BALAJI INSTITUTE OF I.T AND MANAGEMENT KADAPA

OPERATIONS MANAGEMENT (17E00206)

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SYLLABUS
(17E00206) OPERATIONS MANAGEMENT

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

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

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

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

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

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

Text Books:

- Production and Operations Management, Aswathappa K - Himalaya Publishing House
- "Production and Operations Management" - Dr. K.Sai Kumar, Kalyani Publishers

References:

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

UNIT - 1

INTRODUCTION

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

1. 1 PRODUCTION:

Production is the process by which raw materials and other inputs are converted into finished goods.

1.2 NATURE OF PRODUCTION:

Among all the functional areas of management production are considered to be crucial in any industrial organization the other word synonymously used with production is manufacturing.

Manufacturing is understood to refer to the process of producing only tangible goods, where as production includes creation of both tangible goods as well as intangible goods services.

- Nature of production can be better understood by
- Production as a system
- Production as an organizational function
- Production decision making process

1.3 MEANING OF PRODUCTION MANAGEMENT:

Production management refers to the application of management principle to the production function in a factory.

1.4 DEFINITION OF PRODUCTION MANAGEMENT:

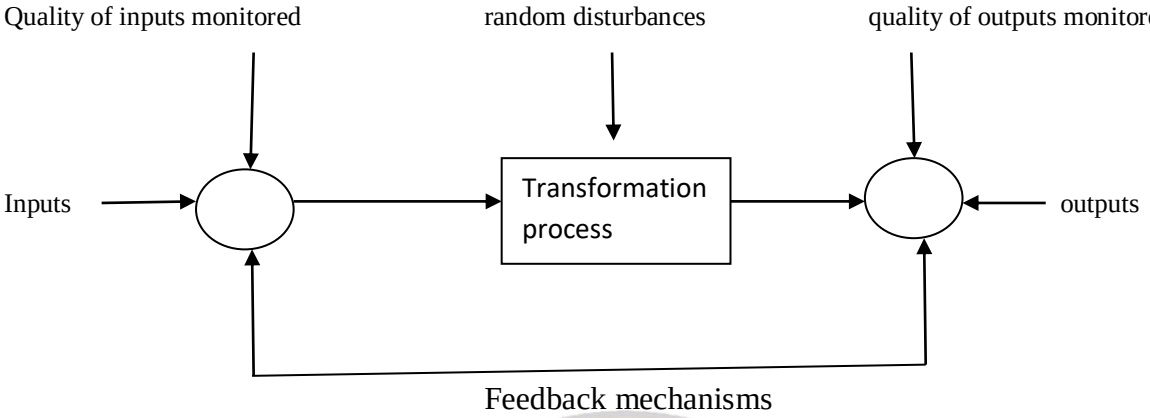
According to Elwood S.BUFFA, Production Management deals with decision making related to production process so that the resulting goods or services are procured according to the specifications in amounts and by the schedules demanded at a minimum cost

1.5 MEANING & DEFINITION OF OPERATION MANAGEMENT:

Operations Management is often used along with production on management in literature on the subject. Operations management is the process in which resources or inputs are converted into more useful products.

1.5 DEFINITION OF PRODUCTION AND OPERATION MANGAMENT (POM)

Production and Operation monument (POM) is defined as the design, operation and improvement of the transformation process which converts the various inputs into desired outputs of products and services.
The term "Production and Operations Management" is being increasingly replaced by simply "Operations Management".



Operation management is a broad term which includes manufacturing as well as service organization.

1.7 OBJECTIVES OF PRODUCTION AND OPERATION MANAGEMENT:

The objectives of the production function are classified as under:

1. Ultimate objectives
2. Intermediate objective

1. ULTIMATE OBJECTIVES:

A. MANUFACTURING COSTS: The Unit cost of the product should be estimated carefully and every effort should be made to stick to the cost standards. Efforts should be made for the following:
Reduction in the variable costs, Reductions in the fixed costs & Increase in volume of production

B. PRODUCT QUALITY: Generally the product quality standards are often established by product specifications or by the consumer. The Manufacturing Organization should try to translate such quality prescription into some measurable objectives. The maintenance of the quality should not result in increase in manufacturing time schedule, manufacturing costs or delay in the production. A proper balance should be maintained between quality and cost.

C. TIMELINESS OF DELIVERY: Timeliness of delivery is one of the parameter to judge the effectiveness of production department. So, the production department has to make the optimal utilization of input resources to achieve its objectives.

D. RIGHT QUANTITY: The manufacturing organization should produce the products in right number. If they are produced in excess of demand the capital will block up in the form of inventory and if the quantity is produced in short of demand, it leads to shortage of products .

2. INTERMEDIATE OBJECTIVES :

a. MACHINERY AND EQUIPMENT:

The objective in the area of machinery equipment are divided into

1. Acquisition of machinery and equipment
2. Utilization of machinery and equipment

Efforts should be made to increase the utilization rate of machinery through repair, maintenance & maximum occupancy of the machines.

b. MATERIALS: The Material objectives must be described in terms of units, rupee value and space requirements. The material costs per units should be specified and efforts should be made to increase the inventory turnover of all types of inventories like raw materials, work in progress and finished goods.

c. MAN POWER: Man power is important as well as typical input in manufacturing actives so the objectives of production actives and manpower must be closely allied with the objectives of selection placement, training rewarding and utilization of manpower. Usually these objectives are considered in terms of employee turnover rate safety measurements, industrial relations etc.

d. MANUFACTURING SERVICES: Proper Objectives should be set for the installation of important facilities such as power water supply, materials handling etc. It can be stated that the objectives of the manufacturing activates are to manufacture a quality product on schedule at the lowest possible costs with maximum asset turnover and to achieve customer satisfaction.

1.8 SCOPE OF PRODUCTION AND OPERATIONS MANGAMENT:

Production & Operations management concern with the conversion of inputs into outputs using physical resources, so as to provide the desired utilities to the customer while meeting the other organizational objectives of effectiveness, efficiency and adaptability. It distinguishes itself from other functions such as personnel, marketing, finance etc. The following are the activates which are listed under Production and Operations Management facilities.

1. **LOCATION OF FACILITIES**:

- Location of facilities for operations is a long term decision that affect a business organization.
- The selection of location is a key decision as large investment is made in building plant and machinery.
- An improper location of plant may lead to waste of investments of a company.
- Hence location of the plant should be based on company's expansion plan and policy, diversification of products and changing sources of raw materials.

2. **PLANT LAYOUT & MATERIAL HANDING**:
   - Plant layout refers to the physical arrangements of facilities.
   - It is the configuration of departments work centers and equipment in the conversion process.
   - The overall objective of the plant layout is to design a physical arrangement that measures the required output quality and quality most economically.
   - Material handling refers to the moving of material from the store room to the machines during manufacturing process.
   - It is also defined as the art and science of moving packing and storing of products in any form. It is a specialized activity of a modern manufacturing concern with 50% to 75% of the cost of production.
   - This cost can be reduced by proper section, Operation & Maintenance of material handling devices which increases the output and improves quality and speeds up the deliveries.

3. **PRODUCT DESIGN**:
   - Product design deals with conversion of ideas into reality.
   - If refers to the arrangement of elements or parts that collectively form a product. Product
   - Design and development provides link between marketing customer needs and expectations and the activities required to manufacture the product.

4. **PROCESS DESIGN**:
   - Process design is concerned with the overall sequence of operations required to achieve the design specification of the product.

1.9 FUNCTIONS OF PRODUCTION AND OPERATIONS MANAGEMENT

A. PRODUCTION PLANNING AND CONTROL**:**

Production planning and control can be defined as the process of planning the production in advance, setting the exact route of each item, fixing the starting and finishing dates for each item. Main function of production planning and control includes

a. **Planning:** Planning is deciding in advance what to do how to do when to do who to do?
b. **Routing:** Routing may be defined as selection of path.
c. **Scheduling:** Scheduling may be defined as the fixation of time and date for each operational activity
d. **Dispatching:** Dispatching is release of orders and instruction for starting of production
e. **Follow zip:** Report daily the progress of work in the shop.

B. PRODUCTION CONTROL**:**

Necessary steps are required to be taken with a view to ensure that resources and other factors are used in an optimal and efficient manner with the following objectives:

a. Cost of Production is kept at the bare minimum

b. The production of finished goods is in accordance with the specifications stipulated by the customer.

c. The requisite quantity of the product is delivered to the customer before or on the scheduled date, and

d. Satisfaction level of the customer should be the priority.

Scheduling of the work is of paramount importance as far as this function is concerned.

C. QUALITY CONTROL**:**

Quality control (QC) may be defined as a system that is used to maintain a desired level of quality in a product or service.

D. INDUSTRIAL ENGINEERING**:**

Industrial Engineering may be defined as a branch of engineering which provides solutions as to how to optimize various complex process or systems. The production manager is also responsible for maintaining a specific quality of the product. Steps should be taken to produce the goods according to the specifications and to minimize the amount of defective work. The defective work should be sorted out and sold separately.

E. PURCHASING**:**

Purchasing is partially a production function. It plays a significant role in arriving at make or buy decisions. Specifications and quality requirements of materials and equipment, etc, are laid down either by the staff department or production department. Decisions relating to quality requirements and frequent of purchases are generally made by the materials department in consultation with the production manager.

F. PLANT ENGINEERING**:**

Plant Engineering has the responsibility for maintaining the plant and equipment, and services including light, heat and power.

G. MANUFACTURING**:**

Manufacturing is the actual process of conversion of Raw Materials into Finished Goods and Services. Industrial Engineering, Plant Engineering, Production Planning and purchasing

perform the staff functions of rendering services and advice to manufacturing. They all set stage for the actual manufacturing operations by providing production programs, schedules, routes and work orders; by specifying methods, processes and standards of operations; by taking care of the maintenance of plant and equipment; and by making supplies and raw materials available to the person in-charge of operations.

H. METHOD ANALYSIS:

There may be so many alternatives for manufacturing a product because all alternatives do not work equally. Some may be more economical than others. The production manger must study the various alternatives and analyse them in right perspective in order to choose the best one. This activity of choosing the best alternative is called Method Analysis. It improves the productivity of the concern and minimized the cost of production.

I. INVENTORY CONTROL**:**

Production manager is supposed to have control over the cost of production by reducing the wastage of man and material. So, he is to make the best use of material. For this purpose, he is to determine the economic lot size, economic order quantity, reorder levels (minimum, maximum and danger levels of the stock of material) so that problems of over and under stock of material may not arise. This involves the physical and financial control of material. Thus, he is to arrange the procurement of raw materials.

J. PLANT LAYOUT AND MATERIALS HANDLING:

Plant Layout is an arrangement of machines and equipment in such a manner so as to maintain the flow of production uninterruptedly. An efficient plant layout aims at efficient material handling which in turn reduces wastages of man and material and helps in reducing the cost of production. The production manager must see the efficient handling systems and plant layout are designed and developed.

K. WORK MEASUREMENT:

One of the main responsibilities of the production manager is to control and reduce the labour cost per unit. At different levels of production, the labour cost per unit differs. Here work-measurement is necessary. By work-measurement methods, we mean the level of performance of work by a worker Time and Motion studies are work-measurement techniques.

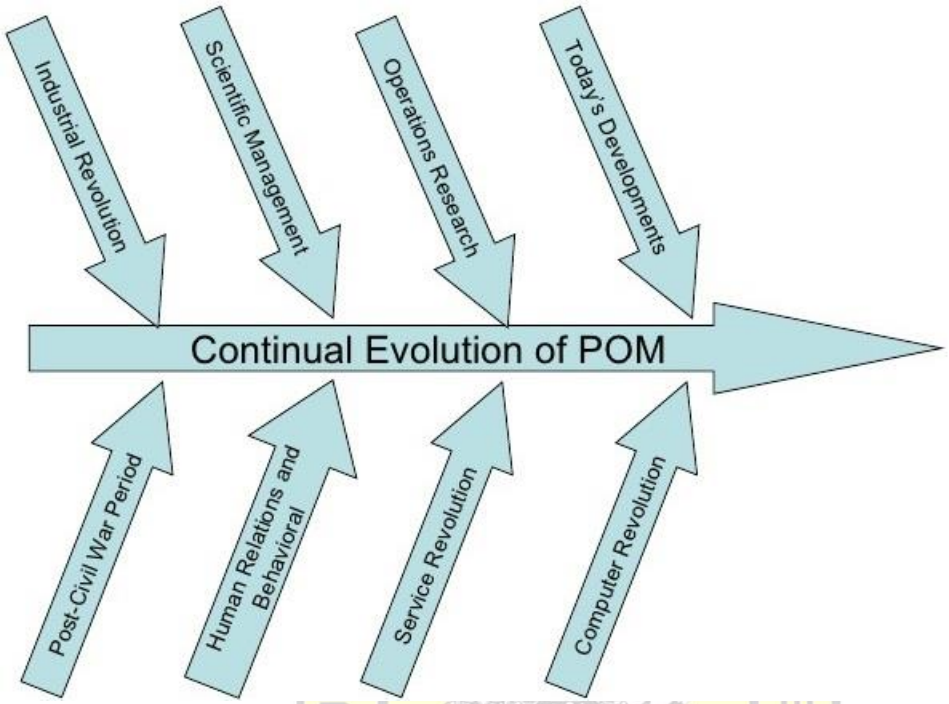
L. OTHER FUNCTIONS:

Apart from the above functions, the production manager is to perform certain other function such as engineering, economics, cost control, maximising the labour efficiency, standardization and storage, price analysis, wage incentives to workers etc.

1.10 PROBLEMS OF PRODUCTION AND OPERATIONS MANAGEMENT:

1. **Problem of plant location**: The first and foremost problem of production planning is take decision about the location of the plant some factors like nears of market availability and sources of raw materials transportation availability of man power etc should be taken into account while locating a plant
2. **Problem of plant layout:** Management should design the operation & equipment in such a way that they may reduce the overall materials handling cost and time. By not choosing a good plant layout problems like heating, lighting, storing space, delay of work, more material handling cost may arise.
3. **Problem of product designing**: The selection of the design of the product is another problem of the production management any change in the design of the product will affect the design of the plant its layout.
4. **Problem of inventory and production control**: The problem of inventory and finished stock control is also very important for the proper flow of production process for inventory control decision regarding economic order quantity (EOQ) reorder level ABC analysis maintaining of safety stock etc their decisions help in order to have continuous flow of materials to have continuous production
5. **Problem of quality control:** The quality of the product be consistent the quality should be as per the specification compromise in quality leads to dissatisfaction of customers
6. **Problem of labour control:** Controlling the labour force is also one of the problems in production because it is a major cost-element especially in services. So, production planning needs labour appraisal and as much efforts are needed to develop work measurement and wage payment systems.
7. **Problems of cost control and improvement:** The aim of the production management is to achieve the maximum production at a minimum cost.

2. HISTORICAL DEVELOPMENT OF POM:



Many events helped to shape production and operations management the following are some of these development

1. **INDUSTRIAL REVOLUTION:** The industrial revolution had a significant impact on the way of production. In England in 1700's a development occurred that we refer to as the industrial revolution. This involved two Principal elements the wide spread substitution of machine power for human power and the establishment of the factory system.
2. **POST – CIVIL WAR PERIOD:** The post civil war period set the stage for the great expansion of production capacity in the new century. The end of the civil war witnessed the beginning of modern forms of capital through establishment of joint stock companies
3. **SCIENTIFIC MANAGEMENT:** LEDRSICK WINSLOW TAYLOR was father of Scientific Management. The main focus of Scientific Management was on machines and the system of their utilization. He mainly focused on work study, time study, Method study etc…
4. **HUMAN RELATION MOVEMENT:** The tem human reactions refer to the ways in which Managers interact with the employees. When a person in management stimulates more and better work the organization has effective human relation when morale and efficiency deteriorates (become gradually worse), its human relations are said to be ineffective

5. **OPERATIONS RESEARCH:**A new multi disciplinary approach to problem solving was developed and called as Operations Research. This was a quantitative approach basically concerned with the efficient allocation and control of resources. Later successful models on linear programming, network flow problems, inventory theory, dynamic programming, queuing and game theory has been developed.
6. **SERVICE REVOLUTION:** One important development of our time in mushrooming of services. In our economy, the share of the service sector in the GDP is much higher than that of industry or agriculture. The impact of this explosion of services organization on production management has evolve strategies and action to mange services areas for better productivity quality and competitiveness.
7. **COMPUTERS REVOLUTION:** The growth of computer and communication technologies had a significant impact on the ways organizations manage their operations. The operations activities can be performed more quickly due to advancements in computer technologies and software applications the following developments that have impacted POM
    a) Robotics and numerical control
    b) Computer assisted design
    c) Bench marking
    d) ISO standards
    e) Process reengineering
    f) Out sourcing
8. **TODAY DEVELOPMENT OR RECENT TRENDS IN POM:**
    Many recent trends in production and operations management relate to global competition and the impact has on manufacturing firms
    1. **GLOBAL MARKET PLACE:** Globalization of business has compelled many manufacturing firms to have operation in many counties. This has resulted in a steep gradual increase in the level of competition among manufacturing firms throughout the world.
    2. **PRODUCTION ORPERTION STRATEGY:**More and more firms are recognizing the importance of production operations strategy for the overall success of their business and the necessity for the relating it to their overall business strategy
    3. **TOTAL QUALITY MANAGEMENT (TQM):** TQM Approach has been adopted by many firms to achieve customer satisfaction
    4. **TECHNOLOGY:** Advances in technology have led to a vast array of new production processes, new products, new material and components. Automation, computerization, information and communication technologies have revolutionized the way companies operate
    5. **RE-ENGINEERING:** This involves drastic measures or break through improvements to improve the performance of the firm.
    6. **SUPPLY CHAIN MANAGEMENT:** Management of supply chain from suppliers to final customers reduces the cost of transpiration, ware housing and distribution throughout the supply chain.

7. **LEAN PRODUCTION:** Production systems have become lean production systems which use minimal amount of resources to produce a high volume of high quality goods with some variety.
8. **TIME REDUCTION:** Reduction of manufacturing cycle time and speed to market for a new product provides competitive edge to a firm over other firms.
9. **WORKERS INVOLVEMENT:**The recent trend is to assign responsibility for decision making and problem solving to the lower levels in the organization.
10. **ENVIRONMENTAL ISSUES:** Today's production mangers are concerned more and more with pollution control and waste disposal which are key issues in protection of environment and social responsibility. There is increasing emphasis on reducing waste, recycling waste using less toxic chemicals.

3. PRODUCT AND PROCESS DESIGN

PRODUCT DESIGN:

PRODUCT: Product is anything that can be offered to a market that might satisfy a want or need. According to PHILP KOTLER, "A product is a bundle of physical services and symbolic particulars expected to yield satisfactions or benefits to the buyers".

3.1 MEANING AND DEFINITION OF PRODUCT DESIGN: Design is the conversion of knowledge requirement into a form, convenient and suitable for use for manufacture.

Product design is concerned with the **form and function** of a product. Form involves the determination of what a product would look like i.e., the shape and appearance of the product, what it will be made of (product structure) and how it will be made (process design). Functional Design deals with what function the product will perform and how it performs.

3.2 OBECTIVES OF PRODUCT DESIGN:

1. The overall objective is profit generation in the long run
2. The achieve the desired product quality
3. To reduce the development time and cost to the minimum
4. To reduce the cost of the product.
5. Top ensure manufacturability i.e., design for manufacturing and assembly.

3.3 FACTORS INFLUENCING PRODUCT DESIGN:

1. **CUSTOMERS REQUIREMENTS:** The designers must find out the exact requirements of the customer and to ensure that products suit the convenience of customers the products should be designed in such a way that they can be used in all kinds of conditions
2. **CONVENICE OF THE OPERATOR OR USES:** The industrial products such as machines and tools should be designed so that they are convenient and comfortable to operate or use.

3. **TYPES OF MATERIALS USED:** Discovery of new and better materials can improve the product design. Designers should keep in touch with the latest developments in materials and components and make use of them in their product designs.
4. **WORK METHODS AND EQUIPMENTS:** Designers must know latest work methods process and equipment and make use of the latest technology to design the product and to achieve reduction in costs.
5. **PRODUCT QUALITY:** The product quality policy of the firm provides the necessary guidelines for the designers regarding the extent to which quality should be built in the design stage.
6. **COST/PRICE RATIO:** In a competitive market there is lot of pressure on designers to design products which are cost effective because cost and quality are inbuilt in the design.
7. **PROCESS CAPABILITY:** The product design should take into consideration the quality of conformance i.e., the degree to which quality of design is achieved in manufacturing. This depends on the process capability of machines and equipments. The designer should have the knowledge whether the available machines and equipments are sufficient/efficient to achieve the required product design.
8. **EFFECT ON EXISTING PRODUCT:** New product designs while replacing existing product designs must take into consideration the use of standard parts and components so the costs of implementing the changes are kept to the minimum.
9. **PACKAGING:** Packaging is an essential part of product and packaging should take into consideration regarding the protection and promotion of the product. Attractive packaging enhance the sales of products particularly consumer products (non durable)

3.4 CHARACTERISTICS OF GOOD PRODUCT DESIGN

1. **FUNCTION (OR) PERFORMANCE**: The function or performance is what customer expects from the product to do or certain benefits.
2. **APPEARANCE OR AESTHETICS:** This includes the style, color, look and feel of the product.
3. **RELIABILITY:** This refers to the length of time a product can be used.
4. **PRODUCIBILITY:**This refers to the case of manufacture with minimum cost
5. **SAFETY:** The product must be safe to the user and should not cause any accident while using or should not cause any health hazard to the user. proper package, Safety storage and proper instructions should be given to the user while handling.

4. PROCESS DESIGN

4.1 MEANING AND DEFINITION OF PROCESS:A process is a sequence of activities that is intended to achieve some result. A process converts inputs into outputs in a production system. It involves the use of organizations resources to provide something of value.

No product or no service exists without a process and no process can exist without a product or service.

4.2 PROCESS PLANNING

Process planning is concerned with planning the conversion processes needed to convert the raw material into finished products. It consists of two parts.

1. Process design
2. Operation design

1. **PROCESS DESIGN**:
   Process design is concerned with the overall sequences of operations required to achieve the product specifications. It specifies the type of work stations to be used, the machines and equipments necessary to carry out the operations. The sequence of operations are determined by
   - The nature of the product
   - The materials used
   - The quantities to be produced and
   - The existing physical layout of the plant.
2. **OPERATIONS DESIGN:**
   Operations Design is concerned with the design of the individual manufacturing operations. Operations design must specify how much labour and machine time is required to produce each unit of the product.

4.3 MAJOR FACTORS AFFECTING PROCESS DESIGN DECISIONS:

1. **NATURE OF PRODUCT OR SERVICE DEMAND:** Demand is nothing but the ability and willingness of a person to purchase the product. Production process must have adequate capacity to produce the volume of products or services according to customer needs and wants.
2. **DEGREE OF VERTICAL INTEGRATION:** Vertical Integration is the amount of product and distribution chain from suppliers of raw materials to distribution of finished goods. There are two directions or types of Vertical Integration.

a. **FORWARD INTEGRATION**: In this firm integrates or firm acquires the channel of distribution. (Own warehouses and retail outlets of the firm.)

b. **BACKWARD INTEGRATION:** It represents moving upstream towards the source of raw materials and parts. Example, A Steel Mill going for backward integration by owning irons ore and coal mines and transport vehicles to move these raw materials to the steel plants.

3. **PRODUCT OR SERVICE AND VOLUME FLEXIBILITY:** Ability to respond fast to the customers need is known as flexibility. There are two forms of flexibility.

a. **PRODUCT OR SERVICE FLEXIBILITY:** Ability of the production system to change quickly from production of one product or service to another is known as product or service flexibility.
b. **VOLUME FLEXIBILITY:** The ability to quick increases or reduce the volume of products or services produced are known as volume flexibility. Volume flexibility is needed when demand is fluctuating.
4. **DEGREE OF AUTOMATION:** The degree of automation to be adopted and integrated into the production system is a key issue in process design. Automation involves high expenses and difficult to integrate in existing operation. The key factors supporting automation are needed to produce products or services quickly and of high quality.
5. **LEVEL OF PRODUCTS OR SERVICE QUALITY:** The choice of design of production process and the degree of automation integrated into the production process has an impact on the level of product quality.
6. **DEGREE OF CUSTOMERS CONTACT:** The extent to which customers get involved into the production system has important implications for the design of production process. In custom built products or service the customer is the central focus of the production process design.

5. MANUFACTURING PROCESS TECHNOLOGY

Manufacturing process technology refers to the equipment people and systems used to produce firm's products and service key process technology decisions relate to

- Organizing the process flows
- Choosing the appropriate product process mix
- Adapting the process to meet strategic requirements
- Evaluating automation and high technology processes.

5.1 TYPES OF MANUFACTURING PROCESS TECHNOLOGY

There are five types of manufacturing process technology. Each is suited to different products or market situations and has its unique operating characteristics problems and challenges.

1. **JOB SHOP TECHNOLOGY:** In this system manufacturing of one or few quantity of products designed and produced as per the specification of customers within preferred time and cost.

CHARACTERISTICS:

a. High variety of products and of low volume
b. Unique technologies requirements

ADVANTAGES:

A. Full potential of operations can be utilized
B. Opportunity exists for creative methods and innovative idea.

LIMITATIONS:

a. Higher cost due to frequent set up changes
b. Production planning is complicated

2. **BATCH TECHNOLOGY:** It is suitable for a variety of products in varying volumes under this system the manufacturing is done in batches or lots on the basis of customers order or with a hope of continuous demand of a product.

CHARACTERISTICS:

a. When there is shorter production runs
b. Cost per unit is lower than job order products

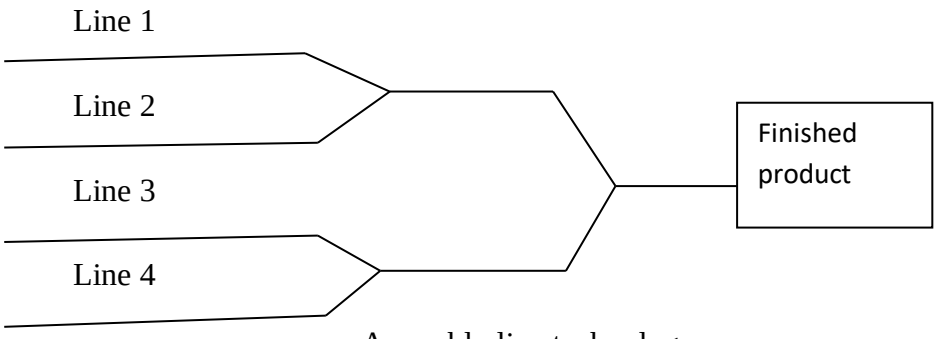
ADVANTAGES:

a. Better utilization of plant and machinery
b. Promotes functional specialization

LIMITATIONS:

a. Material handling is complex because of irregular and longer flows
b. Production planning and control is complex.

3. **ASSEMBLY LINE TECHNOLOGY:** It is suitable for a narrow range of standardized products in high volumes. It was developed in the automobiles industry in USA, here two or more components are combined to manufacture a finished product. Assembly line is particularly useful when a limited variety of similar products is to be product on a mass scale or in fairly large batches on a continuous basis.



Assembly line technology

4. **CONTINOUS FLOW TECHNOLOGY**: Production facilities are arrangement as per the sequence of production operations from the first operations to the finished product. The items are made to flow through the sequence of operations through materials handling devices such as conveyors, transfer devices etc. Example, oil refineries

5. **PROJECT TECHNOLOGY**: It is suitable for producing products that are tailor made to the unique requirements of each customer a general constructions company with its many kinds and sizes of projects is the best example of project technology.

6. COMPUTER AIDED DESIGN (CAD):

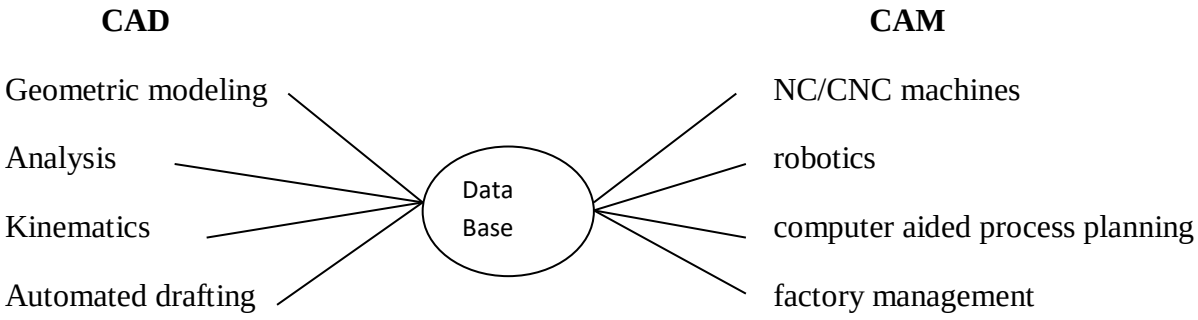
It is an electronic system using computers for designing new parts or products or modifying existing ones replacing the traditional drafting work done by a draftsman on a drafting board. CAD software have been developed designing electronic circuits, printed circuited board design, designing and drafting three dimensional drawings.

ADVANTAGES:

- Allows designers to save time and money by shortening design and developing cycle time...
- Eliminates manual drafting completely
- Allows designers to determine costs and test such variable as stress tolerance product variability interchangeability and serviceability
- Faster development better products and accurate flow of information to other departments.
- Product cost can be determined at the design stage itself.

6.1 COMPUTER AIDED DESIGN AND MANUFACTURING (CAD/CAM):

Computer Aided Manufacturing refers to the use of computer software to direct and control manufacturing equipment. When Computer Aided Design (CAD) information is translated into instructions for Computer Aided Manufacturing (CAM) the result of these two technologies is referred to as CAD/CAM system.



NC – numerical control

CNC – computer numerical control

ADVANTAGES OF CAD/CAM SYSTEMS:

1. **PRODUCT QUALITY:**CAD permits designers to investigate more alternatives and evaluate the designs from the point of view of potential problems and dangers.
2. **SHORTER DESIGN TIME:** A shorter design phase reduces costs and enables a faster response to the market.
3. **PRODUCTION COST REDUCTION:** Reduced inventory, better use of personnel through improved scheduling and faster implementation of design changes lower costs.
4. **DATA BASE AVAILABILITY:** Accurate database can be built up to provide the same information for use by all concerned.
5. **NEW RANGE POSSIBILITIES:** The ability to rotate three dimensional design drawings to check clearance to relate parts and attachments etc. will provide new capability to manufacturing.
6. **MINIMUM INVOLVEMENT OF DIRECT WORKERS:** Minimum involvement of direct labor/workers because CAD information is directly translated into instructions for automated production machines.

CASE STUDY

Question: The Service sector is gaining greater relevance these days. The production system, needs to be organized keeping in mind the peculiar requirements of the service components. Let us know how the Service sector is increasing on the production side instead of Technicians and Engineers.

Sol: The Production Management of today presents certain characteristics which make it look totally different from what it was during the past. Specifically, today's production system is characterized by four features:

1. Manufacturing as Competitive Advantage
2. Services Orientation
3. Disappearance of Smokestacks
4. Small has become Beautiful

The above scenario falls under the second category ' Services Orientation'

S.No.	Products	Services
1	Tangible	Intangible and Perishable; Consumed in the process of their production
2	Can be Produced to Inventory for 'Off the-Shelf' availability	Availability achieved by keeping the productive system open for services
3	Minimal contact with ultimate consumer	High contact with clients of customers
4	Complex and interrelated processing	Simple Processing
5	Demand on system variable on weekly, monthly and seasonable basis	Demand Commonly variable on hourly, daily and weekly basis

6	Markets served by production system are regional, national and international	Markets served by production system are usually local.
7	Large units that can take advantage of economies of scale	Relatively small units to serve local markets
8	Location of System is in relation to regional, national and international	Location, dependent on location of local customers, clients and users.

UNIT-1 IMPORTANT PREVIOUS QUESTIONS:

1. Explain about process and product design.

2 Briefly describe about CAD/CAM analysis.

3. Define 'production system'. What are the inputs of production system?

4. Explain historical development of POM & trends of POM today.

5. Explain the process of product design used in production and operations management.

6. What are the functions of POM?

SYLLABUS
(17E00206) OPERATIONS MANAGEMENT

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

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

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

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

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

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

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UNIT-2

FACILITIES MANAGEMENT & AGGREGATE PLANNING

1. FACILITY LOCATION/PLANT LOCATION

The selection of a place for locating a plant is one of the problems and most important which is faced by an entrepreneur while launching a new an enterprise.

1.1 DEFINITION

Plant location is the function of determining location for plant for maximum operating economy and effectiveness.

1.2 NEED FOR SELECTION OF LOCATION

- When the business is newly started
- The expansion of the existing unit is not possible hence a new location has to be found.
- When a company thinks that there is a possibility of reducing manufacturing cost by shifting from one location to another.
- Other social or economic reasons for instance in adequate labor supply shifting of market etc.

1.3 FACTORS REPONSIBLE FOR PLANT LOCATION CHOICE

(OR) FACTORS INFLUENCE PLANT LOCATION

1. **AVAILABILITY OF RAW MATERIAL:** Areas where industrial raw material is easily available obviously exists greater pull on location of industrial undertaking.
2. **PROXIMITY TO MARKET:** Since goods are produced for sale, it is very essential that the factory should be located near their market. A company that wants to reduce transportation cost locates near market customers-based services such as retailed stores, health care and restaurants must be located close to the market.
3. **AVAILABLE OF LABOUR:** Labour is an important of factor in the production of goods. An adequacy of labor supply at reasonable wages is very essential for the smooth and successful working of an organization.
4. **TYPE OF EQUIPMENT:** The use of single purpose and multipurpose machines substantially affect the plant layout. Similarly noisy and vibrating machines require special attention in the plant layout decision.
5. **TYPE OF BUILDING:** The plant layout in a single story building will be different from that in a multi-story building. The covered area, the number of story's elevators and stairs parking and storage area all affect the layout.
6. **AVAILABILITY OF FLOOR AREA:** The allocation of space for machines, work benches, sub-store etc. is made on the basis of the available floor area.

7. **ARRANGEMENTS OF MATERIAL HANDING EQUIPMENT:** It is necessary to provide adequate passage for free movement of material handling equipment such as hand truck etc.
8. **SERVICE FACILITIES:** The layout of factory must include proper service facilities required for the comfort and welfare of works. These include canteen, lockers drinking water, first aid etc.
9. **POSSIBILITY OF FUTURE EXPANSION:** Plant layout is made in the light of future requirements and installations of additional failures.

2. FACILITY LAYOUT/PLANT LAYOUT

2.1 MEANING & DEFINITION

Plant layout refers to the arrangements of machinery, equipment and other industrial facilities for achieving quicker and smooth production.

Planning and arranging manufacturing machinery, equipment and service for the first time in completely new plants and improvements in layout already in use in order to introduce new methods. - *KNOWLES & THOMSON*

2.2 OBJECTIVES OF A GOOD LAYOUT

- Provide enough production capacity
- Reduce material handling costs
- Reduce hazards to personnel (workers)
- Utilize labor efficiently
- Provide ease of supervision
- Improve productivity
- Utilize available space efficiently and effectively
- Reduce accidents

2.3 FACTORS INFLUENCING PLANT LAYOUT:

1. **MANAGEMENT POLICY:**
   Management policy significantly influence plant layout. The decisions regarding,
- The volume of production
- Extent of automation
- Make or buy decisions of a particular component
- Personnel policies

The layout engineer must have clear and complete understanding of top management policies.

2. **TYPE OR NATURE OF PRODUCT:**
   Types of product whether it is heavier or light, big or small, liquid or solid influence plant layout.
3. **MANUFACTURING PROCESS:**
   The type of manufacturing process will govern the type of plant layout one or a few standardized products can be produced through product layout while process layout is more useful for producing a large variety of non standardized products.
4. **TRANPORTATION FACILITIES:**
   - Speedy transport facilities ensure timely supply of raw material to the company and finished goods to the customers.
   - The transportation facility is a pre-requisite for the location of the plant.
   - There are five basic modes of physical transportation – air, road, rail, water and pipeline. Goods that are mainly intended for exports demand a location near to the seaport or argue airport will clearly depends on relative cost convenience and suitability.
5. **CIVIL AMENITIES FOR WORKERS:**
   Besides good working conditions inside the factory, the employees require certain facilities outside it. Recreation facilities such as clubs, theatres and parks must be provided for the employees, schools for their children. Availability of civil amenities for workers also play role in facility location.
6. **AVAILABLE OF SERVICE:**
   There are six main services which need to be considered – Gas, Electricity, Water, Drainage, Disposal of waste and Communication.
7. **SAFETY REQUIREMENTS:**
   Some production units may cause potential dangers to surrounding neighborhood. For example, nuclear power stations, chemical and explosive factories are often considered dangerous location of such plants in remote areas may desirable.
8. **POLITICAL, CULTURAL AND ECONOMIC SITUATIONS:**
   The political situation in potential locations should be considered. Even if other considerations demand a particular site, knowledge of the political, cultural, economic difficulties can assist in taking decisions.
9. **SPECIAL GRANTS REGIONAL TAXES:**
   In order to attract industries to particular locations certain government and local authorities often offer special grants, low interest loans, low taxes and other inducements.

2.4 TYPES OF FACILITIES LAYOUT:

1. **PRODUCT LAYOUT:**
   It involves the arrangement of machines in one line. The raw materials enter at one end and the final output will be at the other end. This type of Layout is used to achieve a smooth and rapid flow of large volumes of production.

Suitability: It is useful for

a. Mass Production of Standardized products
b. Simple and repetitive manufacturing process

2. **PROCESS LAYOUT:**

It is also called as functional layout or Job Shop Layout. In this Layout machines and services are grouped on a functional basis and operations of the same type are performed. This Layout will provide tremendous flexibility in sequence of operations.

Suitability: It is adopted when

a. Products are not standardized
b. Quantity produced is small
c. If there are frequent change in design and style of the product.

3. OPTIMIZATION OF PRODUCT LAYOUT

Optimization of product layout involves arranging the various manufacturing processes to fit the sequencing required by the product. They are

a.CYCLE TIME: The Cycle time is a vital factor. It is the time interval at which completed products leave the production line/assembly line.

$$\text{Cycle time} = \frac{\text{Available time per period}}{\text{Output units required per period}}$$

Example, suppose a factory is to process wooden doors. The number of doors to be processed is 160 per week and time available to process the doors is 40hrs per week.
In this case cycle time = 40/160 = 1/4hr = 15 min.

b.NUMBER OF STAGES: The next decision concerns the number of processing stages, where a producing stage is a distinct period of time to carry out part of the door manufacture or a good product manufacture. The larger the total work content and the smaller the required cycle time the more stage will be necessary.

$$\text{Number of stages} = \frac{\text{Total work content}}{\text{Required cycle time}}$$

c.TASK TIME VARIATIONS: Task time may not be equal for all stages of processing. This variation can make the flow along the line irregular which in turn can lead to work in progress. To overcome these additional resources like more staff time or more storage space is required to compensate this situation.

d.BALANCING WORK TIME ALLOCATION: Line of Balancing or Assembly Line Balancing is defined as the appointment or arranging of sequential work activities into work stations in order to gain a high utilization of labor and equipment and therefore minimized idle time. Balancing may be occurred by rearranging of work stations or by adding additional machines or workers in some of work stations so that all operations take same amount of time.

e. ARRANGING THE STAGES: All the stages do not have to be laid out in a sequential 'single line'. Some elements can usually be arranged in parallel. According to their requirement they can be in two parallel line or four parallel lines or single long thin line as the parallel lines increases the time taken will also be increased.

f.OPTIMISATION OF PROCESS LAYOUT: The problem in process layout is arranging the different work areas in such a way that the inter area material movement costs are kept to a minimum. A mathematical treatment for this problem is available. It is assumed at best the cost of layout should be reduced at optimizing procedure. The material handling costs between two work areas is as follows.

$= \text{minimize} \sum_{ij} d_{ij} \times L_{ij}$

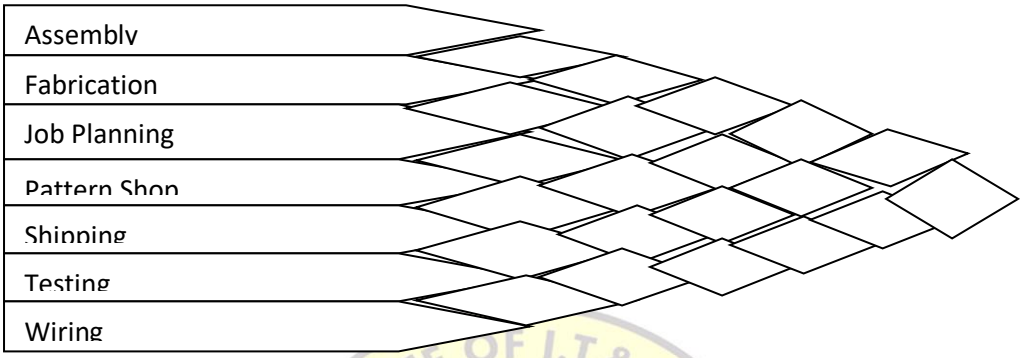
Where dij = distance between departments i and j

Lij = number of loads per unit time moved between department i and j

3.1 TECHNIQUES OF OPTIMISATION OF PROCESS LAYOUT

1. **TRAVEL CHART:** A travel chart as the name suggests, it is a chart of record of amount of travel of material in process from one machine to another. From a travel chart management can easily determine the optimum relative arrangement of various departments.
2. **BLOCK DIAGRAMMING:** A Block diagram is a specialized high level type of flow chart. A block diagram is a useful tool both in designing new processes and in improving existing processes.
3. **TEMPLATES:** Templates are most commonly used while preparing layouts. Templates are two dimensional or block templates consists of a thin plate of wood or metal which serves as a guide in mechanical work. The Template Method is particularly useful in developing a layout for an existing department.
4. **RELATIONSHIP DEPARTMENT:** Relationship diagramming is used in situations where quantitative data is difficult to obtain or do not adequately address the layout problem. RICHARD MUTHER developed a format known as MUTHUR's GRID. This method develops a chart known which rates the relative importance of locating one department close to another department. The importance ratings are indicated by code letters a, e, i, o, u, x is known as nearness code which indicate the following degree of importance.

Nearness code	Degree of Importance
A	Absolutely Necessary
E	Very Important or Essential
I	Important
O	Ok, Ordinary Importance
U	Unimportant
X	Undesirable



RICHERD MUTHER's half matrix for a process layout

4. FLEXIBLE MANUFACTURING SYSTEM (FMS): A Flexible Manufacturing System (FMS) is a configuration of a group of production machines connected by Automated Material Handling and transferring machines and integrated by computer system which can give instructions to produce hundreds of different parts in whatever order specified.

4.1 KEY COMPONENTS OF A FMS

- Several computers controlled machining centers or work stations having CNC (Computer Numerical Control) machines and robots for loading and unloading.
- Computer controlled transport system for moving material and parts from one machine to another and in and out of the system.
- Computer controlling robots for loading and unloading stations
- An automated storing and retrieval system

ADVANTAGES

- Improved capital utilization
- Lower direct labor cost
- Improved productivity

DISADVANTAGES

- High initial capital investment
- Limited ability to adapt to product changes

- Requires long planning and development cycle to install the FMS

5. GROUP TECHNOLOGY OR CELLULAR MANUFACTURING

In Cellular manufacturing, machines are grouped into cells and cells function somewhat like a product layout within a larger shop or process layout. Each cell in the CM layout is formed to produce a single parts family or a few parts all which has common characteristics and that they require the same machines and have similar machine settings. Overall performance offer increases and lowers production costs.

ADVANTAGES OF CELLUR MANUFACTURING

- Low work in progress inventories
- Reduced materials handling cost
- Simplified production planning

DISADVANTAGES

- Reduced manufacturing flexibility
- Potentially increased machine down time
- Finally duplicate piece of equipment may be needed so that parts need not be transported between cells.

6. AGGREGATE PLANNING: Aggregate planning is an operational activity which does an aggregate plan for the production process in advance of 2 to 18 months to give idea to the management that what quantity of materials and other resources area to be produced and when? So that the total cost of operations of the organization is kept to the minimum over that period.

6.1 OBJECTIVES

- To develop plans that are feasible and optimal
- To increase the range of alternatives of capacity use that can be considered by management of the firm

6.2 AGGREGATE PLANNING PROCESS

1. CONCEPT OF AGGREGATION: It starts with a meaning full measure of output. In a single product output organization there is no problem with the output measure. Many organizations have multiple products and it is difficult to find a common factor of measure of output.
2. GOALS FOR AGGREGATE PLANNING:

- It has to provide the overall levels of output inventory dictated by the business plan.
- Proper utilization of the plant capacity

- The aggregate plan should be consistent with the company's goals and policies regarding its employees.

3. AGGREGATE DEAMND FORECASTING: The benefits of aggregate planning depend on the accurate forecasting. The forecasting models can be used to forecast demand for product groups as well as individuals products.
4. INTER RELATIONSHIPS AMONG DECISIONS: The manager must consider the future consequences of current decisions.

7. PREPARATION OF AGGREGATE DEMAND FORECASTING:

7.1 MEANING AND DEFINITION: The benefits of aggregate planning depend on accurate forecasting. Forecasting of demand is the art of predicting demand for a product or a service at some future date.

7.2 METHODS OF DEMAND FORECASTING

1. **OPINION POLLING METHOD:** In this method opinions of buyers can be taken by sales force and experts to determine the emerging trend in the market. The opinion polling methods of demand forecasting are as follows.

A. **SURVEY METHODS:** Surveys are conducted to collect information about future purchase plans of probable buyers of the product. Survey methods used to forecast short run demand survey methods include:

a. **COMPLETE ENUMERATION SURVEY:** Under this method, the firm has to go for a door to door survey for collecting information by the contacting buyers.

b. **SAMPLE SURVEY OR TEST MARKETING:** Under this method, some customers are selected on random basis as samples and their opinion is taken as the generalized opinion.

B. **SALES FORCE OPINION METHOD:** In this method the opinion of sales force is taken as they are regularly in touch with the customers. Their opinion is taken as basic assumption for demand forecasts.

C. **DELPHI TECHNIQUE:** This is also known as expert's opinion method. In this method opinion, different experts are kept as basis for forecast.

2. **STATISTICAL METHODS:** Statistical methods are considering being superior techniques of demand estimation.

A. **TREND PROJECTION METHOD:** An existing firm can use its own data of past years regarding its sales and estimate future sales. These data are known as time series of sales. The trend can be used by the following method.

3. **GRAPHICAL METHOD**: A trend line can be fitted through a series graphically. The old volume of sales is plotted on a graph and a free hand curve is drawn through as many points as possible.

a. **MOVING AVERAGE METHOD:** Moving average of sales of the past years is computed. The computed moving average is taken as forecast for the next year. This is based on the assumption that future sales are the average of the past sales.
b. **REGRESSION METHOD:** This method is used to establish the relationship between quantity demanded and independent variables such as income price of the goods and price of related goods. Once the relationship is established we derive regression equation y = A+BX

8.SPECIFICATION OF ORGANISATION POLICIES FOR SMOOTHING CAPACITY UTILIZATION

MEANING OF CAPACITY

Capacity is the rate of productive capability of a facility. Capacity is usually expressed as volume of output per time period. Operations managers are concerned with capacity for several reasons.

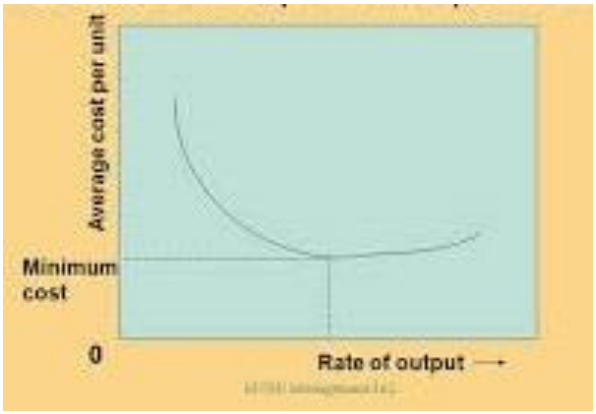
- They want sufficient capacity to meet customer demand in time.
- Capacity affects cost efficiency of operations the ease or difficult of scheduling output and the costs of maintaining the facility.

8.1 NEED FOR CAPACITY PLANNING

- To find the optimal capacity of the facility so that the sum of costs of under capacity and over capacity is the minimum.
- To keep the initial investment in the facility as long as possible to achieve lower break even volume.
- To satisfy the future demand of products without any shortages.

8.2 OPTIMAL CAPACITY DETERMINATION:

- For a given capacity of a plant the average unit cost of production of a product decreases as the output rate increases. This happens because fixed cost incurred in the plant, machinery, equipment etc. remains constant through changes in the volume of output. When a large numbers of units of the product is produced. These fixed costs get divided uniformly in the large number of units.
- When the rate of output is increased beyond a particular limit the average unit cost starts rising because of frequent breakdowns of machines scheduling problem etc. this particular limit of the output rate is called the optimum output rate.



- There is a relationship between the optimum output rate, minimum average cost of a product and the capacity of the plant. The minimum average unit cost of the product is low for small sized plant when compared to medium sized and large sized plants. Thus while determining the optimal capacity of a new facility three important factors have to be kept in mind. These are the demand forecast available capital and other resources and the minimum average unit cost desired to keep the competitors at bay.

9. CAPACITY UTILIZATION

Capacity utilization is the degree to which equipment space or labor is currently being used. It is expressed as a parent mathematically it can be expressed as under.

$$\text{Capacity utilization} = \frac{\text{Average output rate}}{\text{Minimum capacity}} \times 100\%$$

Utilization indicates the need for adding extra capacity or eliminating unneeded capacity. Maximum capacity includes:

a. **PEAK CAPACITY:** The maximum output that a process or facility can achieve under ideal conditions is called peak capacity. It can be sustained only for a short time viz, few hours a day or few days in a month. A process reaches it by using marginal methods of production such as excessive overtime, extra shifts, temporarily reduced maintenance activities, over shifts and subcontracting.
b. **EFFECTIVE CAPACITY:** The maximum output that process or firm can economically sustain under normal conditions is its effective capacity.

10. DETERMINATION OF FEASIBLE PRODUCTION ALTERNATIVES

In choosing or determining a feasible production processes several factors must be considered. Among these are:

1. **BATCH SIZE AND PRODUCT VARIETY:** The type of process design is appropriately depends on the number of product designs and the size of the batches to be produced in a production system. As the number of product designs increases and as the batch system becomes appropriate.
2. **CAPITAL REQUIREMENTS FOR PROCESS DESIGNS:** The amount of capital required for the production system depends on the type of production processing organization. It is the greatest for product focused dedicated systems and diminishes for product focused batch systems and cellular manufacturing systems and the least for process focused job shop production systems.
3. **ECONOMIC ANALYSIS OF PRODUCTION PROCESS:** Fixed and variable costs tend to differ from one form of production process to another. Economic analysis is used for comparing alternative processing plans for the produce of products. The important aspects of economic analysis is as follows:

a. **COST FUNCTION OF PROCESING ALTERNATIVES:** The amount of capital required for each type of process design tends to be different. Capital costs are fixed charges that occur every month. Both fixed costs and variable cost vary with the volume of products produced.

b. **OPERATING LEVERAGE:** Operating leverage is a measure of the relationship between a firm's annual sales. If a high percentage of a firms total costs are fixed then the firm is said to have a high degree of operating leverage. Where there is a substantial amount of uncertainty about the forecast of number of products to be produced then process designs with lower levels of operating leverage tend to be preferred.

c. **BREAK EVEN ANALYSIS:** Break even analysis is based on the fundamental model of economic theory which states that profits arise from the excess of total revenue over total costs. Total costs are composed of total fixed costs and total variable costs.
Profit = Total Revenue (TR) – Total Cost (TC)
Profit = Total Revenue (TR) – (Fixed Cost (FC) + Total Variable Costs (TVC)
Breakeven point is a point where no profit no loss
Total costs = Total Revenue

d. **FINANCIAL ANALYSIS:** Financial Analysis involves methods such as Payback period, Net Present Value, Internal Rate of Return.

CASE STUDY-1

Question. 1

(**a) Suppose a factory is to process wooden doors. The number of doors to be processed is 160 per week and the time available to process the doors is 40 hours per week.**

(b) Suppose the factory calculated that the average work content to manufacture a wooden door is 60 minutes. The number of stages needed to process a wooden door every 15 minutes.

From the following two examples, list out how the Optimization of Product Layout decisions are made

Ans. Optimization of Product Layout involves arranging the various manufacturing processes to fit the sequence required by the product. The decisions to be made are:

(1) What Cycle time is needed?

(a) In this case, Cycle Time (CT) = Average time per period/ Output Units required per period = 40/160 = 15 Minutes. Therefore, the factory layout must be capable of processing one completed wooden door every 15 minutes.

(2) How many processing stages are needed?

(b) Number of Stages = Total Work Content/ Required cycle Time = 60/15 = 4 Stages.

If this number had not been a whole number, then it would have been necessary to round up to the next largest whole number, since it is difficult to hire fraction of people to staff the stages.

(3) How should variation in time taken for different tasks be dealt with

Each stage might on an average take 15 minutes, but this time would vary for each door processed because: Products being processed along the line might be a little different, Products might require slightly different treatment or Products usually have slight variations in the physical coordination and effort of the person or the performance of the machine.

(4) How should the layout be balanced?

Line Balancing or Assembly Line Balancing is arranging a production line so that, there is an even flow of production from one work station to another, so that there are no delays at any work station that will leave it idle for any time being.

(5) How should the stages be arranged.

All the stages do not have to be laid out in sequential single line. Some are usually arranged in parallel. These stages can be arranged in one line of four, 15 minute sequence steps or in two parallel lines of each of two, 30 minute stages or in four parallel lines of single, 60 minutes stages, etc.

CASE STUDY-2

Q.2. A decision has to be made to arrange the layout of a factory, either by grouping similar types of machines together in a separate sections or by arranging them in sequence for line production. Give the factors you would consider in order to arrive at a

decision and State the advantages and Disadvantages of the Product/Sequential method of layout

Ans. Factors considered for Facility/Plant Layout Decision
1. Product and Material Specification
2. Location and Site of the Plant
3. Manufacturing Process
4. Material Handling
5. Storage of In-Process Inventory
6. Plant Personnel and Employee facilities
7. Service Facilities
8. Design of Building
9. Flexibility
10. Work Areas and Equipments
11. Working Conditions
12. Disposal of Waste and Dangerous Gases

Advantages of Product/Sequential Method of Layout:
1. Regulation of Production
2. Scientific Materials Handling
3. No Bottlenecks in production
4. Speedier Production
5. Lesser Supervision
6. Greater possibility of Space Utilization

Disadvantages of Product/Sequential Method of Layout:
1. Heavy Capital Expenditure
2. High Overhead Charges
3. Breakdown
4. Inflexibility
5. Additional Output not possible
6. Lack of Specialized Supervisors

UNIT-2- IMPORTANT PREVIOUS QUESTIONS:

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

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

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

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

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

6. Explain about flexible manufacturing and group technology.

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

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UNIT-3

SCHEDULING

1. SCHEDULING IN JOB:

1.1 MEANING AND DEFINITION OF SCHEDULING

It is actually time phasing of loading. In production control, scheduling means arrangement of different operations involved in manufacturing in order of priority, fixing the time and date when each operation is to be commenced and completed.
According to JAMES L. LUNDY, "Work Scheduling consists of the assignment of starting and completion time for the various operations to be performed".

1.2 OBJECTIVES OF SCHEDULING

1. **CUSTOMER SATISFACTION:** Customer satisfaction is one of the most important objectives of scheduling. Scheduling establishes the date of completion of job and compels the shop floor control to ensure that the finished product is returned to the control of the planning system as per plans. Adhering to the committed delivery date of the order is in fact an important factor in customer satisfaction.
2. **OPTIMIZATION OF COST:** Early or late completion of jobs exposes the organization to significant costs. Completion of job prior to scheduled dates results in increased stock of finished goods or work in progress inventory. This increases the cost and also generates more waste on the other hand, late completion of the job result in idling of machines waiting for the next activity in the transformation process. Waiting for the next activity in the transformation process causes ineffective utilization of machine and man power.
3. **INCREASE IN EFFICIENCY:** Schedules promote overall efficiency on the shop floor. One of the ways to achieve this is to group together the orders with similar components, requirements, activities and set up.
4. **REDUCED VARIANCES IN THE TRANSFORMATION PROCESS:** Transformation process faces number of variances during plant operation. Scheduling of operations and activities remove the over loading and make the transformation process smooth and productive.
5. **EMPLOYEE FOCUS IN SCHEDULING:** Employee plays a key role in scheduling the capacity and capability of the employees determine the time of completion of the job.

1.3 FUNCTIONS OF SCHEDULING

- Operations scheduling deals with the technical constraints directly related to production and serve the following functions
- Allocating orders or jobs to work centers (loading or assignment problem)

- Specifying the sequence in which jobs are processed at the work center (sequence problem)
- Initiating work at the work centers (dispatching problem)
- Monitoring and controlling the progress of jobs and adjusting schedules

1.4 TYPES OF SCHEDULING

The pattern of scheduling differs from one job to another which is explained as below.

1. **PRODUCTION SCHEDULE:** The main aim is to schedule that amount of work which can easily be handled by plant and equipment without interference. It is not independent decision as it takes into account following factors:
- Physical plant facilities of the type required to process the material being scheduled.
- Personnel who possess the derived skills and experience to operate the equipment.
- Necessary materials and purchased parts.
2. **MASTER SCHEDULE:** Scheduling usually starts with preparation of master schedule which is weekly or monthly breakdown of the production requirement for each product. A master schedule is followed by operator schedule which fixes total time required to do a piece of work with a given machine (or) which shows the time required to do each detailed operation of a given job with a given machine (or) process.
3. **MANUFACTURING SCHEDULE:** It is prepared on the basis of type of manufacturing process involved. It is very useful where single or few products are manufactured repeatedly at regular intervals.

   Thus, it would show the required quality of each product and sequence in which the same to be operated.
4. **PARTS SCHEDULING:** Parts schedule gives the number of units of different parts to be produced for the given product. This schedule is prepared for a month.
5. **MACHINE LOADING SCHEDULE:** Machine loading schedule is the process of allocating work load for various machines. It is a time table for the working of various machines.
6. **SCHEDULING OF JOB ORDER MANUFACTURING:** Scheduling acquires greater importance in Job Order manufacturing. This will enable the speedy execution of job at each center point.

1.5 PRINCIPLES OF SCHEDULING:

1. **PRINCIPLE OF OPTIMUM TASK SIZE:** The first principle has a tendency when applied, not only give good results but also to be self-correcting if it is ignored. This principle only repeats the know advantage of maintaining a high rate of stock turnover and of single phase ordering.
2. **PRINCIPLE OF THE OPTIMUM PRODUCTION PLAN:** The second principle merely states that the obvious fact that there will be less idle time and waiting time, if

all the plant is evenly loaded by the production planners. Scheduling tends to achieve its maximum efficiency when the work is planned, so that it imposes an equal/ even load on all the plant.

3. **PRINCIPLE OF THE OPTIMUM OPERATION SEQUENCE:**The Third principle says about Principle of Flow. Sometimes it is also true if we sequence some jobs, which need the same machine set-up, at a time, this avoids machine ancillary time needed, in-case, the jobs of the above type are done at different times.

For Example; Consider drilling a 10mm hole in five different jobs may be done at a time so that the set-up time required for 5 jobs independently at different time are avoided. Scheduling tends to achieve its maximum efficiency when the work is planned so that the work centers are normally used in the same sequence.

1.6 TECHNIQUES OF SCHEDULING:

Techniques used for Scheduling are as follows:

1. **GANTT CHARTS:** The Gantt chart is actually a modified bar chart in which horizontal bars are drawn for each activity in proportion to the time required for completing it. A customer attached to the Gantt chart can be moved across the chart to compare between the actual progress and planned work till any particular date. Gantt charts are useful for tracking job loading, they do not have the sophistication to help management determine what job order priorities should be.
2. **QUEUING ANALYSIS:** Queuing analysis involves the study of waiting lines and queuing systems. A queue refers to customers or units waiting for service. When the rate of arrival of customers exceeds the services rate, a queue is formed. As a result, customers or units have to wait to receive the service.
3. **CRITICAL RATIO METHOD:** The critical ratio method is a job-sequencing technique that an operations manager can use to verify whether a job is being operated on schedule. In this method, the operations manager calculates the critical ratio of a job, which is the ratio of the actual time remaining to complete the job and the scheduled time remaining to complete the job.

$$\text{Critical Ratio} = \frac{\text{Actual time remaining}}{\text{Scheduling time remaining}}$$

4. **JOB SEQUENCING RULES:** Sequencing is a process that determines the priorities job orders should have in the manufacturing process. Sequencing results in priority rules for job orders.

1.7 SCHEDULING IN JOB SHOP TYPE PRODUCTION:

- ✓ Operations scheduling is the organization function of an operations manager. This function of the operations manager is most important in job-shop processing.
- ✓ This is because in job-shop processing the variety of items is large, the number of items to be produced in a batch is usually less, and the machines and workers are versatile .
- ✓ Perform different types of jobs. In continuous and semi-continuous production processes (such as assembly lines),
- ✓ scheduling is automatically done at the time of designing the facility, as the product has almost no variety and the production volumes are very large.
- ✓ In the absence of scheduling, the overall set-up time increases. All these problems (higher waiting/ordering time, higher set-up time etc.,) result in a high average completion time of each job order.

1.8 ACTIVITIES IN SCHEDULING JOB SHOPS:

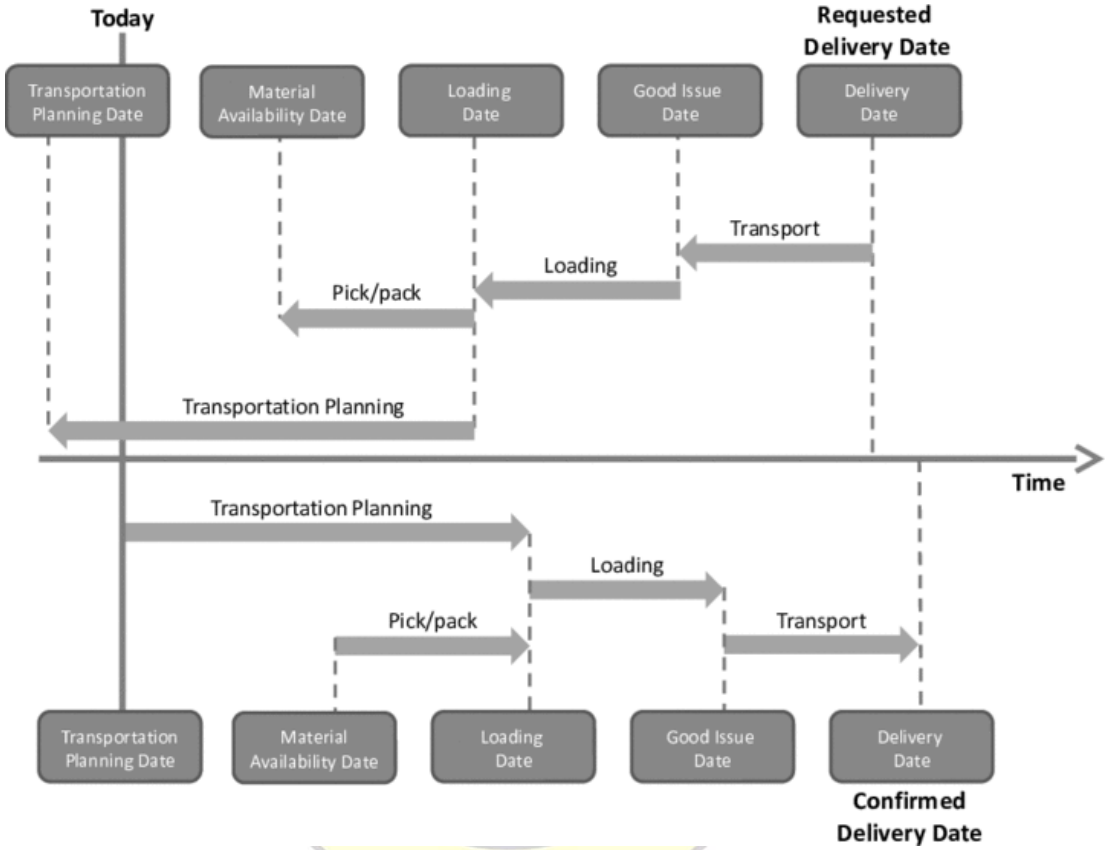
Operations scheduling in job shops involves the following activities:
i. Assigning job orders to different machines (or work centers).
ii. Deciding the sequence of processing on different machines on the basis of some priority rule (called sequencing or prioritization)
iii. Planning the route of movement of materials from one department to another during processing (called Routing)
iv. Issuing dispatch lists to the various work centers containing information about the work centers. A customer's order to be processed first, the amount of time the processing should take, and so on (called dispatching)
v. Tracking the progress of various scheduled jobs and implementation of schedules, revising the schedules in case of delays, and expediting the completion of certain jobs (called expediting)

1.9 SCHEDULING TECHNIQUES FOR JOB SHOP:

This type of Scheduling Technique used in job shop depends on the volume of orders, the nature of operations and the job complexity. Two types of Scheduling Techniques used are:

1. **FORWARD SCHEDULING:**
   Forward scheduling means assigning customer orders or jobs to various work centers based on the **'as early as possible'** approach. Thus, a job is scheduled at work center as soon as it is free to process a job. The job is then finished as soon as possible. This approach is based on the assumption that a customer is ready to receive the goods as soon as these are produced, usually not able to meet the schedule.

2. **BACKWARD SCHEDULING:**
   Backward scheduling is another way of scheduling, which is based on the **'as late as possible'** approach, with the condition that the jobs are finished by their due dates for delivery to the customer. Thus, the planning process starts with assigning the job to the last work center in the processing sequence.



3. **SHOP-LOADING:**
   Shop-loading is the process of determining which work center receives which job. It involves assigning a job to a particular work center to be performed during a scheduled period. Loading procedures are categorized as either finite loading (or) infinite loading.

A. INFINITE LOADING:

Infinite loading indicates the actual released order demand (load) on the work center, so as to facilitate decision about using alternative routings and delaying selected orders.

1.10 METHODS OF EVALUATING INFINITE LOADING:

Following methods can be helpful in evaluating the current loading;

1. **GANTT LOAD CHART:**

The Gantt chart was developed by Henry L Gantt about a century ago. Their purpose is to provide an immediate comparison between schedule and reality (i.e., between planned work and actual progress of the work).

The Gantt chart is actually a modified bar chart in which horizontal bars are drawn for each activity in proportion to the time required for completing it. A cursor attached to the Gantt chart can be moved across the chart to compare between the actual progress and planned work till any particular date.

There are basically two types of Gantt charts;

a. **WORK LOAD CHARTS:**

They are used to illustrate work load levels for equipment, work centers or departments. The vertical axis of the chart represents the machines or any other facilities used to manufacture or process the job orders. The horizontal axis of the chart represents the time taken.

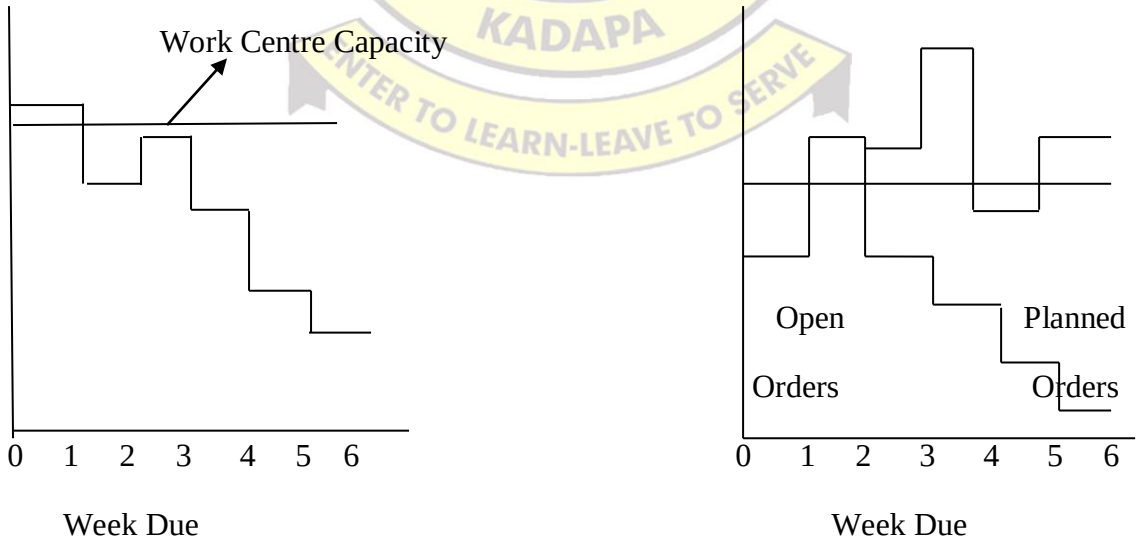
b. **SCHEDULING CHARTS:**

These charts depict the progress of the jobs as they pass through various work centers. They are useful when a particular job requires the use of several machines.

2. **VISUAL LOAD PROFILES:**

Since infinite loading ignores the capacity of the work center, the work center can be under loaded or over loaded. A visual load profile, like these shown in below, compares the load and the capacity.

(a) For Manual System (b) For Computer based System



In a computer- based scheduling system, part (b) of the figure, the load consists of open orders and planned orders, prospective orders from customers we see that loads for weeks 3, 4 and 6 exceed capacity, even though loads for the open orders are feasible.

3. **ASSIGNMENT ALGORITHM**:

Occasionally, linear programming can be useful for solving loading problems; managers often have choices about which jobs should be assigned to which work center. The assignment algorithm is useful for solving these loading problems.

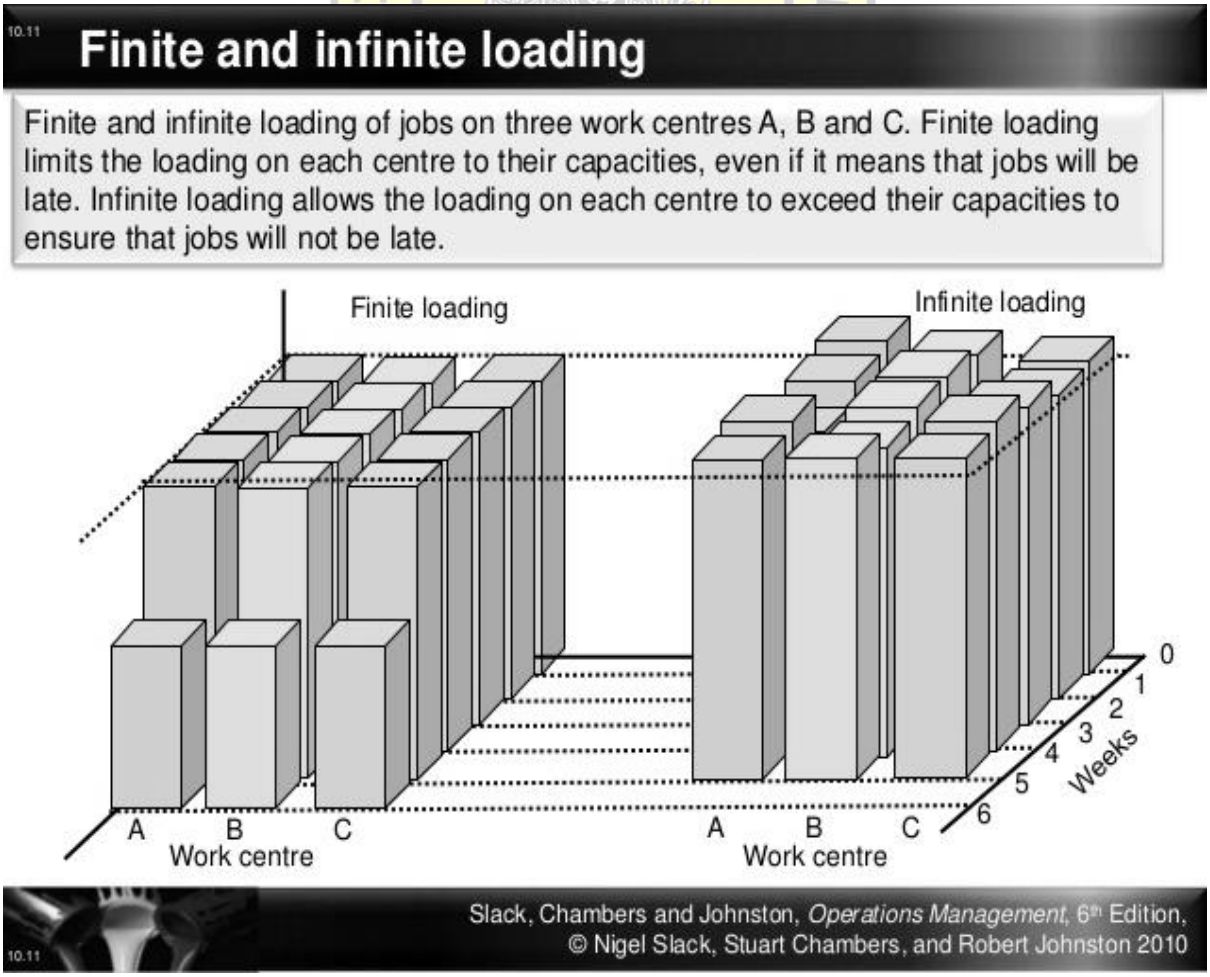
B. **FINITE LOADING**

Finite loading is an alternative scheduling technique that combines into a single system the loading sequencing and detailed scheduling. In contrast to infinite loading finite loading systems start with a specified capacity for each work centre and list of jobs.

This system creates a detailed scheduled for each job and each work centre based on the centers capacities. Jobs are allocated to the centers according to their capacities hour by hour and day by day into the future.

USING FINITE VERSUS INFINITE LOADING

Finite loading has some drawbacks that lead its critics to conclude that it is an inappropriate control technique. Its schedules often become obsolete from unanticipated materials delays and inaccurate processing time estimates. Consequently the finite loading simulation has to be rerun (update) frequently and these runs cost much more than sequencing by priority rules for infinite loading systems advocates of finite loading however claim they get more accurate capacity load estimates for the very short term the next few days than they get from the infinite loading.



2. ASSIGNMENT PROBLEM

As assignment problem is one that involves the assignment of different facilities to different tasks for instance we have three men available and three jobs to be done. Each man is capable of doing any job but due to either individual it takes them different amount of time to do each job. The problem is how to assign the men to the jobs in such a way so as to minimize the total time spent on the jobs. This is an example of assignment problem. This problem can be structured in the transportation frame work with the men being the supply sources the jobs the destinations and costs the item is takes man to perform job J.

2.1 SOLUTION METHODS OF ASSIGNMENT PROBLEM

An assignment problem cans be solved by the following four methods

1. **ENUMERATION METHOD:** In this method a list of all possible assignments among the given resources (Men, Machines etc) and activities (jobs, sales, areas etc) is prepared. If two or more assignments have the same minimum costs, time of distance or maximum profit, then the problem has multiple optimal solution.
2. **SIMPLEX METHOD:** Since each assignment problem can be formulated as an 0 or 1 integer linear programming problem such a problem can also be solved by the simple method. As can be seen in the general mathematical formulation of the assignment problem there are mix decision variables and n + n or 2n equalities.
3. **TRANSPORTATION METHOD:** Since an assignment problem is special case of the transportation problem it can also be solved by transportation methods. Discussed earlier however every basic feasible solution of a general assignment problem having a square pay off matrix of order n should have m+n-1 = n+n-1 = 2n-1 assignments
4. **HUNGARIAN ASSIGNMENT METHOD (HAM):** A method designed specially to handle the assignment problems in an efficient way called the Hungarian assignment method is available which is based on the concept of opportunity cost.
   The Hungarian method successively modifies the rows and columns of the effectiveness matrix until there is at least one zero component is each row and column such and a complete assignment corresponding to these zeros can be made.

3. SEQUENCING

3.1 MEANING OF SEQUENCING: Sequencing is the arrangement of the tasks required to be carried out sequentially. Sequencing problem arise when we are concerned with situations where is a choice as to the order with situations where is a choice as to the order in which a number of tracks can be performed.

The two techniques called priority rules and JOHNSON's rule are used in job sequencing.

1. **PRIORITY RULES:** The basic function of priority rules to provide direction for developing the sequencing in which jobs should be performed. This assist management in ranking job loading decisions for manufacturing centers.

2. **JOHNSON'S RULES:** JOHNSON's rule provides an optimum prioritization based on minimum processing time when N jobs have to be sequentially processed in two production centers. The net results of utilization JOHNSON's rule is a minimization of total idle time at a production center.

3.2 TERMINOLOGY FOR SEQUENCING

Following are the terms which are used in sequencing

1. **NUMBER OF MACHINES:** The number of machines refers to the number of service facilities through which a job must pass before it is assumed to be completed.
2. **PROCESSING TIME:** It is the time required by a job on each machine
3. **PROCESSING ORDER:** It refers to the order sequence in which given machines are required for completing the job.
4. **IDLE TIME ON A MACHINE:** It is the time for which a machine does not have not has a job to process i.e. idle times from the end of job to the start of job.
5. **TOTAL ELAPSED TIME:** It is the time interval between starting first job and completing the last job including the idle time in a particular order by the given set of machines.
6. **NO PASSING RULE:** It refers to the rule of maintaining the order in which jobs are to be processed on given machines. For example if n jobs are to be processed on two machines m1 and m2 in the m1m2 each job should go to machine m1 first and then to m2.

3.3 ASSUMPTIONS OF SEQUENCING

The assumptions behind solving a sequencing problem are as follows.

- The processing times on different machines are exactly known and are independent of the order of the jobs in which they are to be processed.
- The time taken by the jobs in moving from one machine to another is negligible.
- Once a job has begun on machine it must be completed before another job can begin on the same machine.
- All jobs are known and all ready for processing before the period under consideration begins
- Only one job can be processed on a given machine at a time.
- Machines to be used are of different types
- The orders of completion of job are independent of the sequences of jobs.

3.4 OBJECTIVES OF SEQUENCING:-

The Objectives of appropriate sequencing are:-

1. The completing by the due date or with as little delay as possible, as many work orders as possible. This has three components:
   - Completing
   - On-Time and
   - Minimum delay which could be average or a range of delay
2. Utilizing the machinery and such other capital investment to the maximum extent possible.
3. Utilizing the machinery man-power capacity to the maximum extent possible
4. Minimizing the man-power capacity to the maximum extent possible.

3.5 SEQUENCING N JOBS ON ONE MACHINE

In sequencing 'n' jobs on one machine the processing time of each job and their due dates of delivery are required. A priority rule is then decided upon in order to sequences the various jobs accordingly.

3.6 CHOOSING THE RIGHT SEQUENCE RULE

The various criteria for choosing the right sequencing are as follows.

- Set up costs
- In- process inventory costs
- Idle time
- Number (or) percent of jobs that are late
- Average time jobs are late
- Standard deviation of time jobs are late
- Average number of jobs waiting in the queue
- Average time to complete a job
- Standard deviation of time to complete a job.

3.7 SEQUENCING N JOBS ON 2 MACHINES: In sequencing n jobs on two machines the processing order of all the jobs on the two machines is always the same. The following information is available

- Only two machines A and B are involved.
- Each job is to be processed in the order AB so that first the work would be performed on machine A and then on machine B.
- The processing times for different jobs on first machine A1, A2 … An are given and so are processing times on the second machine B1, B2, ….Bn.
- The objective is to determine the sequence in which the jobs should be performed so that the total time taken known as the elapsed time is the minimum.

3.8 SEQUENCING N JOBS ON 3 MACHINES:

There is no solution available except enumeration of course for the general sequencing problems of n jobs through 3 machines. However we do have a method under the circumstance that no passing of jobs is permissible that it to say the same order over each machine is maintained and if either or both the following condition is are satisfied.

- The minimum time on machine A is greater than or equal to maximum time and machine B.
- The minimum time on machine C is greater than or equal to the maximum time on machine B.

CASE STUDY-1

Q. The Seven activities and estimated duration of a small project are shown in the table below:

Activity (i-j)	Estimated Duration (Weeks)		
	Optimistic Time (to)	Most Likely Time (tm)	Pessimistic Time (Tp)
1- 2	1	1	7
1-3	1	4	7
1-4	2	2	8
2-5	1	1	1
3-5	2	5	14
4-6	2	5	8
5-6	3	6	15

1. Construct the network diagram of the activities for the project

2. Determine the expected duration and variance for every activity. Also calculate the expected project length

3. Calculate the Standard Deviation and variance of the project length.

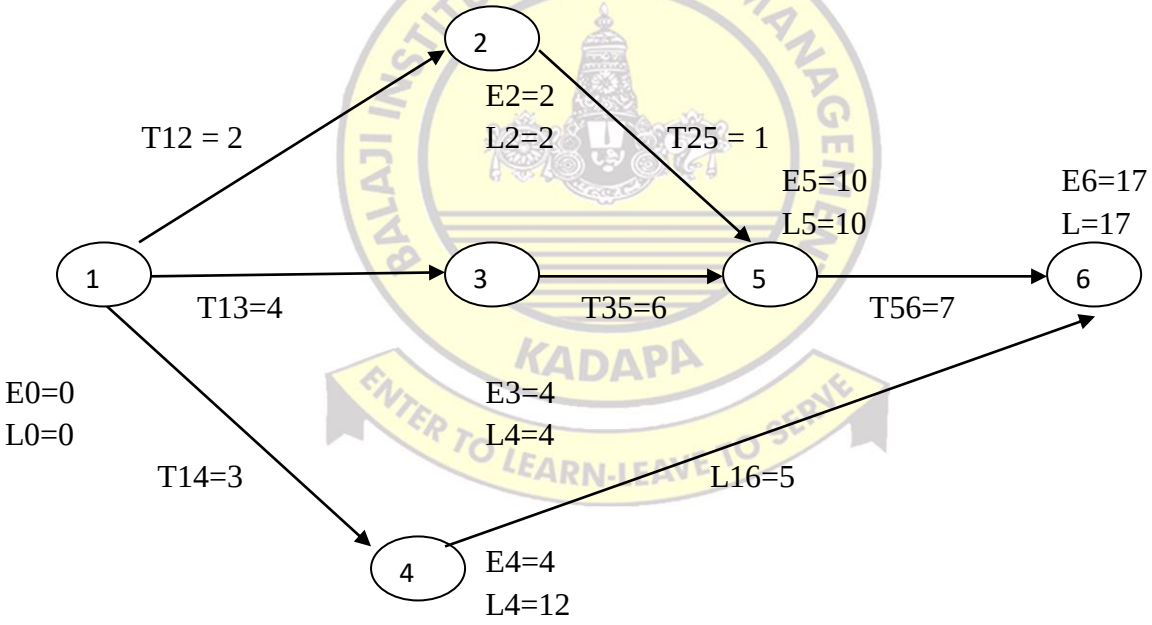
Determine the probability of the project that it will be finished minimum four weeks before than the expected time.

Z	0.67	1.00	1.33	2.00
Probability	0.2514	0.1587	0.0918	0.0228

Ans. Using the value of the to, tm and tp, the expected time (te) and variance (S.D.)2 for each activity can be determined as shown in table below:

Activity	Time Duration (Weeks)			Te = to+4tm+tp/6	S.D.2 = (tp-to/6)2
1-2	1	1	7	2	1
1-3	1	4	7	4	1
1-4	2	2	8	3	1
2-5	1	1	1	1	0
3-5	2	5	14	6	4
4-6	2	5	8	5	1
5-6	3	6	15	7	4

The figure shows the network diagram drawn for the project.



NETWORK DIAGRAM

Table below illustrates the expected duration and variances of each activity. The expected project length can be calculated as given below:

Possible Paths	Path Length
1-2-5-6	1-2-5-6 = 2+1+7 = 10 Weeks
1-3-5-6	1-3-5-6 = 4+6+7 = 17 Weeks
1-4-6	1-4-6 = 3+5 = 8 Weeks

From above paths, we get the critical path 1 -3 -5 -6 and expected project length equal to 17 weeks.

Since the sum of variances of activities on critical path shows the variance of the project length. Thus, using values from table above, we get variance, $\sigma^2 = 1 + 4 + 4 = 9$ days. Now Standard Deviation (S.D.) for the project is equal to 3 weeks. The probability of project so that it will be finished minimum four weeks before the expected time can be calculated as follows:

$$P(x < 13) = P\left[Z < \frac{Te - Ts}{\sigma_e}\right] \quad P\left[Z < \frac{13-17}{3}\right] \quad P(Z < -1.33)$$

$$= 1 - 0.9082 = 0.0918$$

UNIT-3 IMPORTANT PREVIOUS QUESTIONS:

1. Explain the advantages and disadvantages of different types of production.
2. Explain the methods of production control.
3. Explain any three rules used for production scheduling with examples.
4. Find the optimal sequence, total elapsed time for processing the following seven jobs.

JOB	A	B	C	D	E	F	G
MACHINE 1	9	5	8	3	4	1	7
MACHINE 2	2	4	10	5	6	11	6

5. Determine the best sequence, idle time of the machines and total completion for the following jobs.

JOB	A	B	C	D	E
MACHINE 1	8	10	13	11	13
MACHINE 2	4	6	9	7	10

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