Flexibility

PROCESS SELECTION DECISIONS

1. Processes by market Orientation:

i) Make to stock (MTS)

ii) Assemble to Order (ATO).

iii) Make to Order (MTO).

iv) Engineer to Order (ETO).

2. Processes as Production systems:

i) Project.

ii) Job shop.

iii) Batch production (Disconnected Line).

iv) Assembly Line.

v) Continuous Flow.

3. Processes and customer Involvement:

i) Self Service:

ii) Product Selection:

iii) Partnerships:

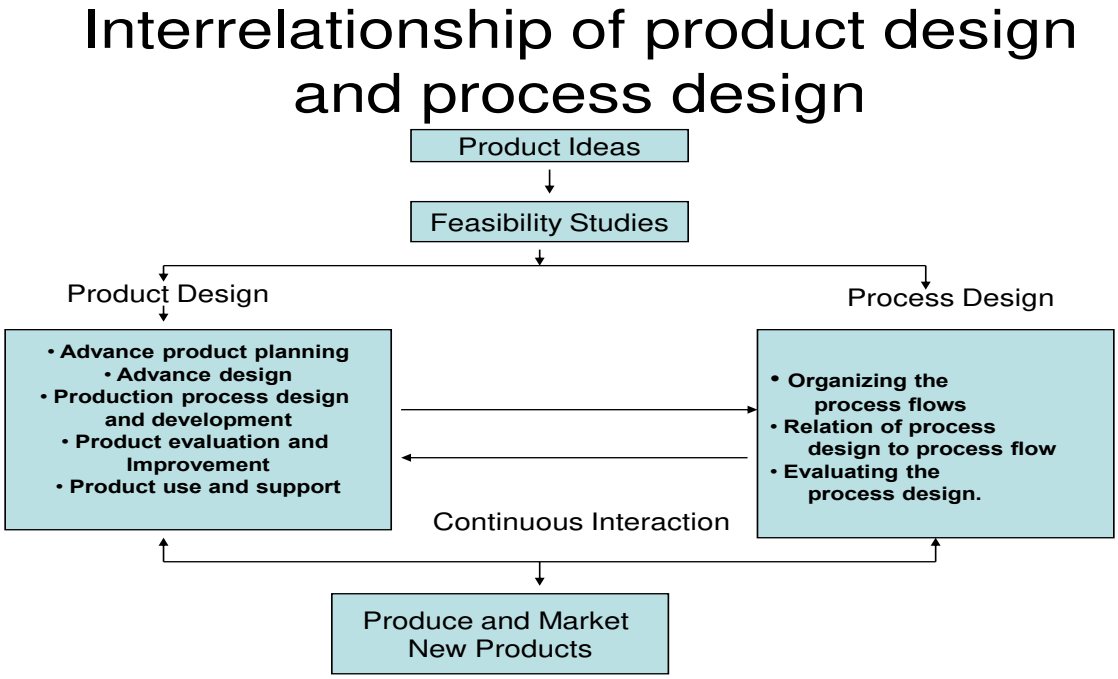
Process design / strategy

- Process design is concerned with the overall sequences of operations required to achieve the product specifications.
- It specifies the type of work stations that are to be used, the machines and equipment necessary and the quantities in which each is required.
- A Process strategy is an organization approach to transforming resources into goods and services.
- The main objective of strategy is to build such production process that meets customer requirements and specifications.
- The process strategies guide the process design.
- Process strategies are also termed as process design.

Types of process strategy / designs

1. Product- Focused System
2. Process- Focused System
3. Repetitive Focus System.

4. Mass Customized Focus
5. Group-Technology / Cellular Manufacturing System



Service Operations

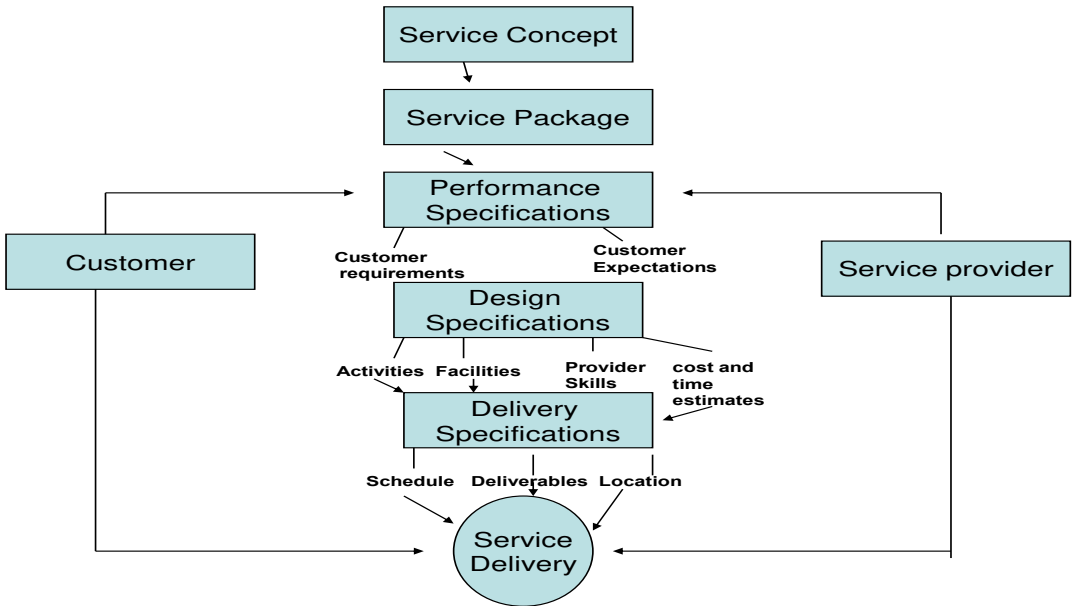
- Service design is the activity of planning and organizing people, infrastructure, communication and material components of a service, in order to improve its quality, the interaction between service provider and customers and the customer's experience.
- Three dimension of service design are:

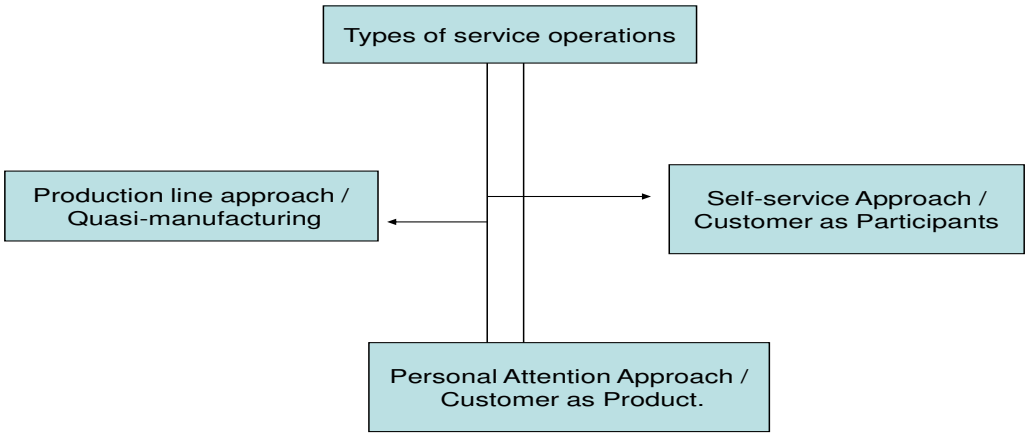
1. Degree of standardization
2. Degree of Customer Contact
3. Mix of goods and services

Stages in Service Operations / design

1. Service Concept
2. Service Package
3. Performance Specifications
4. Design Specifications
5. Delivery Specifications

SERVICE DESIGN PROCESS





Service Operations Strategies

- Customer – oriented focus
- Service – oriented focus
- Customer and service oriented focus

Examples: Fast food restaurants, petrol station, banks, airlines etc.

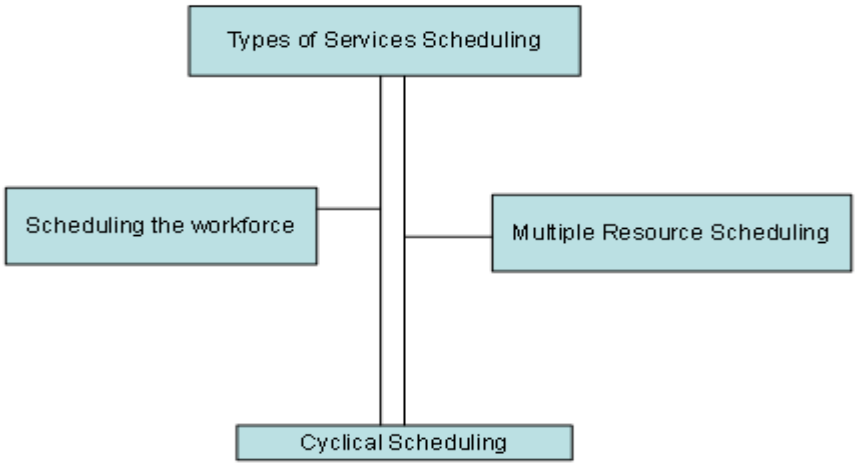
Scheduling service operations

1. Pricing and Promotion
2. Appointment and reservation Systems

i) Improving Appointment Systems:

- Provide economic incentives for showing-up
- Remind people of their appointments
- Penalize customers who arrive late, and do not reward Customers for arriving early
- Use wave schedules where appropriate

ii) Improving reservations systems



Scheduling the workforce

- Scheduling customers is demand management.
- Scheduling the workforce is capacity management.
- This approach works best when demand can be predicted with reasonable accuracy.

Multiple Resource Scheduling

- Resource allocation occurs in a multi-project environment where the demands of one project have to be reconciled with the needs of other projects.
- Organizations must develop and manage systems for efficiently allocating and scheduling resources across several projects with the different priorities, resource requirements, sets of activities and risks.

Problem in multi-project Scheduling

1. Overall Schedule Slippage: Overall schedule slippage, because projects often share resources, delays in one project can have a ripple effect and delay other projects.

2. Inefficient Resource Utilization: Inefficient resource utilization, because projects have different schedules and requirements, there are peaks and valleys in overall resource demands.

3. Resource Bottlenecks: Resource Bottlenecks delays and scheduling are extended as a result of shortages of critical resources that are required by multiple projects.

Cyclical Scheduling

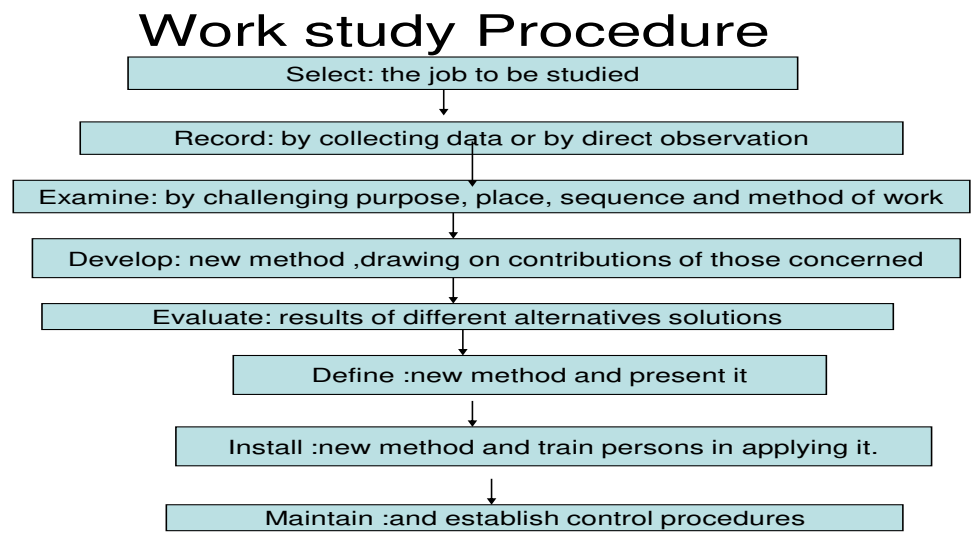
Employees must be assigned to work shifts or time slots and have days-off, on a repeating or cyclical basis.

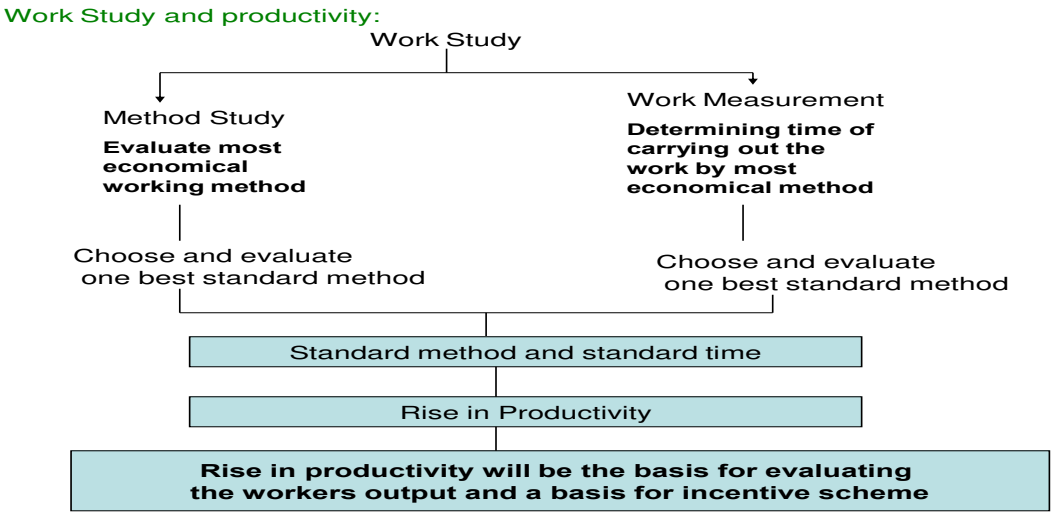
Work study

- According to the ILO, " Work study is a term used to embrace the techniques of method study and work measurement, which are employed to ensure the best possible use of human and material resources in carrying out a specified activity".
- Thus the work study of human works in all aspects in order to improve productivity.
- It is a systematic and analytic study of work process and work methods with the objective of increasing efficiency and reducing costs.
- Work study helps to reduce waste through standardization of qualitative element of the job.

Objectives of work study

1. Provide more and improved physical means to motivate the workers.
2. Improve the basic process by research and development.
3. Improve the methods of operation.
4. Simplify and improve the product and reduce the variety, i.e., standardize the product.
5. Improve organization, product planning and control.
6. Improve manpower efficiency at all levels.





Method Study

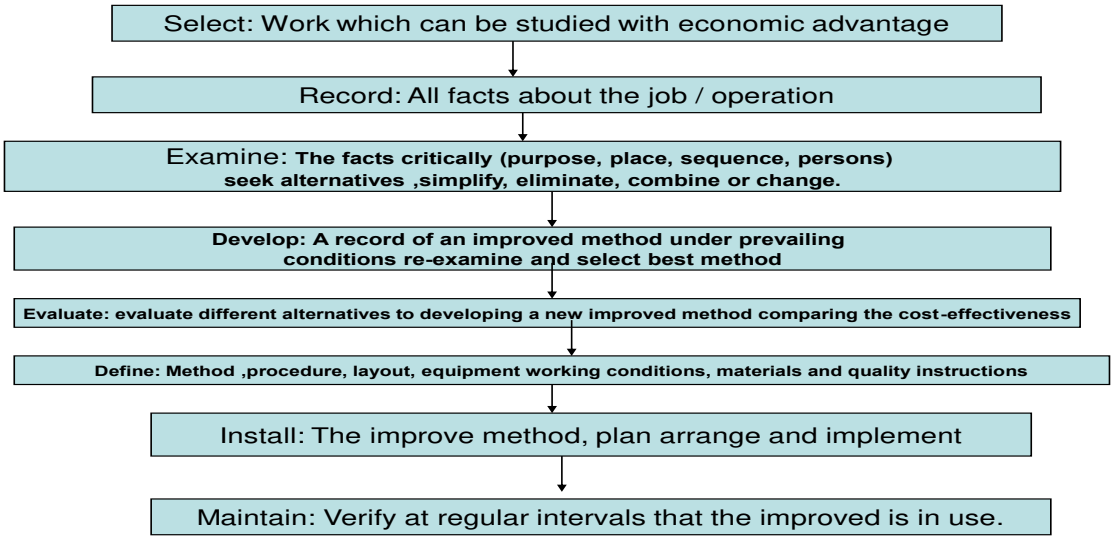
According to British Standard Institute, "Method study may be understood as the systematic recording and critical examination of existing and proposed ways of doing work, as a means of developing and applying easier and more effective method and reducing costs".

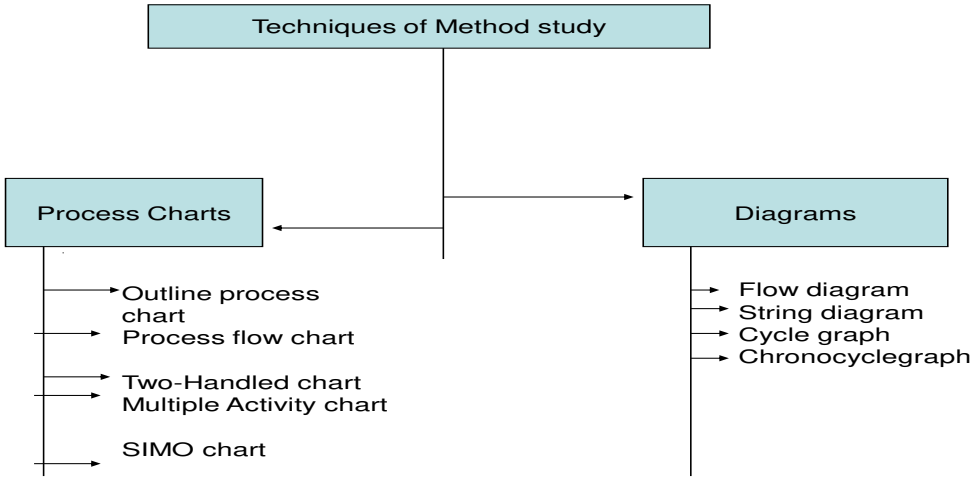
Objectives of Method study

1. To study the existing/ proposed method of doing any job, operation or activity.
2. To develop an improved method to improve productivity and to reduce operating cost.

3. To improve utilization of resources.
4. To eliminate wasteful and inefficient motions.
5. To reduce excessive materials handling or movement and thereby reduce fatigue of workmen.
6. To standardize work methods or processes, working conditions, machinery ,equipments and tools.

Method study procedure





Motion study

- Motion study is formal engineering analysis of motions performed to accomplish work.

- According to Alford and Beatty, " Motion study consist of dividing work into the most fundamental elements possible; studying these elements separately and in relation to one another and from these studied elements, when timed, building methods of least waste".
- Analysis of an operation when carried out in terms of individual motions of a worker is known as motion analysis.

Objectives of Motion study

1. Combine relative activities.
2. Increase the efficiency of activities.
3. Reduce physical fatigue.
4. Eliminate as many unnecessary motions as possible.
5. Changes the sequence of activities.
6. Improve the layout of the work place.
7. Improve the materials handling process.
8. Make the activity more safes.
9. Improve the design of tools, fixtures, jigs and equipment.
10. Standardize the optimum procedures and working conditions so that the employees uniformly use the best possible way of performing activity.
11. Improve the existing product design or invent a new design.

Principles of Motion Economy

- It was originated by Gilbreth and expanded by Barnes, to reduce fatigue, eliminate motions, & to devise smooth flowing, time saving motions and to improve methods of work.
- There are number of rules developed-

1. Related to the use of the human body
2. Related to the arrangement of work place
3. Related to the designing of tools and equipment
4. Related to time conservation

Work Measurement

- Work Measurement has been defined as the application of techniques designed to determine the time required by or defined level of performance to do a specified job. This time is called standard or allowed time.

- According to British standard institution, "the application of techniques designed to establish the time for a qualified worker to carry out a specified job at defined level of performance."

Objectives of Work Measurement

1. To determine the standard cost and as an aid in preparing budgets.
2. To balance the crew activities of those jobs requiring several workers.
3. To determine schedule and planning work.
4. To determine about the effectiveness of machine.
5. To balance production lines for new models or new products.
6. To make cost estimates of new products.
7. To determine time standards to be used for providing the basis for wage incentive plans.
8. To establish supervisory objectives and providing a basis for measuring supervisory efficiency.
9. To determine time standards to be used for providing a basis for labour cost control.

Techniques of Work measurement

1. Repetitive work : the type of work in which the main operation or group of operations occurs continuously during the time spent at the job. This applies equally to work cycles of extremely short duration as light press work jobs, and to those of several minutes, or even hours duration
2. Non-repetitive work : It includes some types of maintenance and construction work, where the work cycle is itself hardly ever repeated identically.

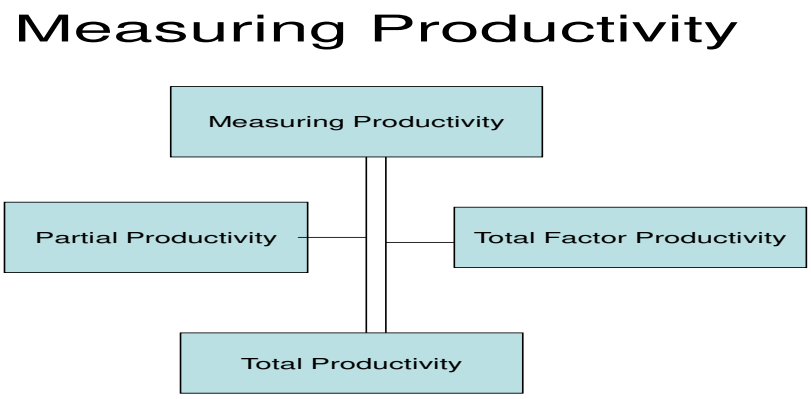
Time Study	Applicable to repetitive work
Synthetic data or synthesis from element types	Applicable to repetitive and non-repetitive work
Pre-determined motion time systems (PMTS)	
Analytical estimating	Applicable to non-repetitive work
Work/activity sampling	Applicable to repetitive work

Time Study/Stop Watch study

According to ILO, “time study is a work measurement technique for recording the time and rates of working for the elements of a specified job carried out under specified conditions and for analyzing the data so as to obtain the time necessary for carrying out the job at a defined level of performance.”

Productivity

- It is a common measure of how well a country, industry or business unit is using its resources (or factors of production)
- Productivity = outputs/inputs
- Production refers to total output.
- Productivity relates to the output relative to inputs and refers to amount of goods and services produced with the resources used.
- ILO has defined the term productivity as “ the ratio between the volume of output as measured by production indices and the corresponding volume of labour input as measured by employment indices. The productivity is a measure of how much input is required to achieve given output.”



Partial Productivity

- It is the ratio of output to one class of input among many factors of production. For e.g. Labour productivity measures productivity of labour
- Labour productivity = Output/labour input

Total Factor Productivity

- Total factor productivity is the ratio of net output to the sum of associated labor and capital (factor) inputs.
- Net output means output minus material, capital, energy, and other input expenses, thus,

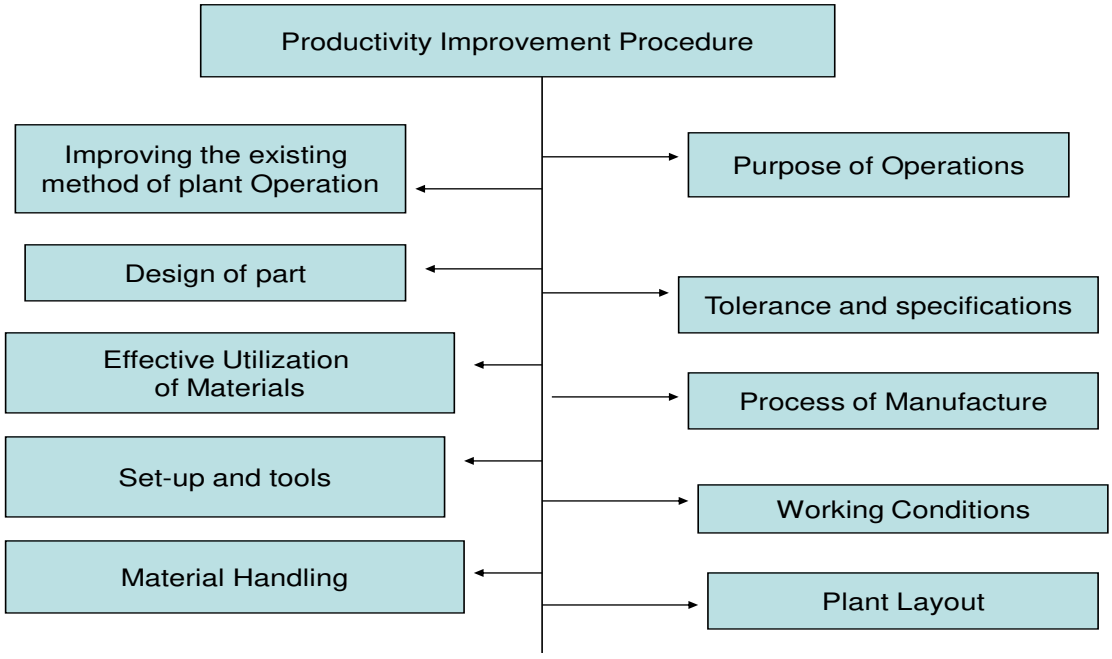
Total factor productivity = Net output / (labour + capital) inputs

Total Productivity

- It is ratio of total output to the sum of all input factors. Thus, it represents the joint impact of all the input factors in producing the output.
- Total productivity = total tangible output/total tangible input

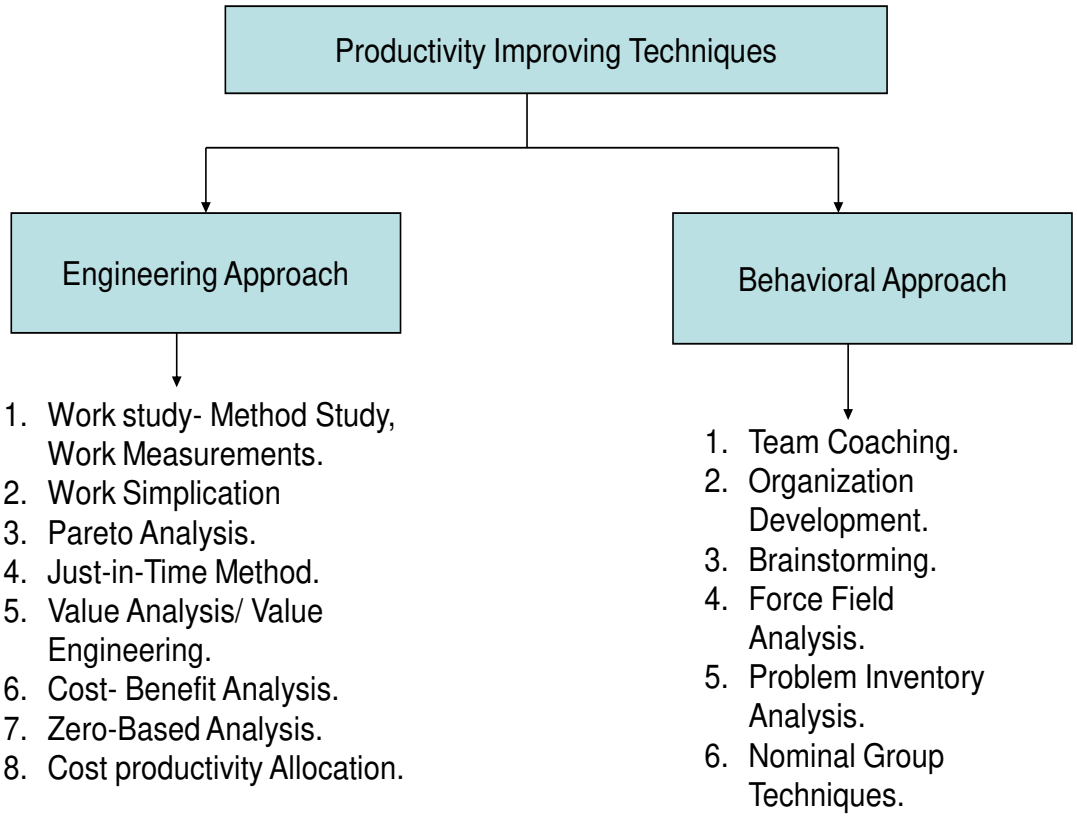
Productivity index: It is used to compare the productivity during the current year with the productivity during the base year. Base year is any year which the company uses for comparative study.

Productivity index = Productivity during the current year / Productivity during the base period.



Methods / Techniques of productivity Improvement

The operations of productivity improvement can be divided into two groups i.e.: Engineering Approach, Behavioral Approach.



PROBLEMS AND SOLUTIONS

14. (a) Using Johnson's Algorithm obtain the optimal sequences which will minimize the makes span. Determine the Idle time of two machines.

Nov. / Dec. 2009 ; May / June 2008

Job(i)	1	2	3	4	5	6
M/C 1	5	2	13	10	8	12
M/C 2	4	3	14	1	9	11

14. (b) Sequence the five jobs on three machines to minimize processing time, based on Johnson's rule. Determine the idle times of the three machines.

May / June 2009 ; May / June 2007 ; Nov. / Dec. 2008

Job	M1	M2	M3
1	8	5	4
2	10	6	9
3	6	2	8
4	7	3	6
5	11	4	5

UNIT – IV

MATERIALS MANAGEMENT

Materials Management

- Material Management is the management of flow of materials into an organization to the point where these materials are converted into the firm's end product.
- Material management is a total concept involving an organization structure unifying into a single responsibility, the systematic flow and control of materials from identification of need through customer delivery.
- Materials Management involves organizing, and co-coordinating all management functions that are responsible for every aspect of materials movements, storage, and transformation.
- Materials Management is defined as the function responsible for the coordination of planning, sourcing, purchasing, moving, storing, and controlling materials in an optimum manner so as to provide a pre-decided service to the customer at a minimum cost.
- The amount spent on materials is increasing in relation to the expenditure on other inputs.
- Materials offer considerable scope for reducing cost and improving profit.

- Materials form an important form of current assets in any organization. The ROI depends a great deal on the manner of utilization of materials. (cash, accounts receivable, inventory, marketable securities, prepaid expenses and other liquid assets that can be readily converted to cash.)
- Materials 'add value' to a product. The margin between the value of raw materials and the finished product is known as 'the value added by manufacture'.
- Materials contribute to the quality of the end product. Quality is understood as the sum of attributes or properties that describe the product.
- Materials management is one of the centre of accountability for performance.

OBJECTIVES OF MATERIALS MANAGEMENT

The main objectives of materials management are:

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

- There are nine objectives of materials management.
- If the contribution is direct, the objective may be called 'primary'.
- If the contribution is indirect (materials department assisting some other department), the objectives may be called 'secondary'.
- Primary or Secondary, the main focus of material management is to procure right materials in right quality, of right quantity, at the right time, brought from right source and at right prices.

- PRIMARY OBJECTIVES:

- Low Prices: If the purchasing department reduces the prices of the items it buys, operating costs are reduced and profits are enhanced. This objective is important for all purchases of materials and services including transportation.
- High Inventory Turnover: When inventories are low in relation to sales, less capital is tied up in inventories. This in turn, increases the efficiency with which, the company's capital is utilized, so that, return on investments is higher. Also, storage and carrying costs of inventories are lower when turnover is high.
- Low cost Acquisition and Possession: Acquisition and possession costs are low when the receiving and stores departments operate efficiently.
- Continuity of supply: It is particularly important for highly automated processes, where, costs are rigid and must be incurred even when production stops because of unavailability of material.
- Consistency of quality: When materials purchased are homogenous and in a primitive stage (e.g. sand, gravel), quality is a problem for purchasing personnel. When a variety of items of different qualities are needed and meeting rigid specifications becomes a challenge to suppliers. Quality may become the single most important materials management objective.
- Low Payroll Costs: The lower the payroll the higher the profits-all other factors being equal. The objective of low payroll costs is common to every organization.
- Favorable Supplier Relations: Maintaining cordial relations with suppliers' benefits buying company in more than one way.
- Development of Personnel: Each department head should spot the potential leaders among the men and women employed in his department and encourage them to develop into future executives, and the company's future profits will depend on the talents of its managers.
- Good Records: Good records are considered a primary objective of materials management.

SECONDARY OBJECTIVES

- Since they represent the materials management's contribution to the achievement of primary objectives of some other departments, they can vary widely from industry to industry.
- Reciprocal Relations: When a company deliberately buys as much as possible from its own customers, it is said to practice reciprocity
- New Materials and products: Engineering and manufacturing managers are always interested in new products and materials that will help them more efficiently and achieve one of their primary objectives.
- Economic Make-or-buy: Make-or-buy decisions are generally made by committees consisting of departmental heads. The purchasing manager should spot the need for a make-or-buy decision and refer it to the committee for action.
- Standardization: The materials personnel to promote standardization and simplification of specifications
- Product Improvement: The engineering department can supplement the technical skills of the engineers on Programs to boost the profits through product development.
- Interdepartmental Harmony: Most materials managers are aware of the need for good inter-departmental relations.
- Forecasts: In large companies, professional economists make forecasts that are used for both sales and purchase planning. Purchasing managers translate these general forecasts into specific forecasts for purchased materials.
- Acquisitions: Business acquisitions and mergers are common. Acquisition is taken as one of the ways of business expansion.

- Buying, storage and movement of material are the three basic objectives of materials management.
- Lee & Dobler define Material management as a confederacy of traditional materials activities bound by a common idea- the idea of an integrated management approach to planning, acquisition, conversion, flow and distribution of production materials from the raw materials state to the finished product state.

MATERIAL PLANNING

- Materials Planning is the scientific way of determining the requirements of raw materials, components, spares and the other items that go into meeting the production needs within economic investment policies. Material planning is one part of overall production planning.
- Sales forecasting and Aggregate Planning are the basic inputs for materials planning.
- The task under planning are:
  - Estimating the individual requirements of parts.
  - Preparing materials budget.
  - Forecasting the levels of inventories.
  - Scheduling the orders.
  - Monitoring the performance in relation to production and sales.

FACTORS INFLUENCING MATERIAL PLANNING

MACRO FACTORS

- Price trends
- Credit policies
- Government policies
- Technology
- Business cycle

MICRO FACTORS

- Corporate policies
- Availability
- Working capital
- Corporate capabilities
- Plant location
- Demand forecasting accuracy
- Seasonal factors
- Availability of substitute materials
- Delegation of powers

- Communication systems

IMPORTANCE OF MATERIAL PLANNING

- Improper planning leads to over ordering or under ordering of materials.
- Poor planning leads to rush order or create emergency.
- Planning enables firm to spend money optimally.
- Good planning aims at motivating people and increases the effective utilization of materials.

BENEFITS OF PLANNING

- Helps in effective material budgeting.
- Helps in proper purchase planning.
- It adds value to material management.
- Results in effective utilization of materials.

Guidelines for a good material planning:

- Computerization of the materials is advisable. So it can handle various difficult situations.
- Computerized results in savings in time and cost, gives accurate forecast.
- Quarterly plans are advisable.
- Planning should cover longest lead time anticipated.

MATERIAL BUDGETING

- Material budgeting is an estimate of expenses to be incurred in the procurement of materials and it helps in effective execution and control of material plans.
- Process of preparing purchase budget or material budget in terms of quantity, quality and money value of materials to be procured for a given period of time is called “Material budgeting”.

FACTORS/BENEFITS OF BUDGET

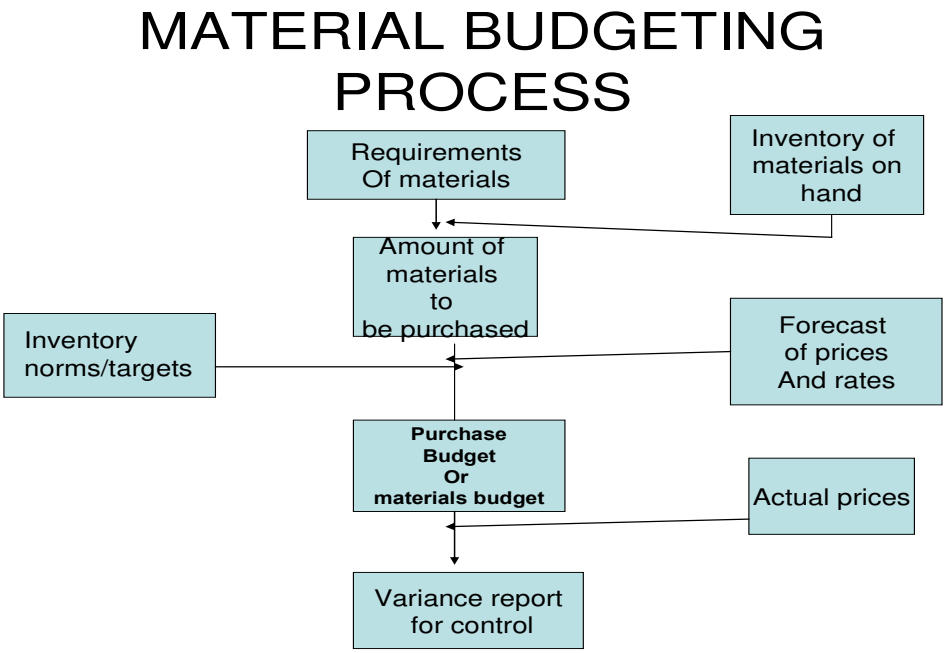
FACTORS

- Inventory in order

- Inventory in transit
- Material required
- Inventory Norms
- Forecasted price of materials.
- Fund allotted for material purchase.
- Logistics available
- Inventory in hand.

BENEFITS

- Budget helps to reduce risk involved in inventory management.
- It improves maximum purchasing lead time.
- It helps in proper and good overall firm's budget.



Benefits of Material Budgets

1. When a material budget is to be expressed in terms of rupees, the purchase manager has to provide the budget department with two types of information (i) estimate of material prices during to coming year. (ii) Plans for the specific timing of purchases.
2. In purchasing, reasonably precise knowledge of materials requirements over an extended period of time facilitates forward buying and permits the advantageous use of contract purchasing and blanket order purchasing techniques.

3. Inventory investment and its associated risks can be reduced by advance planning of material requirements.
4. It also provides maximum purchasing lead time.
5. Supplier relationships can be improved and costs can be reduced because of availability of time to most purchasing requirements with the supplier's production schedule more effectively.

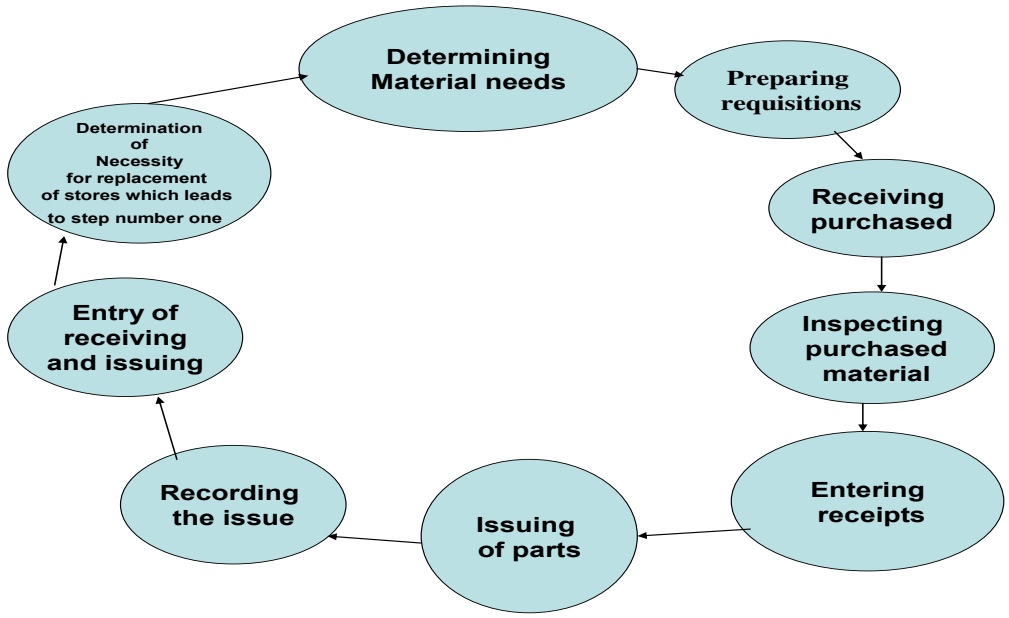
MATERIAL CONTROL

- The function of maintaining constantly available supply of raw materials purchased parts and supplies that are required for the manufacture of products is called "material control".
- Material control includes requisition of materials for purchase for economic cost and quality in right time, and its receipt, storage and production, issuing of materials to production upon authorized request and maintaining and verifying inventory records.

Materials Control Cycle

- Material Control cycle comprises all procedures which are necessary for the provision of materials for the manufacturing process with minimum investment and lowest possible costs.
- A knowledge of this cycle is fundamental to an understanding of the principles and practice of material control.
- The steps of material cycle are as follows.
- Determining material needs.
- Preparing requisitions for purchase items and requests for work orders for parts made in the shops.
- Receiving materials purchased and finished parts into the plant.
- Inspecting purchased material and parts and inspection of finished shop made parts. Delivering all parts and materials to the stores for storage.
- Entering receipts in stores records.
- Issuing of parts and materials to the shop for production and assembly.
- Recording the issue in store record.

- Entry of receiving and issuing transactions to cost and accounting records.
- Determination of necessity for replacement of stores which leads to step number one and the cycle repeats.



DEMAND FORECASTING: PROBLEMS

13. (b) A manufacturing company has monthly demand for one of its product as follows

Month	Demand
February	520
March	490
April	550
May	580
June	600
July	420
August	510
September	610

Develop a three period moving average forecast and a three period weighted moving average forecast with weights of 0.50, 0.30 and 0.20 for the most recent demand values, in that order. (Nov. / Dec. 2009)

Solution

Weighted Moving Average

Month	Demand	Total	Weighted Moving average
Feb	520		
Mar	490		
April	550	526	526
May	580	553	553
Jun	600	584	584
July	420	506	506
Aug	510	501	501
Sep	610	542	542

Weights are 0.50, 0.30, and 0.20

$$\text{Weighted average} = \frac{W_1D_1 + W_2D_2 + W_3D_3}{W_1 + W_2 + W_3}$$

For October the forecasted demand value is 542

$$\text{For month of may forecasted demand} = 550 * \frac{0.5 + 490 * 0.3 + 520 * 0.2}{1}$$

$$= 526$$

13. b) Compute 3 and 5 months moving averages for the delivery orders which management has accumulated. Compare both methods using MAD.

Month:	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct
Orders:	120	90	100	75	110	50	75	130	110	90

(May / June 2009)

Solution

3 months and 5 months moving average:-

Month	Orders	3 Months Total	3 Months Moving Average	5 Months Total	5 Months Moving Average
Jan	120				
Feb	90				
Mar	100	310	103.33		
Apr	75	265	88.33		
May	110	285	95	495	99
Jun	50	235	78.33	425	85
July	75	235	78.33	410	82
Aug	130	255	85	440	88
Sep	110	315	105	475	95
Oct	90	330	110	455	91

MAD =

$$\sum_{t=1}^{n} \frac{(\text{Forecast Demand} - \text{Actual Demand})}{n}$$

$$\text{MAD for 3 months moving average} = \frac{(95-110) + (103.33-100) + (88.33-75) + (78.33-50) + (78.33-75) + (130-85) + (110-105) + (110-90)}{8}$$

= 16.66 units.

$$\text{MAD for 5 months moving average} = \frac{(99-110) + (85-50) + (82-75) + (130-88) + (110-95) + (91-90)}{6}$$

= 18.5 units.

MATERIAL MANGEMENT INFORMATION SYSTEM (MMIS)

- Material Management is a system of interrelated activities combining material movements, storage and transformation involving all management functions like planning, organizing, controlling, coordinating etc.
- MMIS provides online information on stock level of raw materials, in process inventories, finished goods, materials in ware house.
- MMIS provides information at right time, it also request the supplier to supply materials on time.
- Thus, helps in decision making.
- It also helps in accessing information rapidly, detects errors and assures prompt decision making.
- MMIS takes decisions regarding when to buy (or) when to make parts and the like.
- MMIS can do all these only when it is designed with the parameters that capture the management issues like what to buy, when to buy, from whom to buy, how to buy, and how much to pay and it should be constants working overtime
- MMIS should be able to provide unsolicited data (Not asked for), in right time for decision making.
- Any intelligent MMIS should request the supplier computer to send materials whenever the stock levels come to reorder level.

SUPPLY NETWORK

Supply network is a net facility and distribution option that performs the functions of procurement of materials transformation of materials in to finished parts and distribution to customers

COMPONENTS OF INTEGRATED MATERIALS MANAGEMENT SYSTEM

- Material planning
- Inventory control
- Purchase management
- Stores management

MATERIALS MANAGEMENT MANUAL

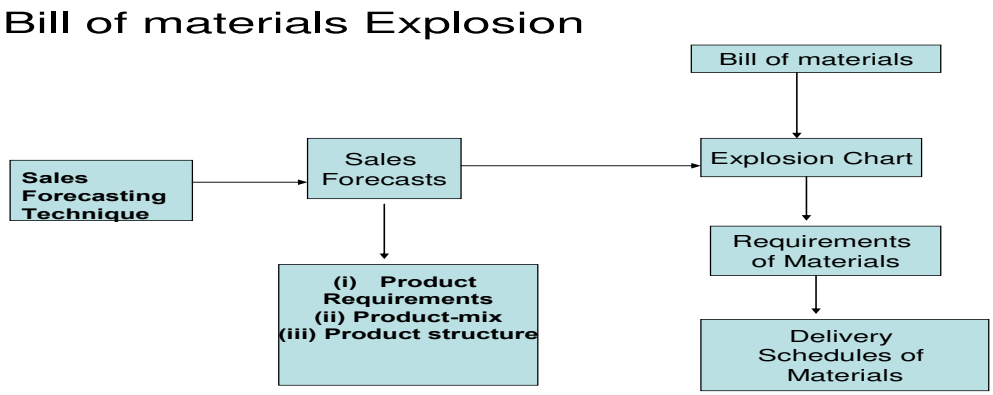
The materials management manual is a document maintained by the material department which contains the details regarding the stocks keep in warehouse, code of the materials, their identification, the suppliers of the materials, the price and all the other details regarding the materials.

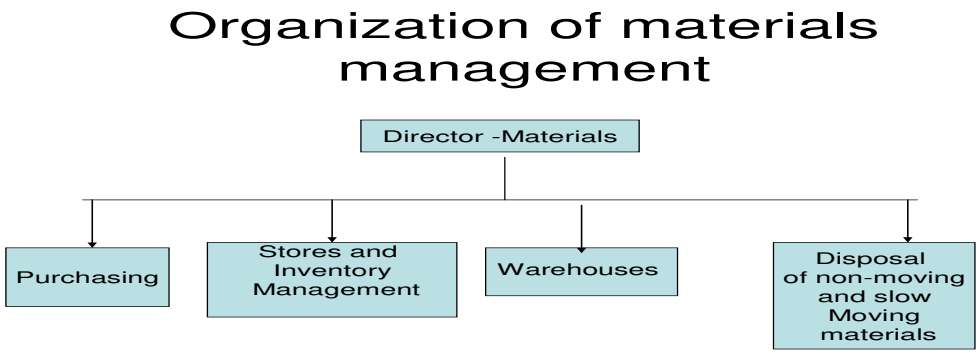
BILL OF MATERIALS

- A Document that shows the list of materials required, and quantities required per unit of the product- “Bill of materials”.

- All materials planning flow from the preliminary master production schedule.

- Requirements of various materials (raw materials, parts, components, subunits etc.) are worked out by exploding the master production schedule for the planning period through the planning horizon. This technique is referred as “Bill of materials explosion”





PURCHASING: OBJECTIVES

Definition: The term 'purchasing' refers to the act of buying an item at a price.

- Purchasing makes it a managerial activity, which goes beyond the simple act of buying and includes the planning and policy activities covering a wide range of related and complementary activities.
- Sometimes writer uses the word 'procurement' instead of purchasing.
- The term procurement covers the duties performed by purchasing as well as such additional functions of materials supervision and management as inventory control, receiving, incoming inspection and salvage operations.

- According to LEVIS, "Purchasing is the acquisition of the manufacture of any necessary primary material suppliers, equipments by any method whatsoever."

"The objective of the purchasing function is to ensure continuity of supply of raw materials, sub-contracted items and spare parts and at the same time reduce the ultimate cost of the finished goods."

The different objectives of purchasing are:

1. Purchasing items with right price
2. Purchasing items with right quantity
3. Purchasing items at right time so that the items are available when needed
4. Purchasing items from right source
5. Purchasing items of right quantity

Purchasing Objectives are:

- Buying raw materials of the right quality, in the right quantity, at the right time, at the right price, and the form the right source.

The specific objectives of purchasing are:

- To pay reasonably low prices for the best values obtainable, negotiating and executing all company commitments.
- To keep inventories as low as possible to be consistent with maintaining production.
- To develop satisfactory sources of supply and maintain good relations with them.
- To secure good vendor performance including prompt deliveries and acceptable quality.
- To locate new materials or products as required.
- To develop good procedures, together with adequate controls and purchasing policy.
- To implement programs as value analysis, cost analysis, and make-or-buy to reduce cost of purchases.
- To achieve a high degree of co-operation and co-ordination with other departments in the organization.

Importance of purchasing

- All production firms have the need of supplies of materials and services from external sources. This makes purchasing, one of the most significant functions of any Production Manager. Purchasing function may include the purchase of Raw Materials.
- In simple words, Purchasing is the act of exchange of goods is the act of exchange of goods and services for money or money's worth.
- Purchasing function provides materials to the factory without which of Machines cannot move.
- A 1% saving in materials cost is equivalent to a 10% increase in turnover. Efficient buying can achieve this.
- Increasing proportion of one's requirements is now bought instead of being made as was the practice in the earlier days. Buying assumes significance.
- Purchasing can contribute to import substitution and save foreign exchange.
- Purchasing is the main factor in timely execution of industrial projects.
- Materials management organizations that exist now have evolved out of purchasing department.
- The stream of salesmen and direct mail advertisement entering the purchasing department day-in and day-out brings information about new products, materials and new ways of doing old jobs.
- Other factors are: cyclical swings of surpluses and shortages and the fast rising materials cost, heavy competition and growing world-wide markets have contributed to the importance of purchasing.

PURCHASING: FUNCTIONS

The functions of purchasing are:

1. Evaluating and rating suppliers
2. Selection of suppliers
3. Finalization of terms of purchase
4. Placement of purchase orders
5. Follow-up

6. Approval of payments to suppliers.

1. Responsibilities often fully delegated to the purchasing function:

- Obtaining prices.
- Selecting vendors.
- Awarding purchase orders.
- Following up on delivery promises.
- Adjusting and settling complaints.
- Selecting and training of purchasing personnel.
- Vendor relations.

2. Responsibilities often shared with functions other than purchasing function:

- Obtaining technical information and advice.
- Receiving sales presentations and arranging for sales opportunities with interested personnel.
- Accounting
- Purchasing and market research.

3. Responsibilities often divorced from purchasing:

- Receiving and warehousing
- Payment of invoices.
- Other functions.

Purchasing Cycle

Purchasing cycle comprising of eight steps:

1. Recognition of need: issuance of requisitions, issuance of a bill of materials.

2. Description of need

3. A Suitable source is selected for the purchase. Often a source has to be developed: Registered suppliers who are approved by the company.

4. Price and availability are determined: Vendors catalogues, Negotiation, Inviting tenders or quotations.
5. Purchase order is prepared and sent out to the supplier
6. Acceptance of the purchase order is obtained from the supplier: Acknowledgement
7. Follow up is done by the purchasing department to ensure timely delivery of the material: Extension of delivery period, Cancellation of orders and penalty.
8. Checking the invoice and approving it for making payment to the supplier: Blanket orders, Stockless Orders.

PURCHASING: POLICIES

1. Forward buying: The purchasing decision for a period (say 1 year) will be taken in advance and the organization will commit accordingly in terms of order quantity, rate and delivery schedule, by taking into consideration the availability of funds and the requirements.

2. Tender buying: The steps are preparing bidder's list, advertising tenders, receiving bids, evaluating bids and placing order with the bidder with the lowest cost.

3. Blanket ordering system: The organization will enter into an agreement with its suppliers to receive items for a required quantity at a particular rate over a period of time. Buyer issues an order covering the requirement of a small item for one year. The order is relevant for one year.

Blanket orders are useful because:

- Paper work is reduced.
- Time of buyers is saved
- Facilitate price negotiation because one order covering a year's requirement is placed once and
- Facilitate inventory contract of small items

Stockless Buying

- It also called ‘systems contracting’; stockless buying is a special type of blanket order.
- In stockless buying stock of items are kept in buyer’s plant, ownership of the stock being with the supplier.

4. Zero Stock: This purchase system is in-line with using the just-in-time manufacturing system. The main idea of this system is to operate the plant with near zero inventories. If the suppliers are situated nearer to the company, they are more reliable in terms of making supply in time. The company can place orders with such suppliers.

5. Rate Contract: Is very much used in public sectors and government departments. The suppliers are on ‘rate contract’ with DGS&D for a specific period. The organizations can place orders straightaway with such firms without going through the lengthy procedure of purchasing.

6. Ancillarisation: When a company decides to buy a component from outside suppliers, it is usually sub-contracted. Sub-contracting is the work of obtaining the prime manufacturer’s requirements, mostly of fabricated parts and components, from outside sources in order to manufacture a certain product in the manufacturer plant. Ancillarisation results in spread of entrepreneurial base. It promotes industrial development.

7. Make-or-buy decision: It is deciding whether a part should be purchased or manufactured. There are three types of make-buy problems:

1. Making or buying something which it never before procured.
2. Making something which it is now buying.
3. Buying something which it is now making.

8. Speculative buying: Speculative buying is done with the hope of making profit out of price changes. Two types of Speculative buying may be distinguished:

- Purchasing department buys certain items at low prices and sells the same when their prices shoot up, thus making profit in the bargain.

- It is conducted by some purchasing departments- it involves the purchases of material in excess of foreseeable requirements in anticipation that a need will arise for the material and that firm will profit by making the purchase at the current price.

Vendor rating

- Vendor rating is a process of rating a supplier based on some rating techniques. The hallmark of an effective purchase department is the quality of suppliers selected. The purchaser's prime interest lies in getting the best value from his suppliers. This implies that he should be in a position to assess and rate their performance against what is expected from an ideal supplier. The absolute standard is difficult to define with exactness but there should be some method for evaluating suppliers and grading them. An objective and accurate vendor rating can become an asset and valuable tool in the hands of a buyer in making his purchase decisions as also providing feedback to suppliers with low rating to encourage improvement in their performance.

There are various rating criteria such as

- Discounts received
- Price
- Compliance with other specifications
- Installation cost
- Market information
- Credit terms
- Maintenance of Specifications
- Promptness of delivery.
- Service
- Co-operation
- Management Competence
- Disposition of rejects,
- Employee training, Adjustment Policies, Cost reduction suggestions, Inventory Plans, Financial Position.

There are different methods in evaluation of suppliers such as

Categorical method: Personnel maintain informal evaluation records

Weighted point method: The performance factors to be evaluated by giving weights.

Cost ratio method

Critical Incidents method: It is based on buyer-vendor relationship

Checklist system: Buyers checklist for evaluating vendors are:

- Reliability.
- Technical Capabilities.
- After-sale Service.
- Availability
- Buying Convenience.
- Sales Assistance.

Problems and solutions

1. Calculate the vendor rating for the following. The item under consideration is the same from all suppliers

Supplier's data	A	B	C
Quantity supplied	90	80	75
Quantity accepted	78	80	70
Price of each item	Rs. 4	Rs. 4.20	Rs. 3.90
Delivery promised	6 weeks	6 weeks	6 weeks
Actual deliveries made in	8 weeks	6.2 weeks	7 weeks

Weightage for quality = 70%, price = 20%, delivery = 10%

Solution

a) Percentage accepted= (Quantity accepted / Quantity supplied) * 100

A = (78 / 90) * 100 = 86.67%

Quality rating (weightage = 70%) = 86.67 * 0.70 = 60.67%

b) Price ratio = (Lowest price / Net price) * 100

A = (3.9 / 4) * 100 = 97.5%

Price rating @ 20% weightage = 97.5 * 0.20 = 19.5%

c) Delivery promise kept = (Delivery promised / Actual deliveries) * 100

A = (6 / 8) * 100 = 75%

Delivery rating @ 10% weightage = 75% * 0.10 = 7.5%

Total vendor rating = Quality rating + Price rating + Delivery rating

= 60.67 + 19.5 + 7.5 = 87.66%

Rating	A	B	C
Quality	60.67	70	65.33
Price	19.5	18.57	20
Delivery	7.5	9.68	8.57
Total rating	87.66 %	98.25 %	93.87 %
Rank	III	I	II

Conclusion: Since Vendor B has the highest rating, he is ranked number one, Vendor C is ranked number two and Vendor A is ranked number three

2. Calculate the vendor rating for the following weightage: quality = 50%, price = 15%, delivery = 25% and response to suggestions = 10%

Supplier's data	I	II	III
Quantity supplied	108	90	80
Equivalent quantity accepted	102	90	75
Price of item	Re. 1	Rs. 1.20	Rs. 1.1

Delivery promised	3 weeks	4 weeks	4 weeks
Actual delivery	2.7 weeks	5 weeks	4.4 weeks
Response to suggestion	90%	85%	100%

Solution

Rating	I	II	III
Quality	47.2	50	46.875
Price	15	12.50	13.63
Delivery	27.77	20	22.72
Response to suggestions	9	8.5	10
Total rating	98.97 %	91 %	93.23 %
Rank	1	3	2

Conclusion: Since Vendor I has the highest rating, he is ranked number one, Vendor III is ranked number two and Vendor II is ranked number three

Value Analysis

- Also called as value engineering.
- Value analysis is an important activity that typically occurs jointly between purchasing and methods engineering.
- This activity is aimed at modifying the specifications of materials, parts and products to reduce its costs while reducing their final function.
- Focus is placed on the value of the product – what function is to be performed by the product and how that value can be achieved at the lowest cost.
- Although value analysis is applied to all phases of the production process, primary attention is devoted to the materials and components going into the product.
- Value Analysis has wide acceptance as it offers increased value of a product without increasing its cost or reducing the usefulness of the product.
- It is applicable in manufacturing processes; organizations have been focusing on finding alternative materials in the place of the present materials.

STORES MANAGEMENT – NATURE

- Store as building is a place, where inventories are kept.
- Store is defined as a place for goods. Storage/storekeeping is defined as the act of storing the goods.
- The store is used to cover all aspects of preservation of goods i.e. building, supplies and the act of storing.
- Stores or Storage is the function of receiving, storing and issuing materials. It involves supervision or the clearance of incoming supplies, to ensure that they are maintained in good condition, safely and in readiness for use when required while they are in storage and issuing them against authorized requisitions.
- In short, it is connected with the physical handling and well-being of the stocks.

Importance / Functions of Stores Management

- Stores ensure ready accessibility of major materials, there-by efficient service to users.
- Efficient storage of stores yields the following benefits:

1. Ready accessibility of major materials permitting efficient service to users.
2. Efficient space utilization and flexibility of arrangement.
3. A reduced need for materials handling equipment.
4. A minimization of materials deterioration and pilferage.
5. Ease of physical counting.

Functions: Minimization of stores cost, and continuous supply is the prime function of stores.

Stores Layout

Principles of Store Layout:

Stores layout is proper placement of materials and storeroom equipment. It may broadly include the stores, the shelves, racks or other appropriate equipments and proper placement of materials with sufficient space for material handling and labor movement. An efficient layout of the store should serve the following objectives:

i) Reduced investment in shelves, racks or other equipment.

ii) Reduced operating expenses by minimizing the movements of materials and thereby reducing the internal transportation cost.

iii) Increased flexibility

iv) Increased safety of workers and materials

v) Easy accessibility and good house keeping

vi) Convenience of traceability

vii) Suitability to the nature and the volume of materials.

viii) Maximum utilization of floor space.

Stores Layout is a fundamental factor in determining the efficient performance of the stores department. Two aspects of Stores Layout are significant:

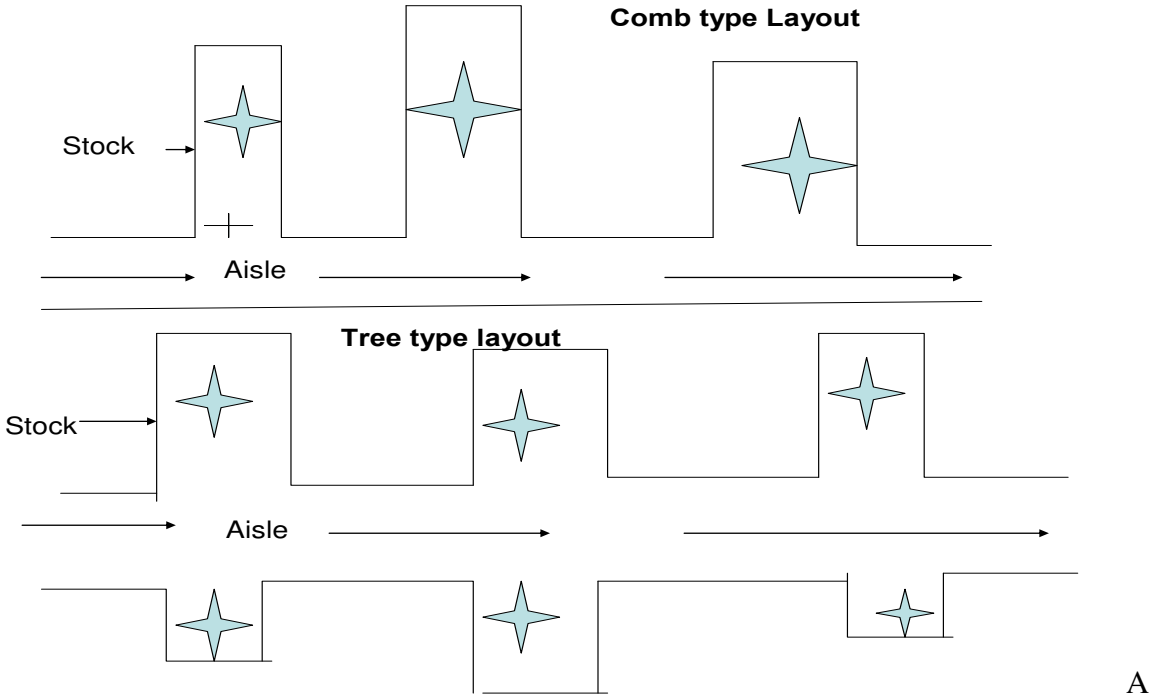
1. Storage System.
2. Type of stores layout.

Storage System: A Satisfactory storage system compromises between the use of space and the use of time. There are three ways of locating stock: Fixed location, random location and Zoned location.

- Fixed location: means that, goods of a particular type have a position in the store assigned to them exclusively. It means while stock can be found immediately without a complex searching process, there can be considerable waste of space, because when stocks of any one item are low the space left vacant cannot be filled.
- Random location: Means that item can be stored in any storage position which is available.
- Zoned location: Means those goods of a particular product group are kept in a given area. They may be randomly stored in a zoned location or stored according to the fixed location.

Types of Stores Layout

- Whatever the location followed, stock may be kept on one side of the aisle in which case it is called comb type layout.
- Or goods may be placed on either side of the aisle in which case the method is called tree layout.
- Selecting a particular type depends on the availability of space and the layout of the building.



A

SRS – Automated Storage and Retrieval System.

Automated Storage and Retrieval System (ASRS) offer incredible pick and put cycle times along with more accurate inventory management. A basic ASRS system is comprised of one or more aisles, each having a robotic crane to retrieve from and store product in the racks on either side of the aisle.

The use of robotic crane allows racks to be built several stories high over almost any length, providing more storage density than almost any other storage solution. The cranes also bring the materials to the operator which virtually eliminates wait, walk and cycle times. ASRS systems can also handle a variety of materials, from small bins of parts up to entire pallets of materials, with fast cycle times and high precision.

Benefits of ASRS system:

- Dramatic improvement in operator efficiency and storage capacity.

- Reduction of work in progress inventory.
- Improvements in quality and just in time performance.
- Provides make to order capability in addition to make to inventory production.
- Real time inventory control and instantaneous reporting functionality.

To further enhance the performance of the system, automation develops custom intelligent – routing algorithms that automatically slot the products in the ASRS to maximize the efficiency of the crane in each aisle. ASAP automations warehouse control software also provides the flexibility to operate on ASRS system as a mini-warehouse, independent of other systems in the facility, or as a transparent picking and putting system with full inventory visibility for the warehouse management system and ERP.

KANBAN SYSTEM

Materials and inventory items are stored in single-use containers (such as trays or boxes). Single-use containers hold all of one type of component/part or material used in the manufacture of a product. Kanban systems also requires some initial inventory to begin the operation.

In a kanban system, cards are used to initiate transactions. The production, conveyance, and purchase of items are the transactions. There are several types of kanbans

1. Production authorization card is used to signal that production of a part can begin. This kanban usually lists the product name, identification number, description, and the materials required in its production
2. Vendor authorization card is used to signal that a vendor is authorized to send the organization a certain specified number of units of supplies and materials. This kanban usually lists the product's name, purchasing company's identification number, vendor's identification number and name, and an order quantity
3. Conveyance authorization card is used to signal that a materials handling agent is authorized to move 'supplies, materials, or inventory items to a specified destination. This kanban usually lists the product's name, identifying number, and the location the item is to be delivered to.

Not all of these kanbans need to be used in an operation. Some organizations use a single-card system and others use a dual-card system. Regardless of which system is used, kanbans can serve the purpose of authorizing the production, purchase, and movement of materials and inventory throughout the organization.

SINGLE-CARD SYSTEM In a single-card system only the conveyance card is used. More organizations use the single-card system than the dual-card system. Once a single-card system is in place, it is an easy step to convert to a dual-card system by adding a production kanban or vendor kanban.

Suppose an assembly line worker needs inventory to complete a product. A conveyance kanban is issued from the assembly line area defining the inventory required. The kanban is then placed in an empty tray at point A. This kanban notifies the materials handlers that inventory is required and they are authorized to obtain it from the inventory department. A materials handler moves the empty tray to the inventory department and drops it off at point C keeping the kanban.

The materials handler then picks up the desired inventory from the trays at point C. Note that initial inventory must be waiting for pickup; otherwise the materials handler will not be able to use that particular conveyance kanban. From point C, the materials handler moves the tray to point D in the assembly area where it can be processed by assembly workers. The materials handler then goes back to point A to begin the cycle again.

The single-card system works fine as long as some initial inventory is available for pickup at the inventory station. Because the kanban represents a continuous flow of materials, the initial excess inventory can be reduced by eliminating some of the kanbans once the system is underway. The number of cards in the system defines the amount of inventory to be moved or produced. In the single-card system, for example, if we had required three trays of inventory, we would have had to issue three kanbans. Likewise, if we had an ongoing kanban system and wanted to eliminate some of the excess inventory in the system, we might issue only two kanbans when in fact we need and will use three trays of materials for the particular order. The effect on the operating system will be a reduction of one tray of inventory. We generally would not under issue kanbans unless excess inventory' exists in

the system and we want to eliminate it. The single-card system is most appropriate in repetitive-type operations. Only standardized containers or trays can be used in this type of system. They are standardized to lot-size production. If we produce, for example, one radio at a time, then a container might include only the parts to manufacture one radio. If, on the other hand, an organization produces five radios at a time, then the tray must contain parts for five radios.

DUAL CARD SYSTEM: In a dual-card kanban system we use two separate cards. To illustrate the dual-card system let's look at the assembly line. In this situation, the organization obtains its materials from a vendor. The conveyance kanban is used in the same manner as in the single-card system (that is, the conveyance kanban travels from A to B to C to D and back to A). A vendor kanban is introduced at point X. The card authorizes a vendor at point Y, to obtain and deliver specified materials. Once the materials are delivered they may have to be broken down into a prescribed container unit at point Z.

Stores-Manual, Stores Efficiency

- Manual is a written statement of policies and procedures.
- Stores are the repository of inventory worth crores of rupees.
- The store-keeper’s performance can be measured objectively through quantitative techniques.

(i) Stores efficiency index=

$$\frac{\text{No. of requisitions delivered on time}}{\text{total number of requirements.}}$$

(ii) Storage loss index =

$$\frac{\text{Value of inventory lost due to deterioration, obsolescence's and pilferage}}{\text{Average value of inventory}}.$$

(iii) Obsolescence index =

$$\frac{\text{Value of non-moving items}}{\text{Total inventory value}}$$

(iv) Space Utilization Index =

$$\frac{\text{Area used for storage}}{\text{Total storage area available}}$$

Classification and Coding

Classification: Classification will be of great value in material and component standardization. Classification aims at systematically grouping together items, based on their common features and subdividing them by their special features. A system of classification and codification is necessary for the design of new products within the defined range. Classification and codification enables reduction in sizes and varieties

Such systems should readily

- Identify and locate identical items.
- Facilitate the use of standard items in new designs.
- Identify substitutes in case of stock outs.
- Help to develop group technology which will be of more use in designing layout facilities.
- Aid to improve parts location in the store

Advantages of Classification and Codification

Good store-keeping requires proper classification and codification of various items stored in the stock. The advantages of proper classification and codification are:

1. Systematic grouping of similar items for correct identification of each and every item
2. Long descriptions are simplified and confusions avoided
3. Avoids duplication of stocks of the same item
4. Enables reduction in size and varieties
5. Helps in standardization of materials
6. Used as a basis for setting up different stores
7. To arrange bin cards, stores record, accounts and inventory ledger in an uniform manner
8. Ensure accuracy in correspondence

Principles of Classification and Codification

1. Consistency in classification and codification
2. Comprehensive: cover all items and allow reasonable scope for extension
3. Mutual exclusiveness: One code for one item

4. Simple: Understood by a layman and be self explanatory

Methods of Classification and Codification

Stores are classified based on its nature or usage. Based on nature, stores are classified into:

- Raw materials
- Components
- Consumable stores
- Spare parts
- Tools
- Packing materials
- Work-in-process
- Finished goods
- Hardware
- Motors
- Gear box
- CKD – Completely Knocked Down items

Inventory Management

- The term 'inventory' includes raw material, work-in- progress, finished goods, stores and spares.
- DEFINITION: The term includes following categories of items:
- Production Inventories: Raw materials, parts, and components which enter the firm's product. These may consist of two general types- (a) Special items manufactured to company specifications. (b) standard industrial items purchased 'off the shelf'.
- MRO Inventories: Maintenance, Repair ,and Operating supplies which are consumed in the production process but which do not become part of the product. (e.g., lubricating oil, soap, machine repair parts).
- In-process Inventories: Semi-finished products found at various stages in the production operation.
- Finished goods Inventories: Completed Products ready for shipment

Objectives of inventories

- The primary Objective of inventory management is to ensure continuous supply of raw materials and facilitate uninterrupted production.
- Inventory facilitates transit and handling.
- Inventories serve to isolate the supplier, the producer and the consumer. It permits the procurement of raw materials in economic lot sizes as well as processing of these raw materials into finished goods in the most economical quantities.
- Isolating- also called decoupling, of producer from supplier, one production department from another, and consumer from producer is necessary for two reasons viz.

  - Is to reduce dependencies of one another .

  - To enable each organization to schedule its operations independently of another.

Inventory-costs

- Inventory costs includes ordering cost and carrying costs.
- Inventories cost money.
- Inventory cost includes ordering cost, carrying cost, out of stock or shortage cost, and capacity cost.

1. Ordering cost:

(a) Cost of placing an order with a vendor of materials:-(i) Preparing a purchase order.-(ii) Processing payments.-(iii) Receiving and inspecting the material.

(b) Ordering from the plant:

(i) Machine set-up.

(ii) Start-up scrap generated from getting a production run started.

2. Carrying costs:

A. Costs connected directly with materials:

(i) Obsolescence-(A loss in the utility of an asset due to the development of improved or superior equipment, but not due to physical deterioration).

(ii) Deterioration-(The process of growing worse, or the state of having grown worse).

(iii) Pilferage- (the act of stealing small amounts or small articles).

B. Financial Costs:

1. Taxes
2. Insurance
3. Storage
4. Interest (as the cost of capital borrowed to acquire and maintain the inventories).

C. Capital costs:

- Interest on money invested in inventory.
- Interest on money invested in land and building to hold inventory.
- Interest on money invested in inventory holding and control equipment.
- Storage Space costs
- Inventory Service Costs.
- Handling- equipment Costs.
- Inventory Risk Costs

3. Out-of-Stock Costs:

A. Back Ordering

B. Lost Sales.

4. Capacity Costs:

A. Overtime Payments when capacity is too large.

B. Lay-offs and idle time when capacity is too low.

PROCESS OF INVENTORY MANAGEMENT AND CONTROL

- It refers to the planning for optimum quantities of materials at all stages in the production cycle and evolving techniques which would ensure the availability of planned inventories. Four steps are involved:

1. Determination of optimum inventory levels and procedures of their review and adjustment.
2. Determination of the degree of control i.e. required for the best results.
3. Planning and design of the inventory control system.
4. Planning of the inventory control organization.

1. Determination of optimum inventory levels

- Too much of inventory results in locking up of working capital accompanied by increased carrying costs (but reduced ordering costs).
- Too less of inventory releases working capital for alternative uses and reduces carrying costs and increases ordering costs.
- To overcome this problem-The trend of sales must be watched closely and inventories adjusted in advance of the change in rate of production as determined by actual sales.
- The actual level of the inventory may also be improved by a close study of the manufacturing cycle.

2. Determination of the degree of control

- The second aspect of inventory management is to decide just how much control is needed to realize the objectives of inventory management.
- ABC classification approach is useful in deciding the degree of control.
- 'A' class items are 'high' in value but 'low' in quantity, 'C' class inventories are the opposite of 'A' group, i.e., 'high' in quantity and 'low' in value.
- In between 'B' group stock which are more or less equal in quantity and value proportion to the total inventory.

3. Planning and design of the inventory system

- An inventory system provides the organizational structure and the operating policies for maintaining and controlling goods to be stocked.
- The system is responsible for ordering and receipt of goods, timing the order placement, and keeping track of what has been ordered, how much, and from whom.

TWO APPROACHES

(a) The fixed order quantity system, and

(b) The fixed order periodic system (variously known as periodic system, the periodic review system, and the fixed order interval system).

FIXED ORDER QUANTITY SYSTEM OR 'Q' SYSTEM

- The fixed quantity of material ordered each time is known as the economic order quantity (EOQ).

- A fixed quantity of material is ordered whenever the stock on hand reaches the reorder point

FIXED-ORDER PERIOD SYSTEM OR 'P' SYSTEM

- 'P' system: In this system, inventory is ordered based on fixed period.
- When the stock level of given item is not sufficient to sustain the production operation until the next scheduled review, an order is placed replenishing the supply.
- It also varies among materials within the same firm, depending upon the importance of the material, specific production schedules, market conditions and order quantities

Differences between P and Q system

Point of Difference	Q System	P System
1. Initiation of order.	1. Stock on hand reaches to reorder point.	1. Based on fixed review period and not stock level.
Period of order	Any time when stock level reaches to reorder point.	Only after the predetermined period.
Record Keeping	Continuously each time a withdrawal or addition is made.	3. Only at the review period.
Order quantity	Constant, the same quantity ordered each time.	Quantity of order varies each time order is placed.
Size of inventory	Less than the 'P' system.	Larger than the Q system.
Time to maintain.	Higher due to perpetual record keeping.	Less due to recording only at the review period.

4. INVENTORY CONTROL TECHNIQUES

- Inventory control techniques are employed by the inventory control department within the framework of one of the basic inventory models:

- Fixed Order quantity system or Fixed order period system.

- Inventory control techniques represent the operational aspect of inventory management and help to realize the objectives of inventory management and control.
- Several Techniques of inventory control are in use and it depends on the convenience of the firm to adopt any of the techniques

Commonly used techniques

- Always Better Control (ABC) classification.
- High, Medium and Low (HML) classification.
- Vital, Essential and Desirable (VED) classification.
- Scarce, Difficult and Easy to obtain (SDE).
- Fast moving, Slow moving and Non-moving (FSN).
- Economic Order quantity (EOQ).
- Max-minimum system
- Two bin system.

ABC analysis

- The objective of ABC control is to vary the expenses associated with maintaining appropriate control according to the potential savings associated with a proper level of such control.
- ABC inventory control technique divides inventory into three categories A,B and C based on their annual consumption value. (acc. to the potential amount to be controlled.)
- ABC analysis is often called the Selective Inventory Control Method (SIM).

ABC ANALYSIS GUIDELINES

A items	B items	C items

Very strict control No safety stocks (or very low) Weekly control statements Maximum follow-up and expediting Rigorous value analysis Minimization of waste, obsolete, and surplus (review every 15 days). Individual Postings Central purchasing and storage. To be handled by senior officers. . Maximum efforts to reduce lead time.	1. Moderate control 2. Low safety stocks 3. Ordered once in 3 months 4. Monthly control statements 5. Moderate value analysis 6. Two or more reliable sources. 7. Estimate based on past data. 8. Quarterly review 9. Small group postings 10. To be handled by middle management.	1. Loose control 2. High safety stocks 3. Bulk ordering once in 6 months. 4. Quarterly reports. 5. Follow –up in exceptional cases. 6. Minimum value analysis 7. Two sources for each item. 8. Rough estimate. 9. Annual reviews 10. Decentralized purchasing 11. Can be fully delegated

HML CLASSIFICATION

- In this classification, Unit value is the criterion and not the annual consumption value.
- The items of inventory should be listed in descending order of unit value and it is up to management to fix the limits for three categories:
  - Rs.2000 and above-H items.
  - Rs.1000 to 2,000 – M items.
  - Less than Rs.1,000- L items.

The HML analysis is useful for keeping control over consumption at departmental levels, for deciding frequency of physical verification, and for controlling purchases.

VED classification

- On the basis of Vital, Essential and Desirable categorization.
- For 'V' items, a large stock of inventory is maintained.
- 'E' items are stocked in moderate quantity
- 'D' items minimum stock is enough

SDE CLASSIFICATION

- '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, items which have to come from distant places.
- 'E' refers to items which are easy to acquire and are available in the local markets.

The SDE Classification is based on problems faced in procurement and is vital to lead time analysis and in deciding on purchasing strategies

FSN CLASSIFICATION

- FSN stand for Fast moving, Slow moving and non-moving.
- The Classification is based on the pattern of issues from stores and is useful in controlling obsolescence.
- It is useful in identifying active items which need to be reviewed regularly, Surplus items which have to be examined and Non-moving items may be examined further and their disposal can be considered.

SOS CLASSIFICATION

- 'S' stands for seasonal items and 'OS' stands for Off-Seasonal items.
- It may be advantageous to buy seasonal items at low prices and keep inventory or buy at high price during off seasons.
- Based on the fluctuation in prices and availability, suitable decision has to be taken regarding how much to purchase and at what prices.

XYZ CLASSIFICATION

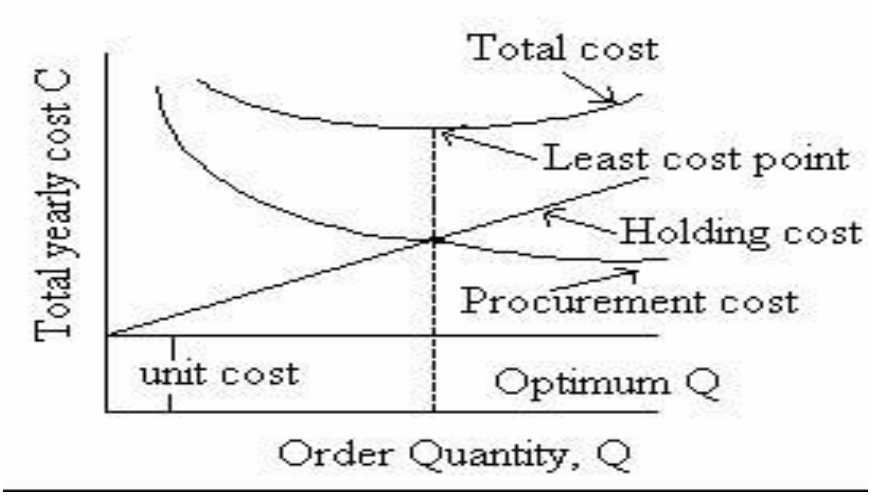
- XYZ analysis helps to control average inventory value by focusing efforts to reduce the inventory of 'X' items which are usually 10% of the number of items stored, but accounting for 70% of the total inventory value.
- Similarly, 'Y' items are 20% of the number of items stored and account for 20% of the total inventory value.
- The remaining 70% of the items accounting for 10% of the total inventory value are 'Z' items.
- The XYZ Classification is the difference being the actual inventory value of items in stores instead of their estimated annual consumption value.

GOLF CLASSIFICATION

- This stands for Government, Open market, Local or Foreign source of supply.
- For many items, imports are canalized through government agencies such as state Trading Corporations, Mineral And Metals Trading Corporations, Indian Drugs and Pharmaceuticals Association etc.
- For such items, the buying firms cannot apply any inventory control techniques and have to accept the quota allotted by the government.
- Open Market are those who form bulk of suppliers and procurement is rather easy.
- 'L' category includes those local suppliers from whom items can be purchased off - the-shelf on cash purchase basis.
- 'F' category indicates foreign suppliers, since elaborate import procedure is involved, it is better to have lots that cover annual requirements.

ECONOMIC ORDER QUANTITY

EOQ is the level of inventory order at which inventory cost is minimum



- It is the order size at which the total cost, comprising ordering cost and plus carrying costs, is the least.
- Graphically, the two costs, carrying costs and ordering costs cut exactly, where the total cost curve is at its lowest point.
- The more the inventory held in any period, greater will be the cost of holding it.
- Ordering in small quantities means more acquisition and higher ordering costs. The ordering costs decreases with increase in order sizes.
- A point where the carrying cost curve and the ordering cost curve meet represent the least total cost which incidentally is the economic order quantity or optimum quantity.

ASSUMPTIONS OF EOQ

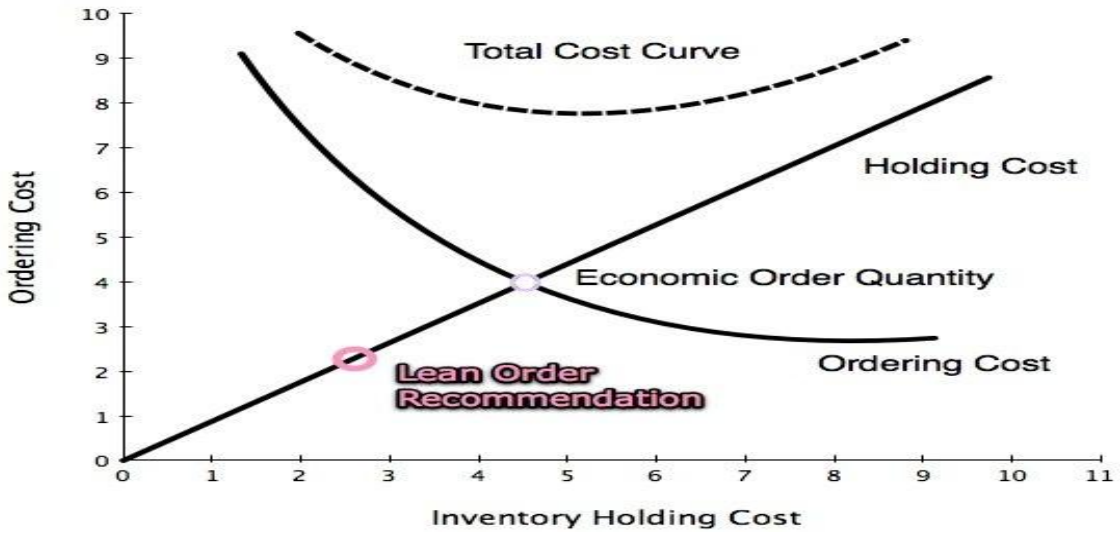
- EOQ can be calculated with the help of a formulae: Following assumptions are implied in the calculation:

1. Demand for the product is constant and uniform throughout the period.
2. Lead time (time from ordering to receipt) is constant.
3. Price per unit of product is constant.
4. Inventory holding cost is based on average inventory.
5. Ordering costs are constant, and
6. All demands for the product will be satisfied (no back orders are allowed)

Calculation of EOQ

- The single-item EOQ formula finds the minimum point of the following cost function:

- Annual Total Cost =Annual purchase cost + Annual ordering cost +Annual holding cost
- Purchase cost: This is the variable cost of goods: purchase unit price × annual demand quantity. This is P×D
- Ordering cost: This is the cost of placing orders: each order has a fixed cost S, and we need to order D/Q times per year. This is S × D/Q
- Holding cost: the average quantity in stock (between fully replenished and empty) is Q/2, so this cost is H × Q/2
- TC = DC +D/Q S + Q/2 H.



ORDER POINT PROBLEM

- Minimum level: minimum stock level that need to be maintained for smooth production.
- To determine the minimum stock level, lead time, consumption rate, material nature must be considered.
- Lead time: The amount of time between the placing of an order and the receipt of the goods ordered.
- Reorder level: It is the level of inventory at which an order should be placed for replenishing the current stock of inventory. It lies between minimum stock level and the maximum stock level.

- Re-order point= Lead time (in days) x Average Daily usage.
- Safety stock: Is that minimum additional inventory to serve as a safety margin or better or buffer or cushion to meet an unanticipated and increase in usage resulting from unusually high demand . (under uncertainty of usage and lead time).
- Reorder point = [Lead time (in days) x Average usage] + Safety stock.
- Maximum level: The level of stock beyond which a firm should not maintain the stock.

  Maximum stock level = Reorder level + Reorder quantity –(Minimum usage x Minimum delivery time).
- Average Stock Level = (Minimum level + Maximum level) /

MINIMUM-MAXIMUM TECHNIQUE

- The Minimum-maximum system is used in connection with manual inventory control systems.
- The minimum quantity is established in the same way as any re-order point.
- The maximum is the minimum quantity plus the optimum lot size

TWO-BIN TECHNIQUE

- In the two-bin system, stock of each item is separated into two bins.
- One bin contains stock, just enough to last from the date a new order is placed until it is received in inventory. the other bin contains a quantity of stock enough to satisfy probable demand during the period of replenishment.
- Two bin Technique: order is placed when one bin inventory is used.

JUST-IN-TIME SYSTEMS

- JIT is defined as " a philosophy of manufacturing based on planned elimination of all waste and continuous improvement of productivity".
- It encompasses the execution of all manufacturing activities required to produce a final product, from design engineering to delivery and including all stages of conversion from raw materials onward.

- The primary elements of JIT are to have only the required inventory when needed, to improve quality to zero defects, to reduce lead times by reducing set-up times, queue lengths and lot sizes, to incrementally revise the operations themselves and to accomplish these things at minimum cost.
- In the broad sense, "it applies to all forms of manufacturing, job-shop, process as well as repetitive tasks".

CONCEPT OF JIT

The Three fundamental concepts of JIT are:

(i) Elimination of waste and variability.

(ii) "pull" versus "push" system and

(iii) Manufacturing cycle time (or "throughput" time).

WASTE REDUCTION

- 'Any thing that does not add value' is described as waste in the production of goods or services.
- Products being stored, inspected or delayed, products waiting in queue and defective products do not add value and hence ,they are 100% waste.
- JIT speeds throughput, allowing faster delivery times and reducing work-in-progress.

VARIABILITY REDUCTION

- Variability is any deviation from the optimum process that delivers perfect product on time, every time.
- Reasons for occurrence of variability are:

(i) Employees, machines and suppliers produce units that do not conform to standards, are late or are not the proper quantity.

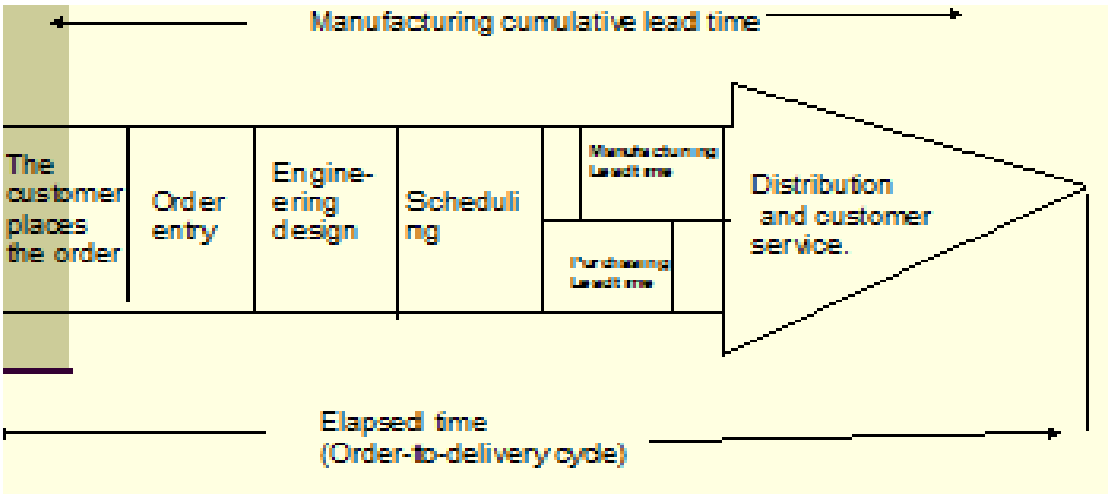
(ii) Engineering drawings or specification are inaccurate.

(iii) Production personnel try to produce before drawings or specifications are complete.

(iv) Customer demands are unknown.

The JIT philosophy of continuous improvement removes variability, which allows movement of good materials just-in-time for use. JIT reduces materials throughput the supply chain.

The Time-From-Order-to-Delivery Cycle



OVERVIEW OF JIT MANUFACTURING

JIT manufacturing includes activities:

(i) Inventory reduction.

(ii) Quality improvement.

(iii) Lead time reduction.

(iv) Vendor Control/performance improvement.

(v) Continuous Improvement.

(vi) Total Preventive Maintenance.

(vii) Strategic Gain.

UNIT – V

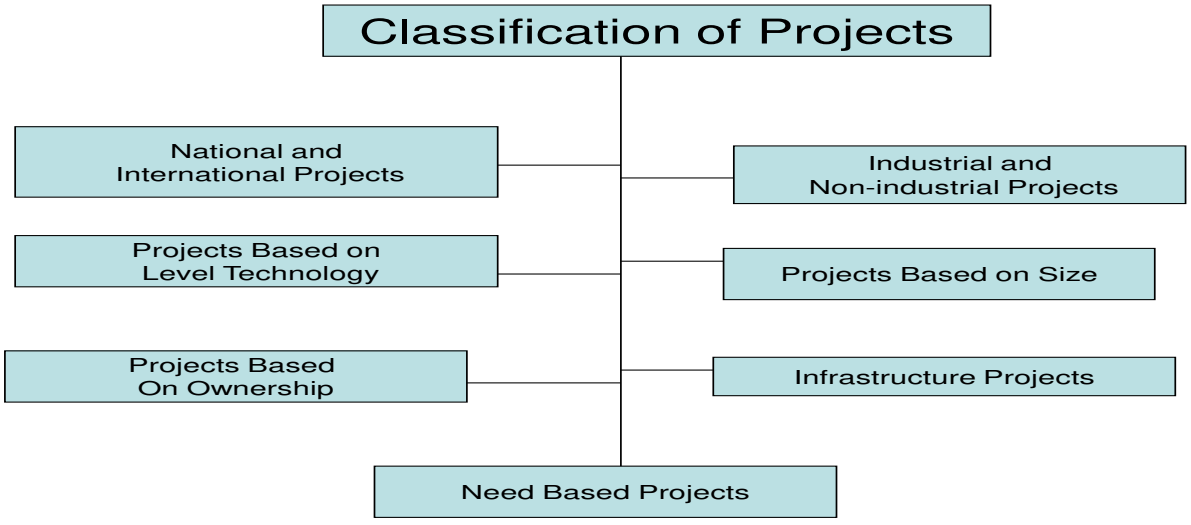
PROJECT AND FACILITY PLANNING

Project

- A project is a group of unique, interrelated activities that are planned and executed in a certain sequence to create a unique product/ service, within a specific time frame, budget and the client's specifications.
- According to the project management Institute's (PMI) publication, "A Guide to the Project Management Body of Knowledge , a project is defined as, " a temporary undertaken to create a unique product or service."
- According to the British Standard, a project is define as, "a unique set of co-ordinated activities, with definite starting and finishing and technical performance goals."

Objectives of project

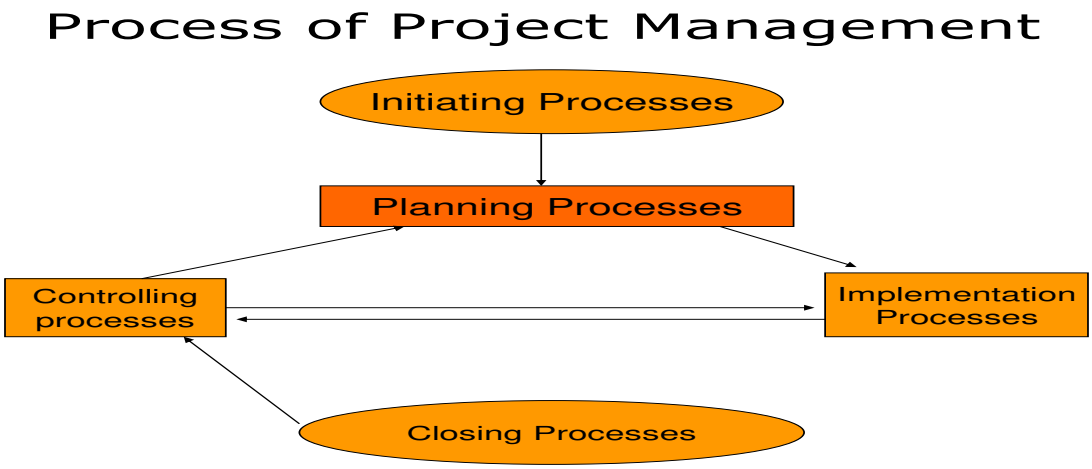
- Time
- Cost
- Safety
- Quality Performance

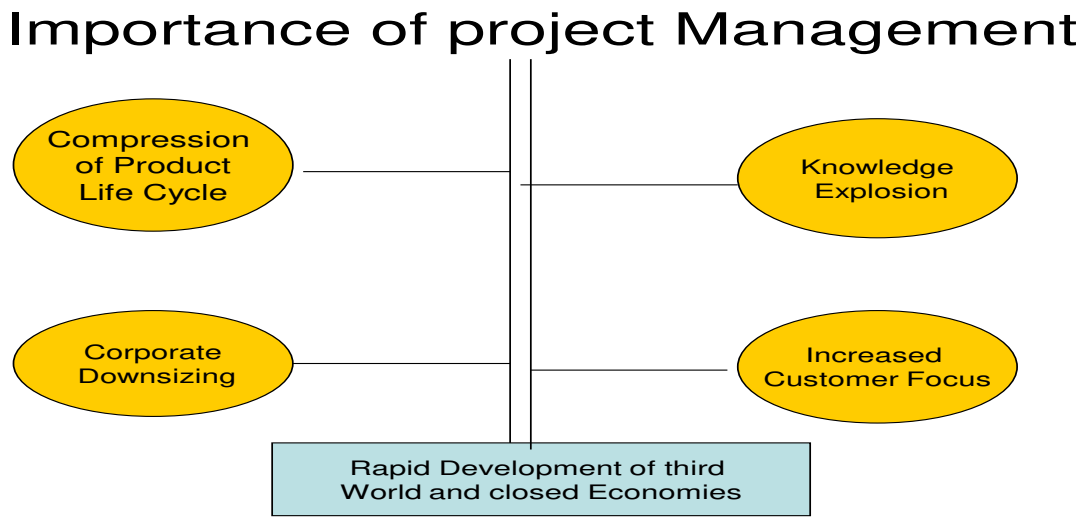


Project Management

- According to the project management Institute's (PMI), " Project management is the application of knowledge, skills, tools and techniques to project act6ivites to project activities in order to meet or exceed stakeholder needs and expectations.
- Elements of Project Management:

1. Identification of the project.
2. Technical and financial appraisal of the project.
3. Proper formulation of project.
4. Actual implementation of the project.
5. Feedback and revision of objectives.
6. Policy restrictions.
7. Government regulation.
8. Manage staff.
9. Manage client relationship
10. Evaluation at the end of the project.





Project Management Techniques

- Project scheduling is the process identifying and organizing the tasks of a project into a sequence of events ensuring a harmonious completion of the venture.
- Project scheduling enables the project manager to identify risk points, understand the proper linkage of events, assist in resource planning, and allows the project manager to establish goals for the team and the project.
- The Gantt chart technique is applied for highly repetitive production operations, where work performance of various departments can be combined on a single chart.
- PERT/Networking and the Critical Path Method (CPM) is designed for scheduling activities in the development phases, both identifying the critical path, float and slack.

Gantt chart

- A Gantt chart is a type of bar chart that illustrates a project schedule. Gantt charts illustrate the start and finish dates of the terminal elements and summary elements of a project. Terminal elements and summary elements comprise the work breakdown structure of the project. Some Gantt charts also show the dependency (i.e., precedence network)

relationships between activities. Gantt charts can be used to show current schedule status using percent-complete shadings and a vertical "TODAY" line as shown here.

- Although now regarded as a common charting technique, Gantt charts were considered revolutionary when they were introduced. In recognition of Henry Gantt's contributions, the Henry Laurence Gantt Medal is awarded for distinguished achievement in management and in community service. This chart is used also in Information Technology to represent data that have been collected.

Program Evaluation and Review Technique (PERT)

- The Program (or Project) Evaluation and Review Technique, commonly abbreviated PERT, is a model for project management designed to analyze and represent the tasks involved in completing a given project. It is commonly used in conjunction with the critical path method or CPM.
- PERT event: a point that marks the start or completion of one or more activities. It consumes no time and uses no resources. When it marks the completion of one or more tasks, it is not “reached” (does not occur) until all of the activities leading to that event have been completed.
- Predecessor event: an event that immediately precedes some other event without any other events intervening. An event can have multiple predecessor events and can be the predecessor of multiple events.
- Successor event: an event that immediately follows some other event without any other intervening events. An event can have multiple successor events and can be the successor of multiple events.
- PERT activity: the actual performance of a task which consumes time and requires resources (such as labor, materials, space, machinery). It can be understood as representing the time, effort, and resources required to move from one event to another. A PERT activity cannot be performed until the predecessor event has occurred.
- Optimistic time (O): the minimum possible time required to accomplish a task, assuming everything proceeds better than is normally expected

Terminologies

- Pessimistic time (P): the maximum possible time required to accomplish a task, assuming everything goes wrong (but excluding major catastrophes).
- Most likely time (M): the best estimate of the time required to accomplish a task, assuming everything proceeds as normal.
- Expected time (TE): the best estimate of the time required to accomplish a task, accounting for the fact that things don't always proceed as normal (the implication being that the expected time is the average time the task would require if the task were repeated on a number of occasions over an extended period of time).
- Float or Slack is the amount of time that a task in a project network can be delayed without causing a delay - Subsequent tasks – (free float) or Project Completion – (total float)
- Critical Path: the longest possible continuous pathway taken from the initial event to the terminal event. It determines the total calendar time required for the project; and, therefore, any time delays along the critical path will delay the reaching of the terminal event by at least the same amount.
- Critical Activity: An activity that has total float equal to zero. Activity with zero float does not mean it is on the critical path.
- Lead time: the time by which a predecessor event must be completed in order to allow sufficient time for the activities that must elapse before a specific PERT event reaches completion.
- Lag time: the earliest time by which a successor event can follow a specific PERT event.
- Slack: the slack of an event is a measure of the excess time and resources available in achieving this event. Positive slack would indicate ahead of schedule; negative slack would indicate behind schedule; and zero slack would indicate on schedule.
- Fast tracking: performing more critical activities in parallel
- Crashing critical path: Shortening duration of critical activities

Critical path method (CPM)

- CPM methods can be applied with success to large scale research and development programs e.g. construction work, industrial maintenance and installation operations.
- Objectives of CPM Analysis:

1. To determine a route between two or more operations which optimizes some measures of performance.
2. To locate the obstacles and difficulties involved in a production process.
3. To assign the starting and finishing times for each operation or activity.
4. To determine the float associated with each non-critical activity.

- Applications of CPM:

1. In production planning
2. Location of and deliveries from a warehouse.
3. Road systems and traffic schedules.
4. Communication network.

Determination of the Float

1. Total Float: The total float of an activity represents the amount of time by which it can be delayed without delaying the project completion date.

- It refers to the amount of free time associated with an activity which can be used before, during or after the performance of this activity.
- It is equal to the difference between the total time available for the performance of an activity and the time require for its performance.
- Total Float = latest finish time - earliest finish time.
  = latest start time - earliest start time.
  = latest finish time - earliest finish time – duration of the activity.

Difference between PERT and CPM

PERT	CPM
1. PERT is appropriate where time estimates are uncertain in the duration of activities as measured by optimistic time,	CPM assumes that the duration of every activity is constant and therefore every activity is critical or not.

most likely time, and pessimistic time.	
2. PERT is concerned with events which are the beginning or ending points of operation.	CPM is concerned with activities
3. PERT is suitable for non-repetitive projects.	CPM is designed for repetitive projects.
4. PERT can be analyzed statistically.	CPM can not be analyzed statistically.
5. PERT is not concerned with the relationship between time cost.	CPM establishes a relationship between time and cost and cost is proportionate to time.

Facility / Plant Location

- Facility / Plant Location may be understood as the function of determining where the plant should be located for maximum operating economy and effectiveness. The locations where firm set up their operations is simply called as plant location.
- According to Prof. R.C. Davis, "The function of determining where the plant should be located for maximum operating economy and effectiveness."
- "Plant location stands for that spot where in consideration of business as a whole, the total cost of production and delivering goods to all the consumers is the lowest."
- NEED FOR SELECTION OF LOCATION:

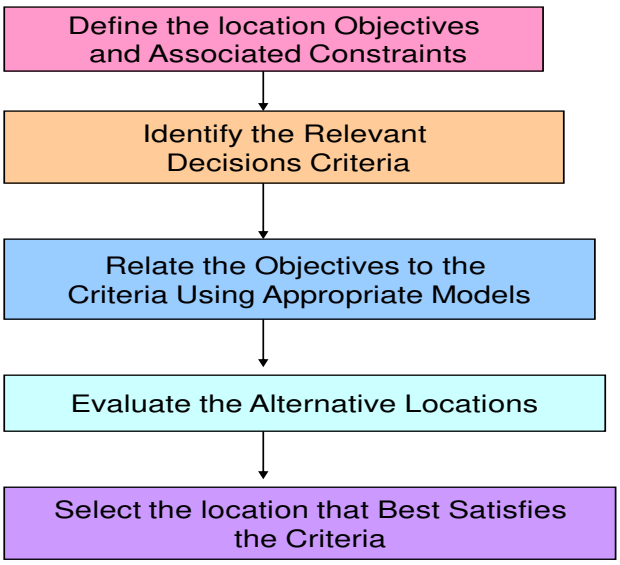
1. Starting New Organization: - identification of region, choice of a site within a region, Dimensional Analysis.
2. Existing Organization: -Manufacturing distinct products, specific market area.
3. Global location: - Virtual Proximity,- Virtual Factory.

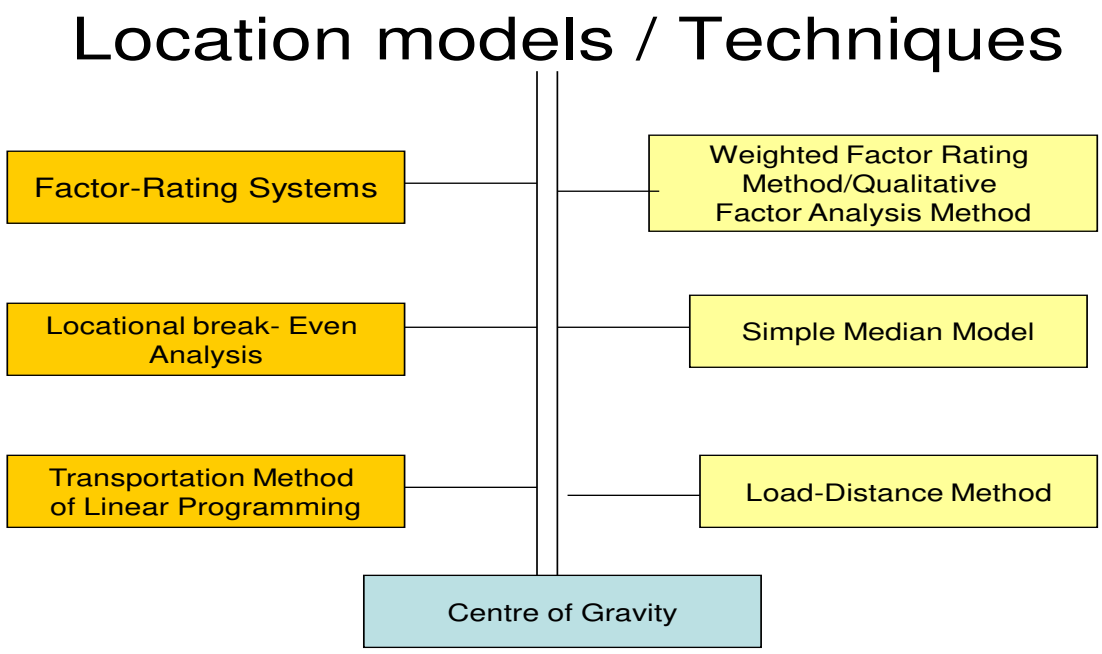
Plant Location Theory

- In 1909, Alfred Weber, Theory of the location of Industries,".

- Weber recognized that transport costs could be minimized by locating attainable transport and labor destination market and that the employment and relatively cheap labor could also prove to be a valuable route to improving a company's profitability. This is called as 'primary locational factor'.
- 'Secondary' locational factors were related to the external economies of scale that were afforded to companies deciding to locate in a particular region.
- Weber proposed that a regional concentration of industrial activity may generate these benefits, especially if the companies located there are functionally connected to each other in some manner.
- Agglomeration or concentration of firms in a local occurs when there is sufficient demand for support services for the company and labor force, including new investments in schools and hospitals.
- Deglommeration: Occurs when companies and services leave because of over concentration of industries or of the wrong types of industries or shortage of labor, capital, affordable land.

Steps in Selection / location decision process



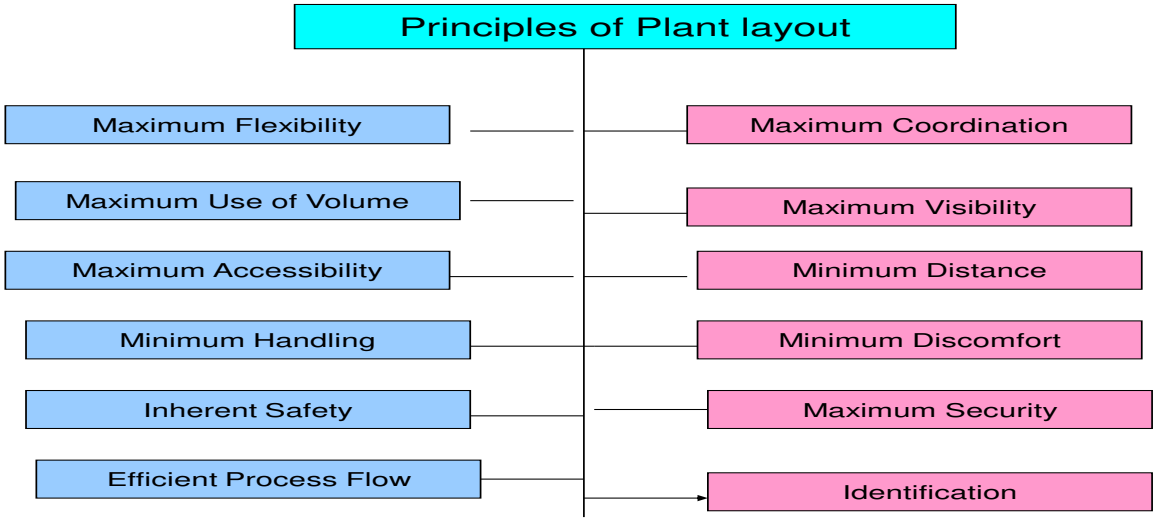


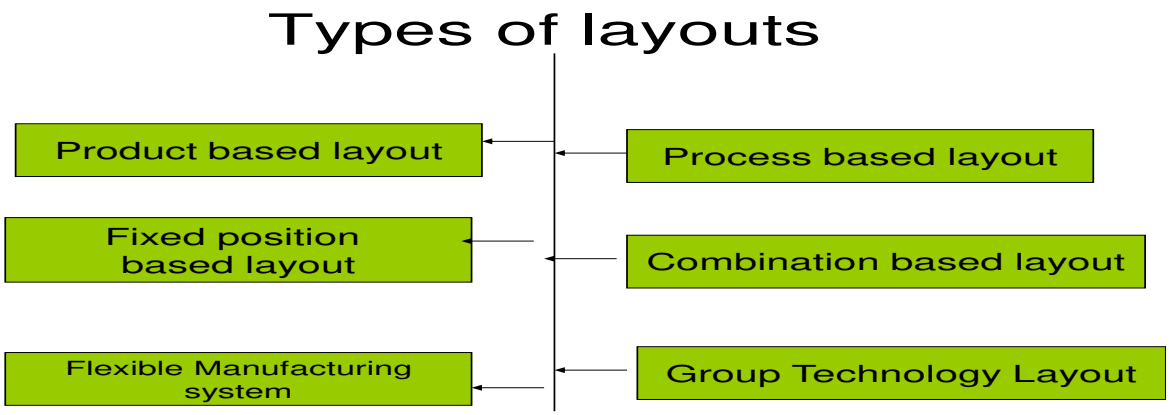
Facility / plant Layout

- Layout depends on the process structure employed and the technology used. A good layout ensures flow of work, materials, persons and information.
- Facility Layout refers to the placement of departments, workgroups within departments, workstations, machines and stock holding points within a production facility.
- According to Shubin, "Plant layout is the arrangement and location of production machinery, work centers and auxiliary facilities and activities (Expectation, handling of material storage and shipping) for the purpose achieving efficiency in manufacturing products or supplying consumer services".

Objectives of Good Layout

1. Integrate the production Centre
2. Reduce material Handling
3. Effective Utilization of available space
4. Worker Convenience and job satisfaction
5. Flexibility
6. Quick Disposal of work
7. Avoids Industrial Accidents





Planning Tools and techniques

- Designing and installing a layout for the first time and its subsequent revision may be looked after by the Engineering or Planning Department.
- Different Models:

1. Templates
2. Three Dimensional Models
3. Operations Sequence Analysis
4. Line Balancing
5. Use of Computers

PROBLEMS AND SOLUTIONS

14. (b) Identify the critical path based on total float. Nov. / Dec. 2009

Activity	A	B	C	D	E	F	G
Predecessors	-	A	A	B	B	C,D	E,F
Activity Time (weeks)	4	3	2	5	3	4	3

14) a) Find.

i) critical path of the project and its expected duration and the

ii) the probability that the project will be completed within 50 days May / June 2009

Activity	Note	a	m	b
A	1-2	10	11	12
B	2-3	6	10	14
C	2-4	5	8	11
D	2-5	1	5	9
E	3-6	3	5	7
F	4-6	4	9	14
G	5-7	1	2	3
H	6-7	3	7	11
I	7-8	9	12	15
J	7-9	3	5	7

14. (b) Consider the following data of a project

Activity	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*
Predecessors	-	-	*A*	*B*	*A*	*C,D*	*C,D,E*	*F*

a	*1*	*2*	*6*	*1*	*1*	*1*	*1*	*1*
m	*2*	*2*	*7*	*2*	*4*	*5*	*2*	*2*
b	*3*	*8*	*8*	*3*	*7*	*9*	*3*	*9*

Construct the project network and find the project duration. Nov. / Dec. 2008