BALAJI INSTITUTE OF I.T AND MANAGEMENT KADAPA

OPERATIONS MANAGEMENT (17E00206)

ICET CODE: BIMK

1st Internal Exam Syllabus

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Name of the Faculty: Dr. G. SARIKA

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

E-Mail Id : sarika.management14@gmail.com

SYLLABUS

(17E00206) OPERATIONS MANAGEMENT

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

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

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

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

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

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

Text Books:

Production and Operations Management, Aswathappa K - Himalaya Publishing House

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

References:

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

UNIT - 1
INTRODUCTION

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

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

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

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

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

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

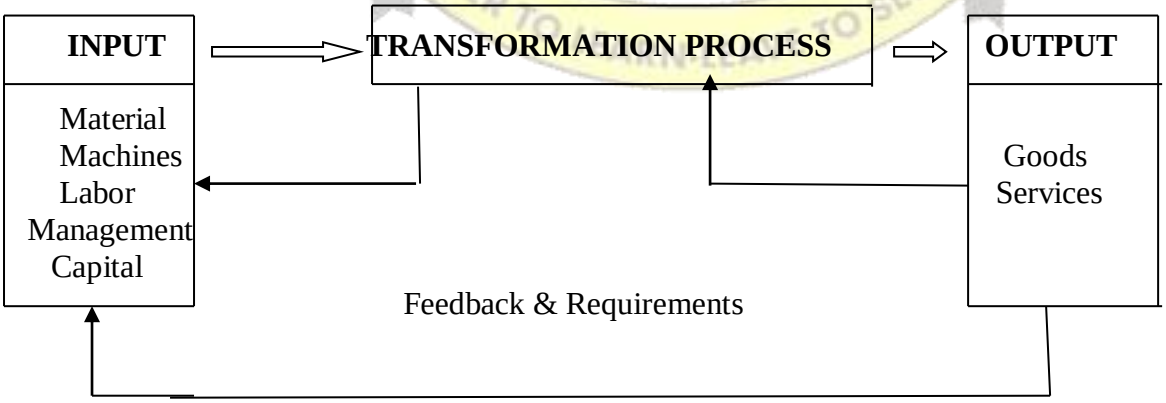

Fig:1.1.Transformation process

DIFFERENCE BETWEEN OPERATIONS AND PRODUCTION

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

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

Examples: (Products/goods)

Boiler with a specific capacity,

Constructing flats,

Car, bus, radio & television.

Examples: (Services)

Medical facilities,

Travel booking services.

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

PRODUCTIVITY

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

Productivity = Output/Input

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

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

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

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

Functions or departments in business „

Three primary functions:

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

FUNCTIONS OF PRODUCTION MANAGEMENT

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

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

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

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

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

1.2. HISTORICAL SUMMARY OF OPERATIONS MANAGEMENT

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

THE HISTORICAL EVOLUTION OF PRODUCTION/OPERATIONS MANAGEMENT

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

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

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

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

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

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

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

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

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

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

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

1.3. POM SCENARIO TODAY

TECHNOLOGY BASED

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

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

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

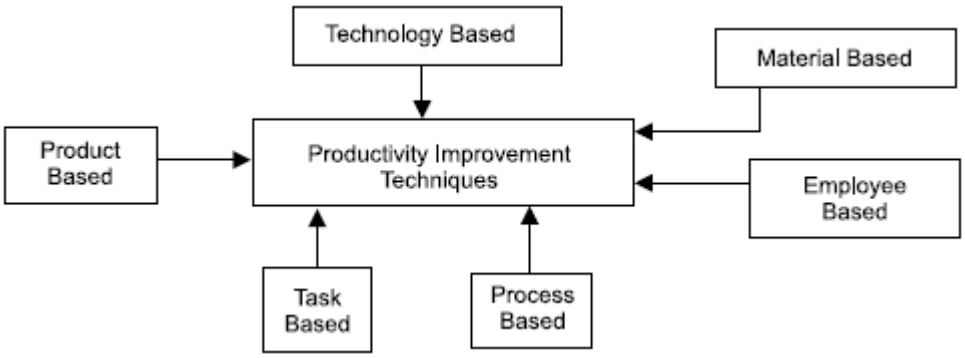

Fig: 1.2. Production process

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

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

2. **COMPUTER INTEGRATED MANUFACTURING:**

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

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

EMPLOYEE BASED

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

ATERAL BASED

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

PROCESS BASED

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

PRODUCT BASED

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

B.

TASK BASED

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

PROCESS-FOCUSED AND PRODUCT-FOCUSED SYSTEM:

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

COMPARISON OF PROCESS ORIENTED LAYOUT AND PRODUCT ORIENTED LAYOUT.

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

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

1.4. PRODUCT AND PROCESS DESIGN

PRODUCT DESIGN

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

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

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

1.5. PRODUCT AND PRODUCT DEVELOPMENT

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

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

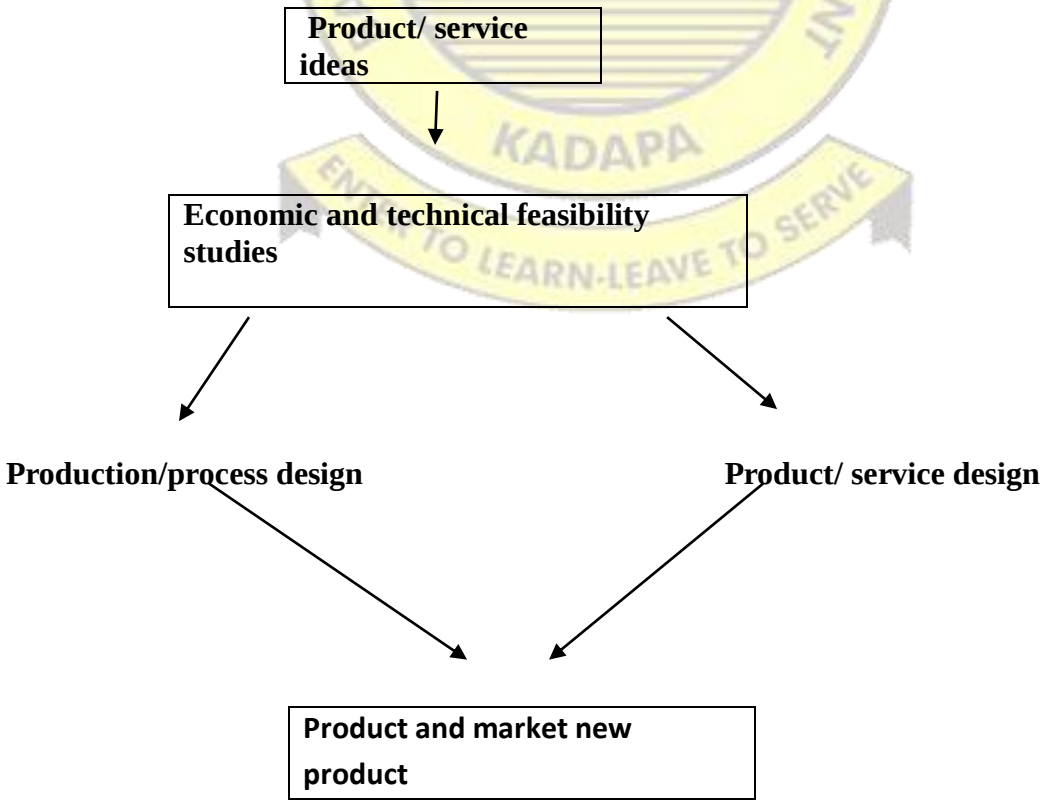

Fig:1.3. Product Development Process

1.6. MANUFACTURING PROCESS TECHNOLOGY

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

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

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

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

1.7. CAD/CAM ANALYSIS

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

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

Computer + Designing software =CAD

Advantages of CAD

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

Disadvantages of CAD

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

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

Manufacturing Tools + Computer = CAM

Advantages of CAM

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

Disadvantages of CAM

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

UNIT-1

IMPORTANT PREVIOUS QUESTIONS:

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

PREPARED BY;

Dr.SARIKA.G
PRINCIPAL
BALAJI INSTITUTE OF IT & MANAGEMENT
KADAPA.


BALAJI INSTITUTE OF I.T.& MANAGEMENT
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ENTER TO LEARN-LEAVE TO SERVE

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UNIT-2

FACILITIES MANAGEMENT & AGGREGATE PLANNING

2.1. LOCATION OF FACILITY

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

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

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

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

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

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

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

2.2. LAYOUT OF FACILITY

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

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

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

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

FACTORS AFFECTING FACILITY LAYOUT

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

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

DESIGN OF FACILITY LAYOUT

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

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

DESIGN LAYOUT TECHNIQUES

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

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

TYPES OF FACILITY LAYOUT

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

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

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

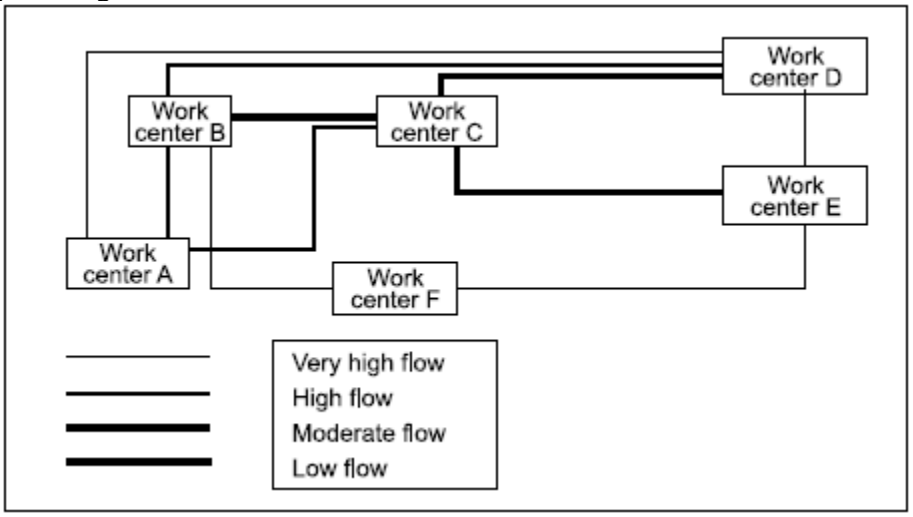
1. List and describe each functional work centre.
2. Obtain a drawing and description of the facility being designed.
3. Identify and estimate the amount of material and personnel flow among work centers
4. Use structured analytical methods to obtain a good general layout.
5. Evaluate and modify the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

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

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

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

Relationship flow diagram



2.3. OPTIMIZATION OF PRODUCT/PROCESS LAYOUT

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

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

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

Process layout

ADVANTAGES

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

LIMITATIONS

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

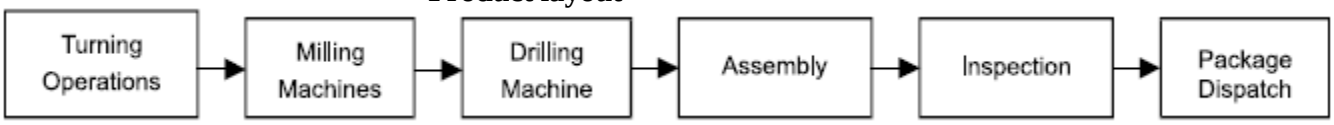
3. Process time is prolonged which reduce the inventory turnover and increases the in- process inventory.
4. Lowered productivity due to number of set-ups.
5. Throughput (time gap between in and out in the process) time is longer.
6. Space and capital are tied up by work-in-process.

PRODUCTLAYOUT:

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

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

Product layout



Advantages

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

LIMITATIONS

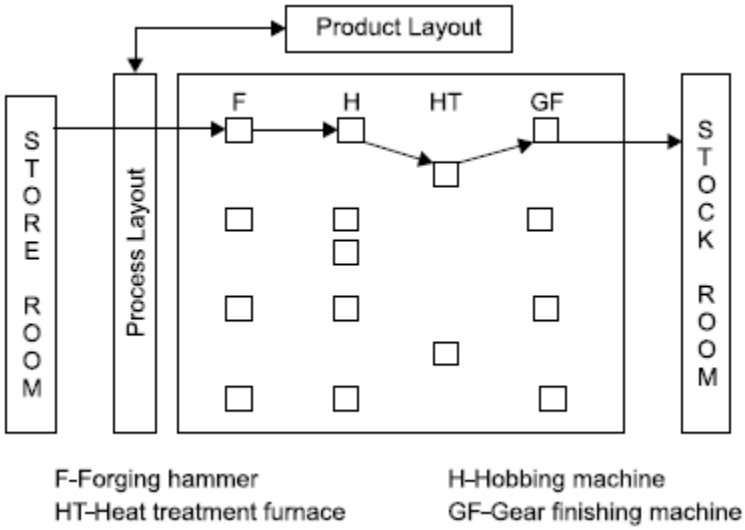
1. A breakdown of one machine in a product line may cause stoppages of machines in the downstream of the line.
2. A change in product design may require major alterations in the layout.
3. The line output is decided by the bottleneck machine.
4. Comparatively high investment in equipments is required.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

COMBINATION LAYOUT ADVANTAGES AND DISADVANTAGES

COMBINATIONLAYOUT

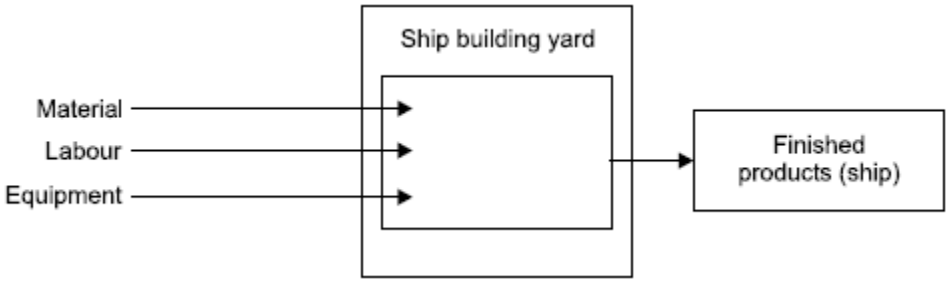
A combination of process and product layouts combines the advantages of both types of layouts. A combination layout is possible where an item is being made in different types and sizes. Here machinery is arranged in a process layout but the process grouping is then arranged in a sequence to manufacture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

Combination layout for making different types and sizes of gears



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

Fixed position layout



Advantages

The major advantages of this type of layout are:

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

GROUP LAYOUT (OR CELLULAR LAYOUT)

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

GROUP TECHNOLOGY LAYOUT IN OPERATION MANAGEMENT

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

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

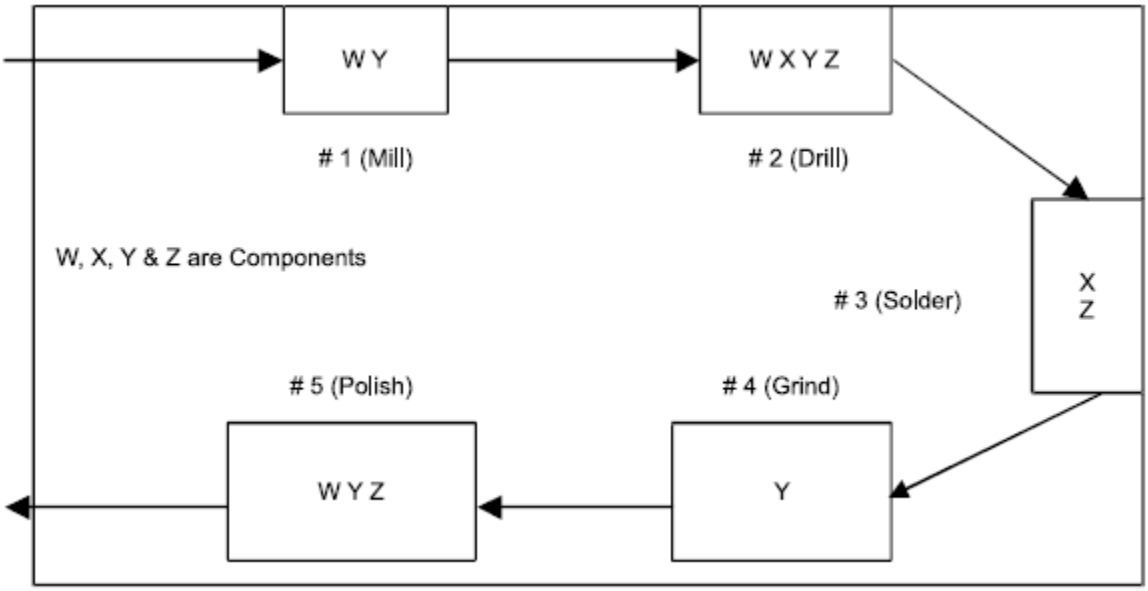
The application of group technology involves two basic steps; first step is to determine component families or groups. The second step in applying group technology is to arrange the plants equipment used to process a particular family of components. This represents small plants within the plants. The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

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

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

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

GROUP LAYOUT OR CELLULAR LAYOUT



Group Technology layout can increase

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

It can decrease the

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

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

FACTORS AFFECTING AGGREGATE PLANNING

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

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

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

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

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

1. **Level Strategy**

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

2. **Chase Strategy**

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

3. **Hybrid Strategy**

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

FORECASTING

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

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

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

BUSINESS FORECASTING

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

CLASSIFICATION OF BUSINESS FORECASTING

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

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

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

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

Timeline of Business Forecasting

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

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

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

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

CHARACTERISTICS OF GOOD FORECAST

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

FORECASTING METHODS

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

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

CAPACITY UTILIZATION

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

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

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

The use of capacity utilization as a KPI

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

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

DETERMINATION OF FEASIBLE PRODUCTION ALTERNATIVES

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

FACTOR RATING METHOD

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

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

WEIGHTED FACTOR RATING METHOD

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

LOAD-DISTANCE METHOD

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

DISTANCE MEASURES

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

CENTRE OF GRAVITY

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

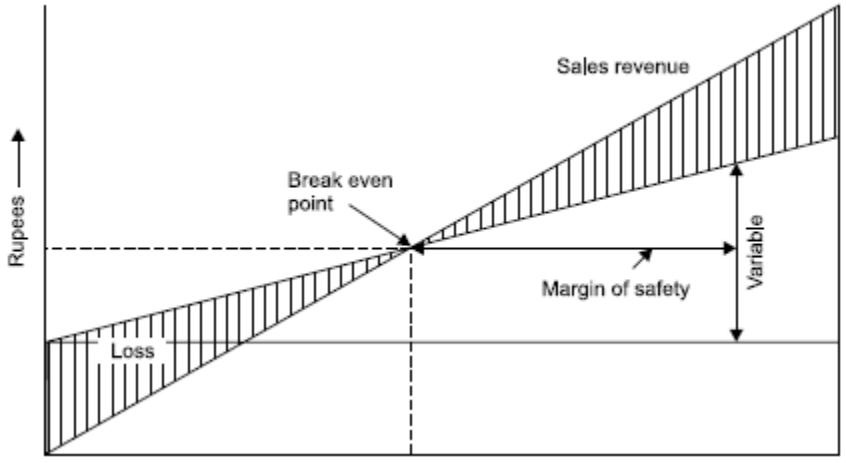
The centre of gravity is defined to be the location that minimizes the weighted distance between the warehouse and its supply and distribution points, where the distance is weighted by the

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

BREAK EVEN ANALYSIS

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

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



UNIT-2- IMPORTANT PREVIOUS QUESTIONS:

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

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

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

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

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

6. Explain about flexible manufacturing and group technology.

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

PREPARED BY;

Dr.SARIKA.G
PRINCIPAL
BALAJI INSTITUTE OF IT & MANAGEMENT
KADAPA.

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.
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- 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-3

SCHEDULING

SCHEDULING IN PRODUCTION AND OPERATION MANAGEMENT

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

PRINCIPLES OF SCHEDULING

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

INPUTS TO SCHEDULING

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

SCHEDULING STRATEGIES

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

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

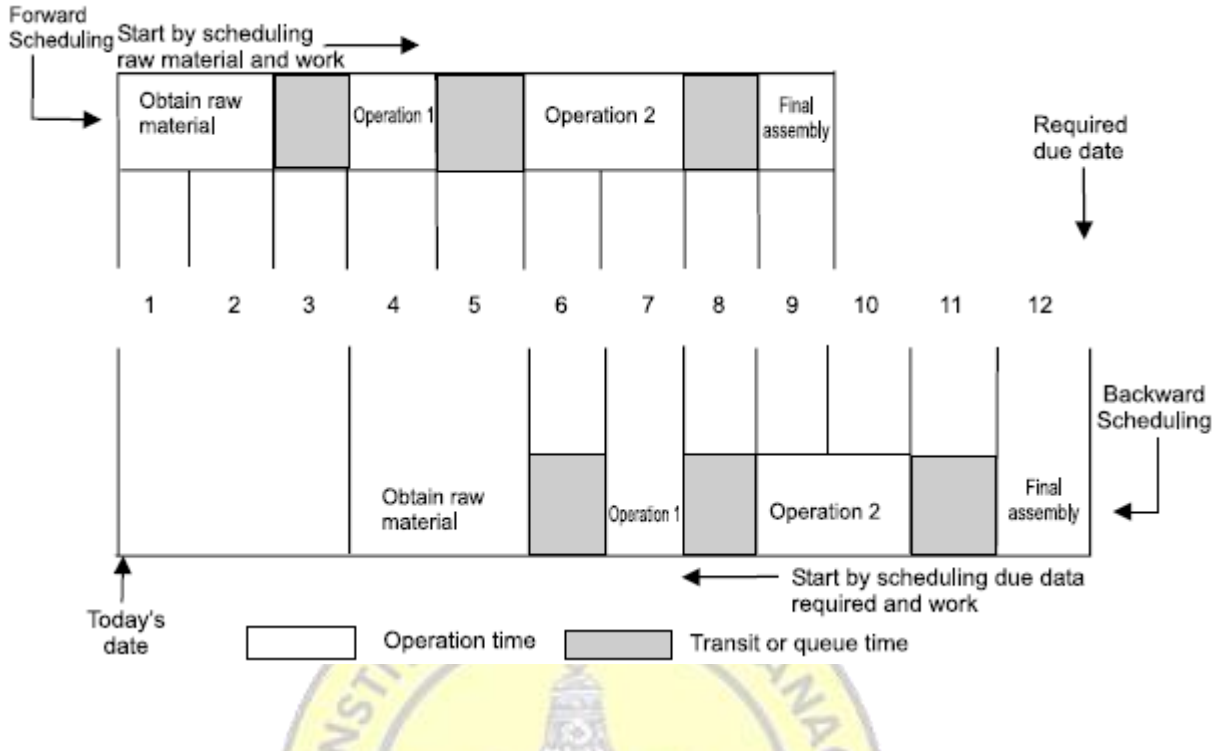
TYPES OF SCHEDULING

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

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

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

FORWARD AND BACKWARD SCHEDULING



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

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

1. GANTT CHARTS AND BOARDS

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

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

2. PRIORITY DECISION RULES

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

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

3. MATHEMATICAL PROGRAMMING METHODS

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

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

a. Linear programming model:

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

b. PERT/CPM network model:

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

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

SEQUENCING

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

a. Customer satisfaction.

b. Order urgency

c. Order profitability

d. Impact on capacity utilization

e. Shop performance

The most popular priority rules are

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

PREPARED BY;

Dr.SARIKA.G
PRINCIPAL
BALAJI INSTITUTE OF IT & MANAGEMENT
KADAPA.