UNIT 1 OPERATIONS MANAGEMENT — AN OVERVIEW

Objectives

Upon completion of this unit, you should be able to:

- know the production/operation function as process of value addition
- recognise the distinction between products and services
- comprehend all organisations as conversion systems whether in manufacturing or service sectors
- understand the systems concepts in operations management
- appreciate the purpose and objectives in operations management
- identify various problems of decision-making in operations management
- distinguish various structures of production systems and their associated problems
- appreciate the role of materials management
- know the concepts in systems life-cycle
- appreciate the role of scientific approach of industrial engineering/operations research in the management of production/service systems
- understand the basic theme of the subject and be familiar with the conceptual scheme we will follow in this text
- have a brief idea of the historical profile of the development of operations management

Structure

1.1 INTRODUCTION

In this unit you will learn about the aspects of management of production and service organisations. For long the term 'production' has been associated only with a factory like situation where goods are produced in the physical sense. Factory has been defined as "..... any premises in which persons are employed for the purpose of making, altering, repairing, ornamenting, finishing, cleaning, washing, breaking, demolishing or adopting for sale, any article".

However, by generalising the concept of production as the "process through which goods and services are created" we can include both manufacturing and service organisations within the purview of production management. Thus the essential features of the production function are to bring together people, machines and materials to provide goods or services thereby satisfying the wants of the people.

Inclusion of services within the scope of production enables us to look at the problem of production management in a much wider perspective. This brings a number of seemingly non-manufacturing sectors of economy such as transport, energy, health, agriculture, warehousing, banking etc. within the scope of production systems. That is why the terms production and operations management or operations management have been suggested by many to indicate the general applications of the techniques of management of machines and materials.

This broad concept of production is kept in mind throughout this book although the apparent emphasis may be on techniques used in the context of manufacturing organisation but you should always be able to extend and apply these management techniques to all types of service organisations as well.

The Value Added Process

Perhaps a more general concept of 'operations' instead of 'production' will better include both manufacturing as well as service organisations. Operations—either in manufacturing or in service—are purposeful activities of an organisation. Operations function is the heart of and indeed the very reason for an organisation to come into being. All operations can be said to add value to some object thereby enhancing its usefulness. We may formally define an operation as "the process of changing inputs into outputs and thereby adding value to some entity; this constitutes the primary function of virtually every organisation"

Now let us consider how value can be added to an entity by performing an 'operation' function. There are four major ways:

a) **Alter:** This refers to change in the form or state of the inputs. This change may be physical as in manufacturing, or sensual or psychological such as the feeling of comfort or satisfaction after getting cured from an illness.

b) **Transport:** The entity gets value added through transport because it may have more value if located somewhere other than where it currently is. Entity may include people, goods or garbage.

c) **Store:** The value is enhanced if the entity is kept in a protected environment for some period of time, such as potatoes in cold storage or foodgrains in warehouses.

d) **Inspect:** The value of an entity may be enriched through an inspection as we better understand its properties and can therefore take more informed decisions regarding their purchase, use, repair etc.

Thus we see that the value may be added to an entity through a number of different means. It may directly change in space, in time or even just in our mental image of it. All these processes can be called 'operations'. Thus almost every organisation—manufacturing, transportation, warehousing, health-care, education etc. come within the purview of operations management.

Products and Services

The output of an operations (or production) system may be in terms of end-product—physical goods such as automobiles or rendering a service such as in transportation, hospitals, educational institutions, cinema-halls etc. Rendering a service may involve physical goods (or facilitating goods) such as dentist making a set of false teeth while rendering dental care. Thus services can be considered as bundles of benefits, some may be tangible and others intangible (such as reduced waiting, courteous calls, convenient location etc.) and these may or may not be accompanied by facilitating goods. Based on this grouping it is possible to segregate organisations producing goods or services or both.

The Conversion Process

From the foregoing description, it should now be clear that all production or operation functions are essentially a part of the conversion process which transforms entities in shape, size, form, location, space, time and state. Hence every organisation can be considered essentially as a conversion system which converts inputs into outputs through the conversion process (or operations). This aspect is further highlighted in the next section.

1.2 SYSTEMS CONCEPTS IN OPERATIONS MANAGEMENT

A system may be defined as "a purposeful collection of people, objects and procedures for operating within an environment". Thus every organisation can be represented as a system consisting of interacting sub-systems. The features of a system are that these have inputs and outputs. The basic process of the system converts the resource inputs into some useful form of outputs. Of course, depending upon the efficiency of the conversion process we may have undesirable outputs too—such as pollution, scrap or wastage, rejections, loss of human life (in a hospital) etc. Using the generalised concept of production (which includes services) we can call such systems as production systems.

Figure I: Conceptual Model of A Production/Operation System

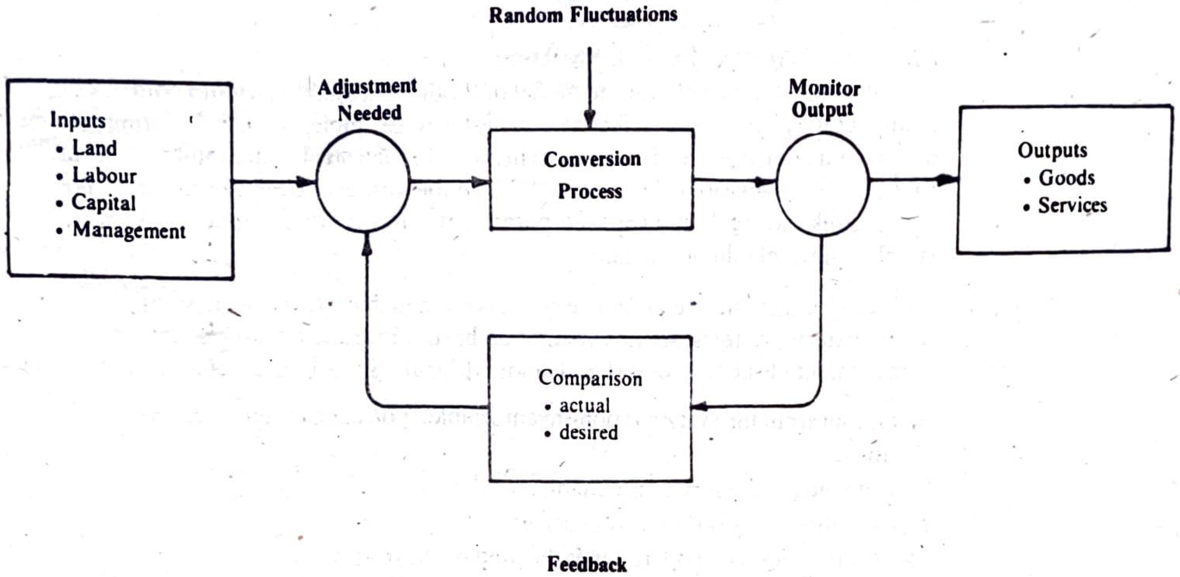


Figure I describes a generalised concept of production system. It takes resource inputs and processes them to produce useful outputs in the form of goods or services.

Inputs and Outputs

Inputs to the system may be labour, material, equipment (machines), facilities, energy, information and technology. Thus machines and materials, which constitute the main focus of this book are the resource inputs required by the production system. Other inputs to operating system can be—customers in a bank, patients in a hospital, commuters to a public transport system, files and papers to an office situation, and programmes to be run in a computer centre etc.

Similarly outputs from a system may be in terms of finished products, transported goods, delivered messages, cured patients, serviced customers etc.

Productivity of Conversion Process

Now we come to the main question of how we know that we are managing our system operations well. This concerns the efficiency with which we are converting the inputs into outputs. This conversion efficiency can be roughly gauged by the ratio of output/input; a term which is generally known as 'productivity' of the system. It is obvious that productivity can be improved by maximising the desirable form of outputs from the system for a given level of resource inputs or alternatively by requiring a minimum amount of resource inputs for a given level of output from the system.

Thus,

$$\text{Productivity (P)} = \frac{\text{Output (O)}}{\text{Inputs (I)}}$$

Management of production systems is essentially concerned with the management for productivity. An alternate way of looking at the concept of productivity is to look at the amount of waste generated in the system. If waste is 'unnecessary input' and 'undesirable output' from a system, then productivity can be improved by reducing wastefulness (or wastivity) of the system.

Thus a simple way to look at the productivity improvement is to attack wastes of all types of resources—materials, labour, capacity of machines, time, space, capital etc.

If you look a bit deeper into what is happening inside the conversion system—you could find only two mutually exclusive things happening. Either, the resources are being processed (operation) taking it nearer to the completion stage or nothing useful is happening to the resource inputs. For example materials may be waiting in the form of inventory in stores, waiting to be loaded on the machine. Job orders may be waiting to be processed. In a hospital a patient may be waiting to be attended to etc. All these forms of waiting, delays in inventories are non-productive events and any drive to improve productivity must aim at eliminating or at least reducing such idle time, waiting etc. Thus if you wish to improve your system operations, try to attack such non-productive elements in the total throughput time of the entity in the system.

Manufacturing and Service Systems

As stated earlier, the generalised model of production system includes both manufacturing systems as well as service systems. Examples of manufacturing systems are: Manufacturing of fertilisers, cement, coal, textile, steel, automobiles, machine tools, blades, televisions, furnitures etc. Examples of service systems include a post office, bank, hospital, municipal corporation, transport organisation, university, supply office, telephone exchange etc.

Although basic structure of service systems is amenable to same analysis as manufacturing systems, service systems do have some salient features making the management of such systems slightly more difficult. Some of these characteristics are:

a) Output from the system is non-inventoriable. You cannot generally produce to stock.
b) Demand for the service is variable.
c) Operations may be labour-intensive.
d) Location of service operation is dictated by location of users.

1.3 OBJECTIVES IN OPERATIONS MANAGEMENT

Every system (or organisation) has a purpose, certain objectives and goals to achieve. Since the objectives of an organisation have hierarchical structure, sub-goals lead to accomplishment of goals which contribute to the achievement of objectives and eventually the purpose or mission of an organisation. It is very important that these objectives should be unambiguously identified, properly structured and explicitly stated.

In general terms, the objectives of an organisation may be to produce the goods/or services in required quantities and of quality as per schedule and at a **minimum cost.** Thus quantity, quality and time schedule are the objectives that determine the extent of customer satisfaction. If an organisation can provide for these at a minimum cost then the 'value' of goods created or services rendered enhances and that is the only way to remain competitive. Thus various objectives can be grouped as—performance objectives and cost objectives.

Performance Objectives

The performance objectives may include:

a) **Efficiency** or productivity as output per unit of input.
b) **Effectiveness:** It concerns whether a right set of outputs is being produced. Where efficiency may refer to 'doing things right', effectiveness may mean 'doing the right things'.
c) **Quality:** Quality is the extent to which a product or service satisfies the customer needs. The output has to conform to quality specifications laid down before it can be accepted.
d) **Lead times:** Manufacturing lead time or throughput time is the time elapsed in the conversion process. Minimisation of idle time, delays, waiting etc. will reduce throughput time.
e) **Capacity utilisation:** Percentage utilisation of manpower, machines etc.
f) **Flexibility:** If the conversion process has the flexibility of producing a combination of outputs, it is possible to satisfy a variety of customer needs.

Cost Objectives

Attaining high degree of customer satisfaction on performance front must be coupled with lower cost of producing the goods or rendering a service. Thus cost minimisation is an important systems objective. Costs can be explicit (visible) or implicit (hidden or invisible). These could be tangible in economic terms or intangible in social cost terms—such as delayed supplies, customer complaints etc. While managing production systems we must consider both the visible and invisible, tangible and intangible costs. Some examples of these costs are:

a) Explicit (visible) costs:
   - Material cost
   - Direct and indirect labour cost
   - Scrap/rework cost
   - Maintenance cost

b) Implicit (invisible/hidden) costs:
   - Cost of carrying inventory
   - Cost of stockouts, shortages, back-logging, lost sales
   - Cost of delayed deliveries
   - Cost of material handling
   - Cost of inspection
   - Cost of grievances, dissatisfaction
   - Downtime costs
   - Opportunity costs

For the purpose of managerial decision-making, we should consider the total relevant systems costs including visible and invisible. A longer term cost implications rather than only short-term will help in arriving at better decisions.

1.4 OPERATIONS MANAGEMENT DECISIONS

Operations Management is essentially a function concerning decision-making with respect to a production/operation system so as to render the necessary customer satisfaction at lowest cost.

The Process of Management

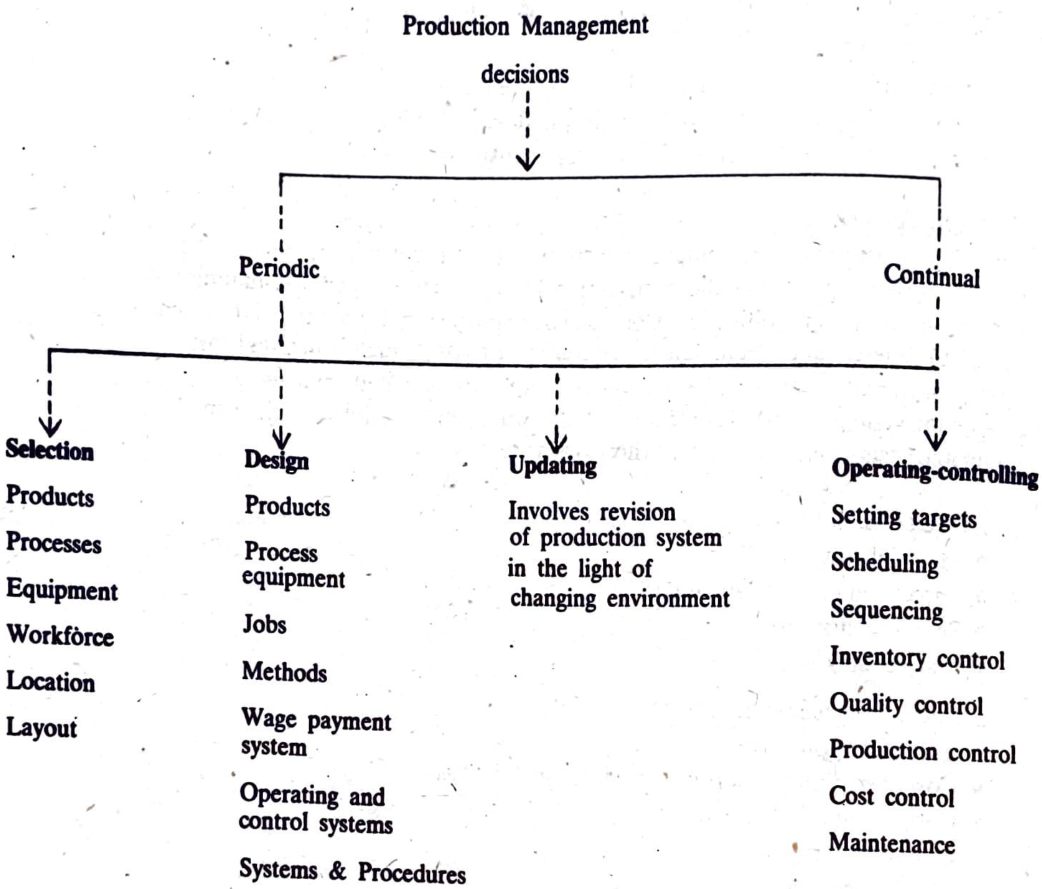
Essentially management can be considered as a process of planning, organising, coordinating and control.

There are different ways in which the production management functions can be grouped for the sake of discussion. For instance, all the decisions concerning the production system could be divided as:—

a) **Periodic decisions** which include selection, design and updating of resources, structures, systems and procedures.

b) **Continual decisions** which are required in day-to-day operation and control of production systems.

Figure II: A classification of Production Management Decisions



Source: Chase, R.B. and N.J. Aquilano, 1973. Production and Operations Management: A Life-cycle Approach, Richard D. Irwin: Homewood.

Figure II shows a listing of some of the decisions according to this scheme of functional classification. It may be seen that decisions in (a) above are generally strategic decisions having long-term implications while in (b) we have operational (short-term) decisions.

And yet another way of looking at these decisions may be:

i) Planning and Design of Production Systems.

ii) Operations and Control of Production Systems.

The major topics covered in this book will be grouped according to the above mentioned classification.

A third way to group these decisions could be:

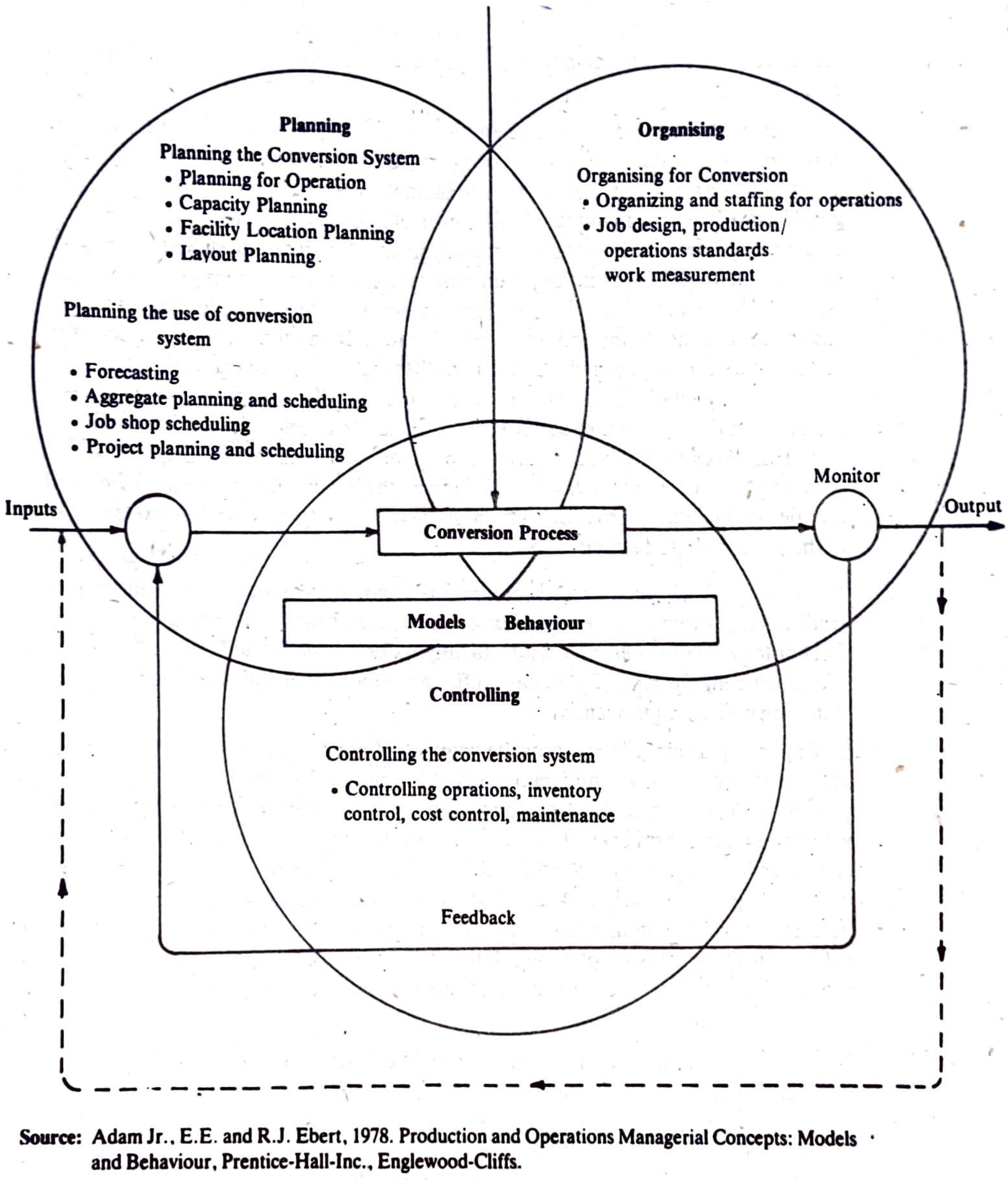
I Planning Decisions — Planning the conversion systems
Planning the use of the conversion systems

II Organising Decisions —
- Organising for conversion
- Structuring of operations
- Staffing
- Job and work-design
- Production/operation standards
- Payment systems etc.

III Controlling Decisions — Monitoring and control of conversion systems on aspects of
- Quantity
- Quality
- Time
- Inventory
- Cost
- Maintenance

Figure III shows schematically a listing of production management decisions according to this classification.

Figure III: A Framework of Planning, Organizing and Control Decisions in Production Systems



Source: Adam Jr., E.E. and R.J. Ebert, 1978. Production and Operations Managerial Concepts: Models and Behaviour, Prentice-Hall-Inc., Englewood-Cliffs.

Strategic (long-term) Decisions

A decision is said to be strategic if it has a long-term impact; influences a larger part of the system and is difficult to undo once implemented. These decisions in the context of production systems are essentially those which deal with the Design and Planning (long-range or intermediate range) aspects. Some examples of these decisions are:

a) Product selection and design: What products or services are to be offered constitute a crucial decision. A wrong choice of product or poor design of the product may render our systems' operations ineffective and non-competitive. A careful evaluation of product/service alternatives on the multiple objective basis can help in choosing right product(s). Techniques of value engineering can be useful in creating a good design which does not incorporate unnecessary features and can attain the intended functions at lowest costs.

b) Process selection and planning: Choosing optimal (best under the circumstances and for the purpose) process of conversion systems is an important decision concerning choice of technology, equipment and machines. Process planning pertains to careful detailing of processes of resource conversion required and their sequence. Included in such decisions are the aspects of mechanisation and automation.

c) Facilities location: It concerns decision regarding location of production system or its facilities. A poor location may spell operating disadvantages for all times to come. Therefore it is important to choose a right location which will minimise total 'delivered-to-customer' cost (production and distribution cost) by virtue of location. Evidently such a decision calls for evaluation of location alternatives against multiplicity of relevant factors considering their relative importance for the system under consideration.

d) Facilities layout and materials handling: Facilities layout planning problems are concerned with relative location of one department (activity centre) with another in order to facilitate material flow, reduce handling cost, delays and congestion, provide good house-keeping, facilitate coordination etc. A detailed layout plan gives a blueprint of how actual factors of production are to be integrated. The types of layout will depend upon the nature of production systems. Most of the concepts used in layout planning models are based on the importance of locating departments close to each other in order to minimise the cost of materials handling. Proper choice of the material handling equipment such as fork-lift truck, conveyors etc. is a related decision in layout planning. There are large number of computer packages developed such as CRAFT (Computerised Relative Allocation of Facilities Techniques), CORELAP (Computerised Relationship Layout Planning) etc. to help in layout planning for process based layouts. Balancing the production or assembly line and line-design including provision of inter-stage storage capacity are some relevant issues in the product-based layouts.

Newer technologies, particularly computer-based, are significantly altering the traditional concepts in layout planning. More recently the concepts in Group Technology (GT), Cellular Manufacturing Systems (CMS) and Flexible Manufacturing Systems (FMS) have influenced the layout planning and material handling policies significantly.

e) Capacity planning: It concerns the acquisition of productive resources. Capacity may be considered as the maximum available amount of output of the conversion process over some specified time span. Capacity planning may be over short-term as well as on a long-term basis. In service systems the concept of capacity and hence capacity planning is a bit more difficult problem. Long-term capacity planning includes expansion and contraction of major facilities required in conversion process, determination of economics of multiple shift operation etc. Break even analysis is a valuable tool for capacity planning. Other techniques like learning curves, linear programming and decision tree are also useful tools in capacity planning.

The above mentioned five decision areas will be described in detail in the units immediately following this one.

Operational (short-term) Decisions

Operational level decisions deal with short-term planning and control problems. Some of these are:

a) Production planning, scheduling and control: In operation scheduling we wish to determine the optimal schedule and sequence of operations, economic batch quantity, machine assignment and despatching priorities for sequencing. Production control is a complementary activity to production planning and involves follow up of the production plans.

b) Inventory planning and control: This problem deals with determination of optimal inventory levels at raw material, in-process and finished goods stages of a production system. How much to order, when to order are two typical decisions involving inventories. Materials requirement planning (MRP) is an important upcoming concept in such a situation.

c) **Quality assurance:** Quality is an important aspect of production systems and we must ensure that whatever product or service is produced it satisfies the quality requirements of the customer at lowest cost. This may be termed as quality assurance. Setting standards of quality, control of quality of products, processes are some of the aspects of quality assurance. Value engineering considerations are related issues in quality assurance.

d) **Work and job design:** These are problems concerning design of work methods, systems and procedures, methods improvement, elimination of avoidable delays, work measurement, work place layout, ergonomic considerations in job design, work and job restructuring, job enlargement etc. Design and operation of wage incentives is an associated problem area.

e) **Maintenance and replacement:** These include decisions regarding optimal policies for preventive, scheduled and breakdown maintenance of the machines, repair policies and replacement decisions. Maintenance of manpower scheduling and sequencing of repair jobs; preventive replacement and condition monitoring of the equipment and machines are some other important decisions involving equipment maintenance. Maintenance is extremely crucial problem area particularly for a developing economy such as ours because it is only through a very effective maintenance management that we can improve capacity utilisation and keep our plant and machinery productive and available for use.

f) **Cost reduction and control:** For an on-going production system the role of cost reduction is prominent because through effective control of total cost of production, we can offer more competitive products and services. Cost avoidance and cost reduction can be achieved through various productivity techniques. Value engineering is a prominent technique available for cost reduction. Concepts like standard costing and budgetary control help in monitoring and controlling the costs of labour, material etc. and suggest appropriate follow up action to keep these costs within limits.

Monitoring and Feedback Control

In every system, the actual accomplishment of objectives may not be as planned for various reasons. It is therefore very important to monitor the actual performance by measuring the actual output or some performance indicators. Basic elements of monitoring and feedback control—be it control of quantity, quality, time, inventory or cost—are:

1 Establish standards of performance or outputs.
2 Measure actual performance.
3 Compare the difference between the actual and planned.
4 Take appropriate remedial actions by changing inputs revising plans, changing priorities, expediting the progress etc.

Design of an appropriate feedback control system is therefore vital for all production/operations management problems. Control is complementary to planning. Without monitoring and control, planning may not be effective; without planning, control may not be effective. Thus planning and control are two sides of the same coin.

In the design of control systems, we should consider cost-benefit aspect of control in mind. If cost of control exceeds its benefits, it becomes counter-productive. Thus selective controls must be exercised employing the exception principle or Pareto's Law. A more effective control could be self-control or cybernetic or steering control but it may be difficult to design such controls in a large and complex organisation.

Need for Updating and Review of Decisions

When we plan or design our production system, the process of planning assumes certain external and internal environment or work. In a dynamic system there may be changes in the environmental parameters which make our previous decisions out of date and irrelevant. In such a situation, we need to review, revise and update our decisions. For example, we may switch over to group technology layout from existing process type; we may add or delete our product lines; we may revise the product design in the light of newer types of materials that have developed or on the basis of feedback from customers etc.

It is a good practice to incorporate periodic reviews and updating as a part of our system so that our decisions are relevant to the prevailing circumstances and are compatible with the external environment. Thus, we should be able to revise all the previously stated decisions should the contingency of the situation so demand.

1.5 TYPES OF PRODUCTION SYSTEMS

Looking from a different point of view, the entire problem of production/operations management can be visualised as that of managing the 'material' flow into, through, and out of the production system. If we try to detail out the flow characteristics inside the conversion systems, we shall find that some systems have very smooth and streamlined flow; some others may have more complex flow characteristics. In general, the more complex the flow characteristics inside the system, the more difficult it becomes to manage the system. On the basis of material flow characteristics, the production system can be grouped into the following four categories:

a) Mass production or flow line production system

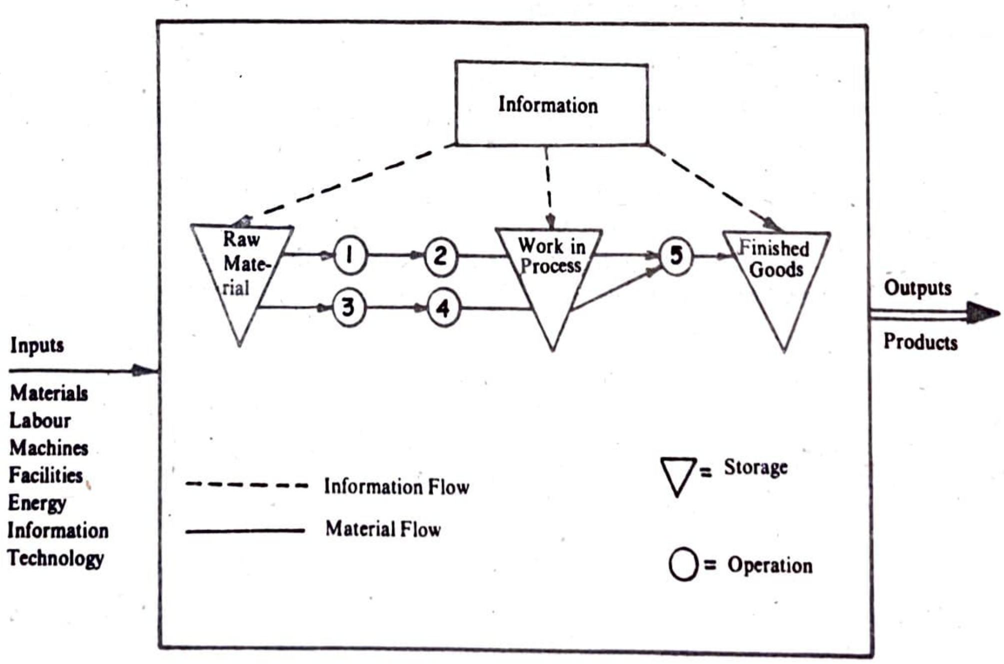
b) Batch production system

c) Job shop

d) Unit manufacture of projects.

The main focus of production management problems will therefore depend upon the type of the system. Problems which are very crucial for mass production may not be relevant for batch production and vice-versa. It is therefore very important to identify the type of systems we are managing and then focus on main problems of planning and control relevant to that system. A brief description of these problems are given in the following sub-sections. Figure IV shows the flow characteristics of a typical production system.

Figure IV: Material Flow Characteristics of A Typical Production Process



Source: Menipaz, E. 1984. Essentials of production and Operations Management, Prentice-Hall Inc.: Englewood-Cliffs.

Mass Production or Flow Line Production Systems

These systems have simplest flow characteristics constituting straight line flow. Facilities are arranged according to sequence of operations where the output of one stage becomes input to the next stage. The whole system is cascaded.

Major production management problems in mass production systems are—balancing of production/assembly lines, machine maintenance and raw materials supply. In a production line consists of the series of production centres, if workload is unbalanced, then the most bottle-necked production stage will govern the whole output rate. This will result in increased throughput time and poor capacity utilisation thus contributing to low productivity. Hence a production or assembly line should be designed such that its workload is as evenly balanced as possible. Maintenance becomes important because if any production stage is under breakdown it will block the whole line unless quickly restored back into operational effectiveness. Raw material to first stage is important to avoid shortage and subsequent starvation of the whole line.

There are methods and techniques available to attend to the above mentioned problem areas. Some of these will be discussed in a later unit on operations planning and control aspect of mass production system.

Batch Production System

If a variety of products are made with relatively small volume of production, it may not be possible to layout a separate line for each product. In such cases, batch production concept is adopted when a product is made in a certain quantity called as 'batch quantity' on a machine, and after a while it is discontinued and another product is scheduled in a certain batch quantity. Thus various products compete for the share of a machine. The machines are for general purposes. Material flow in such systems is more complex than in mass production systems. Accordingly, the planning and control aspects are relatively more difficult. Some prominent problem areas are:

a) Optimal layout planning for the production system;

b) Aggregate production planning to absorb demand fluctuations economically;

c) Machine-job allocation problem;

d) Determination of economic batch quantity; and

e) Scheduling and sequencing of operations.

Production control assumes significance in such systems as the status of progress of various products must be chased up and effectively monitored.

Job Shop

A job shop does not have its own standard product but accepts whatever customer orders come in. Thus it is essentially a group of facilities and processes a wide variety of customer orders in varying batch sizes. Each order may be a new order requiring process planning, tooling and sequencing. Material flow in job shop like situation is quite complex. A dynamic job shop where even customer orders come in a random fashion is a very difficult system to analyse at least from the point of view of production. planning and control. The main problem is despatching priority rule to determine the sequence in which various waiting job orders are to be processed on manufacturing facilities. For example, a production manager may sequence the job orders on the basis of the short processing time (SPT) rule. The job requiring smallest operation time gets top most priority in order-scheduling. From analytical point of view a job shop can be treated as a network of queues and the waiting line models or simulation techniques can be used to analyse it.

Unit Manufacture or Projects

Suppose we want to make a ship. Obviously due to large size of the product, the entire concept of material flow should change. In the previous three cases the manpower and facilities were fixed and product (or material) was moving from place to place. Here product remains fixed and manpower/facilities put work on it some chosen sequence. Since such products are not made in large number and have long throughput time, we can treat each product as a project. Thus project planning, scheduling and monitoring techniques based on network models such as PERT/CPM can be used for planning and control of such production systems.

UNIT 4 FACILITIES LOCATION

Objectives

After going through this unit, you should be able to:

- understand the strategic importance and objectives of facilities location
- realise the enlarged scope of dealing with facility rather than just plant/factory location
- identify various factors relevant for general territory selection as well as those relevant for specific site/community selection
- appreciate that the location decisions are quite complex because of the existence of subjective intangible factors along with objective tangible factors
- be in a position to apply some relevant technique either subjective, qualitative or semi-quantitative in nature
- grasp some simple operational research oriented models
- realise the need for recognition of the assumptions and limitations of the quantitative models discussed
- provide a blend of some good rational qualitative judgment and the analytical model solutions
- be in a position to identify relevant factors for facility location

Structure

4.1 INTRODUCTION

Facility location decisions are strategic, long term and non-repetitive in nature. Without sound and careful location planning in the beginning itself, the new facility may pose continuous operating disadvantages, for the future operations. Location decisions are affected by many factors, both internal and external to the organisation's operations. Internal factors include the technology used, the capacity, the financial position, and the work force required. External factors include the economic political and social conditions in the various localities. Most of the fixed and some of the variable costs are determined by the location decision. The efficiency, effectiveness, productivity and profitability of the facility are also affected by the location decision. The facilities location problem is concerned primarily with the best (or optimal!) location depending on appropriate criteria of effectiveness. Location decisions are based on a host of factors, some subjective, qualitative and intangible while some others are objective, quantitative and tangible.

Concept of a facility

Traditionally, location theorists have dealt with industrial plant/factory location. However, the concept of **plant location** has now been generalised into that of **facility location,** since the facility could include a production operation or service system. The term 'Plant' has been traditionally used as synonymous to a factory, manufacturing or assembly unit. This could include fertiliser, steel, cement, rice milling plants, textile, jute, sugar mills, rubber factories, breweries, refineries, thermal or hydro-electric nuclear power stations etc.

However, with the enlarged scope of a facility, this term can now be used to refer to banks, hospitals, blood banks, fire stations, police stations, warehouse, godown, depot, recreation centre, central repair workshop etc. At a lower hierarchical level is the facility/plant layout problem which will be discussed in the next unit. In such a case machines, equipment, desks, workshop, canteen, emergency room etc. could mean a facility. Thus, in fact, we could generally state that a facility could connote almost any physical object relevant to location analysis. Let us now see when a location decision arises.

4.2 WHEN DOES A LOCATION DECISION ARISE?

The impetus to embark upon a facility location study can usually be attributed to various reasons:

i) It may arise when a new facility is to be established.

ii) In some cases, the facility or plant operations and subsequent expansion are restricted by a poor site, thereby necessitating the setting up of the facility at a new site.

iii) The growing volume of business makes it advisable to establish additional facilities in new territories.

iv) Decentralisation and dispersal of industries reflected in the Industrial Policy resolution so as to achieve an overall development of a developing country, would necessitate a location decision at a macro level.

v) It could happen that the original advantages of the plant have been outweighed due to new developments.

vi) New economic, social, legal or political factors could suggest a change of location of the exisiting plant.

Some or all the above factors could force a firm or an organisation to question whether the location of its plant should be changed or not.

Whenever the plant location decision arises, it deserves careful attention because of the long term consequences. Any mistake in selection of a proper location could prove to be costly. Poor location could be a constant source of higher cost, higher investment, difficult marketing and transportation, dissatisfied and frustrated employees and consumers, frequent interruptions of production, abnormal wastages, delays and substandard quality, denied advantages of geographical specialisation and so on. Once a facility is set up at a location, it is very difficult to shift later to a better location because of numerous economic, political and sociological reasons. Economic reasons could include total costs, profits, availability of raw materials, labour, power, transportation facilities, markets etc. Social reasons could include employee welfare, employment opportunities etc. Political reasons could be because of pursuance of a policy of decentralisation, regional and developmental planning especially in a developing country like ours. There could be security considerations on risk of military invasions, sabotage from anti-social elements etc. and some may be prone to natural calamities like floods, earthquake etc. Policy matters like anti- pollution etc. would have to be given their due consideration.

Alfred Weber's analysis was one of the first attempts to base location decisions on some sort of analysis, its imperfections notwithstanding. Besides discussing the importance of transport and labour cost differentials in deciding location, the main burden of Weber's analysis is transport cost of raw material which was least mobile.

One the basis of availability, he categorised raw materials into: (a) **ubiquities**—to denote those available almost everywhere like sand, water etc. and (b) **localised materials**, having specific locations, which are further divided into pure material which contributes nearly the total weight of it to the finished goods, and gross material, which contributes only a small fractions of total weight to the finished goods. It is obvious that ubiquities hardly influence the decision of location. Weber then proceeds to formulate the material index which equals the weight of localised material used in the finished product divided by the weight of the finished product

$$\text{Material Index (MI)} = \frac{\text{Weight of localised material used in finished product}}{\text{Weight of the finished product}}$$

If the material index is greater than unity, location should be nearer to the source of raw material and if it is less than unity, then a location nearer to market is advised. The commonsense involved in such conclusion is unquestionable. But such an approach tacitly assumes the existence of a static point of lowest transportation cost for raw material.

Later analyses by various other authors, like, Weigman, Palander, Losch, Ohlin and others have been attempted on increasingly comprehensive bases such as the interrelationship between factors like, (a) economic differences—(prices, market), (b) cost differences—(productivity, transport cost and accessibility), (c) human differences—(attitudes of founders and wage-earners), (d) national characteristics, and (e) various barriers—(political, geographic and transportation). Let us now see how a location study is made.

region
↓
territory
↓
site

4.3 STEPS IN THE FACILITY LOCATION STUDY

Location studies are usually made in two phases namely, (i) the general territory selection phase, and (ii) the exact site/community selection phase amongst those available in the general locale. The considerations vary at the two levels, though there is substantial overlap as shown in Table 1.

Table 1
Overlap of considerations of factors in the two stages of facility location

	Location Factors	Phase I General Territory Selection	Phase II Particular Selection of Site and Community
1	Market	●	
2	Raw Materials	●	
3	Power	●	
4	Transportation	●	●
5	Climate and Fuel	●	●
6	Labour and Wages	●	●
7	Laws and Taxation	●	●
8	Community Services and Attitude		●
9	Water and Waste		●
10	Ecology and Pollution		●
11	Capital Availability	●	●
12	Vulnerability to enemy attack	●	●

A Typical team studying location possibilities for a large project might involve economists, accountants, geographers, town planners, lawyers, marketing experts, politicians, executives, industrial engineers, defence analysts, ecologists etc. It is indeed an inter-disciplinary team that should be set up for undertaking location studies.

Territory Selection

Now in step (i) for the general territory/region/area selection, the following are some of the important factors that influence the selection decision.

Markets: There has to be some customer/market for your product/service. The market growth potential and the location of competitors are important factors that could influence the location. Locating a plant or facility nearer to the market is preferred if promptness of service required, if the product is fragile, or is susceptible to spoilage. Moreover, if the product is relatively inexpensive and transportation costs add substantially to the cost, a location close to the markets is desirable. Assembly type industries also tend to locate near markets.

Raw Materials and Supplies: Sometimes accessibility to vendors/suppliers of raw materials, parts supplies, tools, equipment etc. may be very important. The issue here is promptness and regularity of delivery and inward freight cost minimisation.

If the raw material is bulky or low in cost, or if it is greatly reduced in bulk viz. transformed into various products and by-products of if it is perishable and processing makes it less so, then location near raw materials sources is important. If raw materials come from a variety of locations, the plant/facility may be situated so as to minimise total transportation costs. The costs vary depending upon specific routes, mode of transportation and specific product classifications.

Transportation Facilities: Adequate transportation facilities are essential for the economic operation of a production system. For companies that produce or buy heavy bulky and low value per ton commodities, water transportation could be an important factor in locating plants. It can be seen that civilisations grew along rivers/waterways etc. Many facilities/plants are located along river banks.

Manpower Supply: The availability of skilled manpower, the prevailing wage pattern, living costs and the industrial relations situation influence the location.

Infrastructure: This factor refers to the availability and reliability of power, water, fuel and communication facilities in addition to transportation facilities.

Legislation and Taxation: Factors such as financial and other incentives for new industries in backward areas or no-industry-district centres, exemption from certain state and local taxes, octroi etc. are important.

Climate: Climatic factors could dictate the location of certain type of industries like textile industry which requires high humidity zones.

Site/Community Selection

Having selected the general territory/region, next we would have to go in for site/community selection. Let us discuss some factors relevant for this stage.

Community Facilities: These involve factors such as quality of life which in turn depends on availability of facilities like schools, places of worship, medical services, police and fire stations, cultural, social and recreation opportunities, housing, good streets and good communication and transportation facilities.

Community Attitudes: These can be difficult to evaluate. Most communities usually welcome setting up of a new industry especially since it would provide opportunities to the local people directly or indirectly. However, in case of polluting, or 'dirty' industries, they would try their utmost to locate them as far away as possible. Sometimes because of prevailing law and order situation, companies have been forced to relocate their units. The attitude of people as well as the state government has an impact on industrial location.

Waste Disposal: The facilities required for the disposal of process waste including solid, liquid and gaseous effluents need to be considered. The plant should be positioned so that prevailing winds carry any fumes away from populated areas and so that waste may be disposed off properly and at reasonable expense.

Ecology and Pollution: These days there is a great deal of awareness towards maintenance of natural ecological balance. There are quite a few agencies propagating the concepts to make the society at large more conscious of the dangers of certain avoidable actions.

Site Size: The plot of land must be large enough to hold the proposed plant and parking and access facilities and provide room for future expansion. These days a lot of industrial areas/parks are being earmarked in which certain standard sheds are being provided to entrepreneurs (especially small scale ones).

Topography: The topography, soil structure and drainage must be suitable. If considerable land improvement is required, low priced land might turn out to be expensive.

Transportation Facilities: The site should be accessible by road and rail preferably. The dependability and character of the available transport carriers, frequency of service and freight and terminal facilities is also worth considering.

Supporting Industries and Services: The availability of supporting services such as tool rooms, plant services etc. need to be considered.

Land Costs: These are generally of lesser importance as they are non-recurring and possibly make up a relatively small proportion of the total cost of locating a new plant. Generally speaking, the site will be in a city, suburb or country location. In general, the location for large-scale industries should be in rural areas, which helps in regional development also. It is seen that once a large industry is set up (or even if a decision to this effect has been taken), a lot of infrastructure develops around it as a result of the location decision. As for the location of medium scale industries, these could be preferably in the suburban/semi-urban areas where the advantages of urban and rural areas are available. For the Small-scale Industries, the location could be urban areas where the infrastructural facilities are already available. However, in real life, the situation is somewhat paradoxical as people, with money and means, are usually in the cities and would like to locate the units in the city itself.

Some of the industrial needs and characteristics that tend to favour each of these locales are now discussed. **Requirements** governing choice **of a city location** are:

1 Availability of adequate supply of labour force.
2 High proportion of skilled employees.
3 Rapid public transportation and contact with suppliers and customers.
4 Small plant site or multi floor operation.
5 Processes heavily dependent on city facilities and utilities.
6 Good communication facilities like telephone, telex, post offices.
7 Good banking and health care delivery systems.

Requirements governing the choice **of a suburban location** are:

1 Large plant site close to transportation or population centre.
2 Free from some common city building zoning (industrial areas) and other restrictions.
3 Freedom from higher parking and other city taxes etc.
4 Labour force required resides close to plant.
5 Community close to, but not in, large population centre.
6 Plant expansion easier than in the city.

Requirements governing the choice **of a country/rural location** are:

1 Large plant site required for either present demands or expansion.
2 Dangerous production processes.
3 Lesser effort required for anti-pollution measures.
4 Large volume of relatively clean water.
5 Lower property taxes, away from Urban Land Ceiling Act restrictions.
6 Protection against possible sabotage or for a secret process.
7 Balanced growth and development of a developing or underdeveloped area.
8 Unskilled labour force required.
9 Low wages required to meet competition.

4.4 SUBJECTIVE, QUALITIVE AND SEMI-QUANTITATIVE TECHNIQUES

Three subjective techniques used for facility location are Industry Precedence, Preferential Factor and Dominant Factor. Most of us are always looking for some precedents. So in the industry precedence subjective technique, the basic assumption is that if a location was best for similar firms in the past, it must be the best for us now. As such, there is no need for conducting a detailed location study and the location choice is thus subject to the principle of precedence–good or bad. However, in the case of the preferential factor, the location decision is dictated by a personal factor. It depends on the individual whims or preferences e.g. if one belongs to a particular state, he may like to locate his unit only in that state. Such personal

UNIT 5 FACILITIES LAYOUT AND MATERIALS HANDLING

Objectives

After going through this unit, you should be able to

- appreciate different types of layout problems
- become familiar with the basic types of plant layouts and the factors to be considered for layout design
- comprehend the procedure for designing the layouts in a systematic manner
- understand different kinds of tools that can be used for the analysis of material flow and activities in a plant
- realise how the space is estimated and allocated for different work centres and the facilities
- know the use of computerised techniques for designing the layouts
- learn how to evaluate, specify, present and implement a layout
- identify the factors that should be considered in the selection of material handling system
- become familiar with different types of material handling equipments used in plant design
- appreciate the integrated approach to layout planning and material handling system design and the role of automation in plant design.

Structure

5.1 INTRODUCTION

Importance and Function

Facilities layout refers to an optimum arrangement of different facilities including man, machine, equipment, material etc. Since a layout once implemented cannot be easily changed and costs of such a change are substantial, the facilities layout is a strategic decision. A poor layout will result in continuous losses in terms of higher efforts for material handling, more scrap and rework, poor space utilisation etc. Hence, need to analyse and design a sound plant layout can hardly be over emphasised. It is a crucial function that has to be performed both at the time of initial design of any facility, and during its growth, development and diversification.

The problem of plant layout should be seen in relation to overall plant design which includes many other functions such as product design, sales planning, selection of the production process, plant size, plant location, buildings, diversification etc. The layout problem occurs because of many developments including:

- change in product design
- introduction of new product
- obsolescence of facilities
- changes in demand
- market changes
- competitive cost reduction
- frequent accidents
- adoption of new safety standards
- decision to build a new plant

Plant layout problem is defined by Moore (1962) as follows:

"Plant layout is a plan of, or the act of planning, an optimum arrangement of facilities, including personnel, operating equipment, storage space, materials-handling equipment, and all other supporting services, along with the design of the best structure to contain these facilities."

Objectives and Advantages

Some of the important **objectives of a good plant layout** are as follows:

i) Overall simplification of production process in terms of equipment utilisation, minimisation of delays, reducing manufacturing time, and better provisions for maintenance.

ii) Overall integration of man, materials, machinery, supporting activities and any other considerations in a way that result in the best compromise.

iii) Minimisation of material handling cost by suitably placing the facilities in the best flow sequence.

iv) Saving in floor space, effective space utilisation and less congestion/confusion.

v) Increased output and reduced inventories-in-process.

vi) Better supervision and control.

vii) Worker convenience, improved morale and worker satisfaction.

viii) Better working environment, safety of employees and reduced hazards.

ix) Minimisation of waste and higher productivity

x) Avoid unnecessary capital investment

xi) Higher flexibility and adaptability to changing conditions.

Types of Layout Problems

The facilities layout problems can be classified according to the type of facility under consideration e.g.

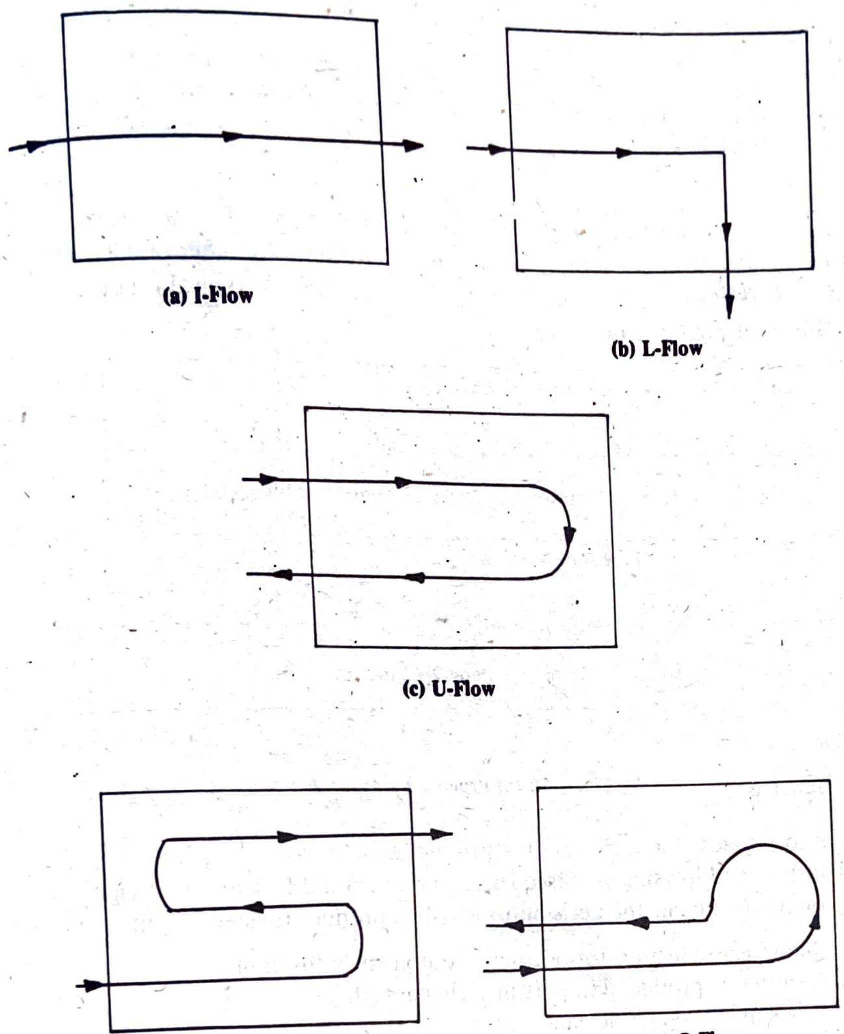
i) Manufacturing Plants
ii) Commercial facilities, e.g., shops, offices, Bank etc.
iii) Service facilities, e.g., Hospitals, Post Offices etc.
iv) Residential facilities, e.g., houses, apartments etc.
v) Cities, townships
vi) Recreational facilities, e.g. parks.theatres etc.

According to the nature of layout problem, it can be categorised into four types as follows:

- Planning a completely new facility
- Expanding or relocating an existing facility
- Rearrangement of existing layout
- Minor modifications in present layout

Flow Patterns

According to the principle of flow, the layout plan arranges the work area for each operation or process so as to have an overall smooth flow through the production/service facility. The basic types of flow patterns that are employed in designing the layouts are I-flow, L-flow, U-flow, O-flow, S-flow as shown in Figure I. These are briefly explained below:



(a) I-Flow

(b) L-Flow

(c) U-Flow

(d) S-Flow

(e) O-Flow

Figure I Flow Pattern

I-Flow: separate receiving and shipping area.

L-Flow: when straight line flow chart to be accommodated.

U-Flow: very popular as a combination of receiving and shipping.

O-Flow: when it is desired to terminate the flow near where it is originated.

Serpentine or S-Flow: when the production line is long and zigzagging on the production floor is required.

Activity A

Can you identify the flow pattern in the layout of facilities you work in?

5.2 BASIC TYPES OF PLANT LAYOUTS

Depending upon the focus of layout design there are five basic or classical types of layouts. Most of the practical layouts are a suitable combination of these basic types to match the requirements of activities and flow. The basic types of the layouts are:

Product or Line Layout

This type of layout is developed for product focused systems. In this type of layout only one product, or one type of product, is produced in a given area. In case of product being assembled, this type of layout is popular an 'assembly line'.

The work centres are organised in the sequence of appearance. The raw material enters at one end of the line and goes from one operation to another rapidly with minimum of work-in-process storage and material handling. A typical product layout is shown in Figure II (a).

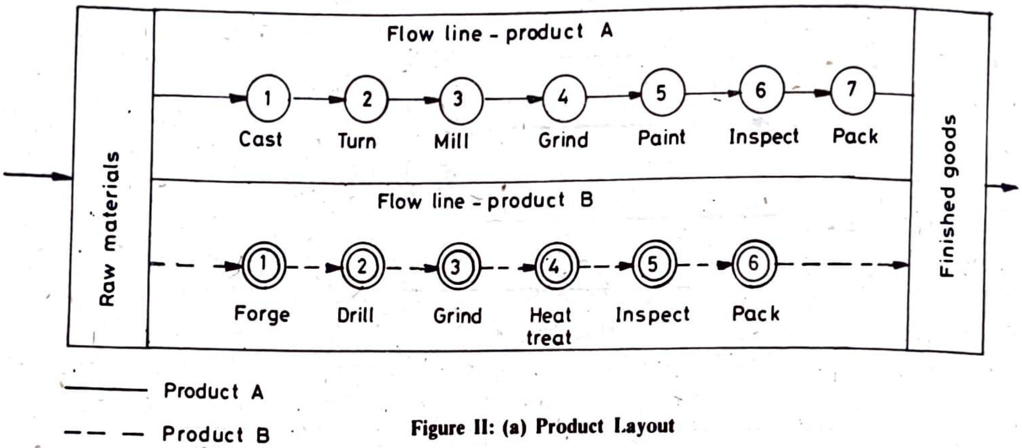


Figure II: (a) Product Layout

The decision to organise the facilities on a product or line basis is dependent upon a number of factors and has many consequences which should be carefully weighed. Following conditions favour the decision to go for a product focused layout.

i) High volume of production for adequate equipment utilisation.
ii) Standardisation of product and part interchangeability.
iii) Reasonably stable product demand.
iv) Uninterrupted supply of material.

The major problem in designing the product-focused systems is to decide the cycle time and the sub-division of work which is properly balanced (popularly known as line balancing).

Some of the major advantages of this type of layout are:

i) Reduction in material handling
ii) Less work-in-process
iii) Better utilisation and specialisation of labour
iv) Reduced congestion and smooth flow
v) Effective supervision and control.

Process or Functional Layout

This type of layout is developed for process focused systems. The processing units are organised by functions into departments on the assumption that certain skills and facilities are available in each department. Similar equipments and operations are grouped together, e.g., milling, foundry, drilling, plating, heat treatment etc. A typical process layout is shown in Figure II (b)

The use of process-focused systems is very wide both in manufacturing and other service facilities such as hospitals, large offices, municipal services etc.

The functional layout is more suited for low-volumes of production (batch production) and particularly when the product is not standardised. It is economical when flexibility is the basic system requirement. The flexibility may be in terms of the

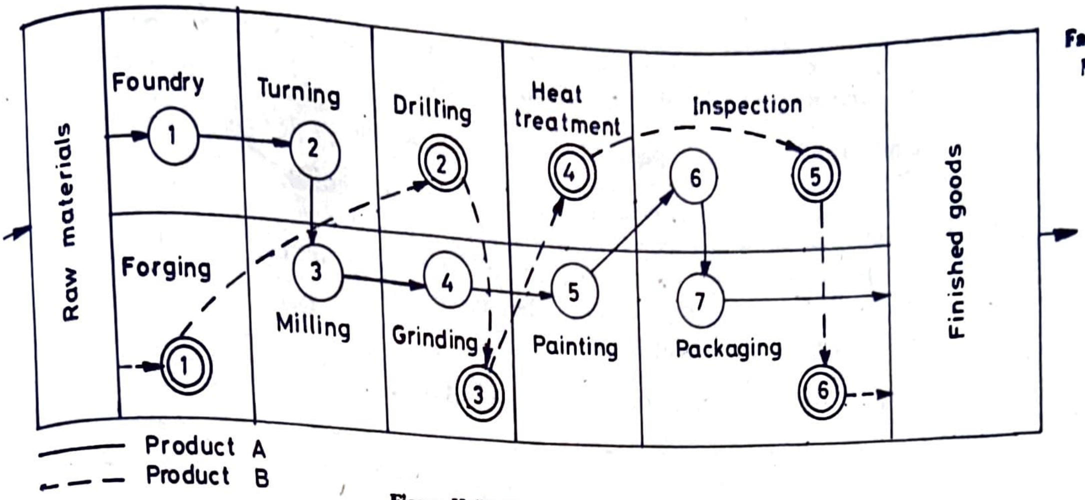


Figure II (b) Process Layout

routes through the system, volume of each order, and the processing requirements of the items.

The major advantages of a process layout are:

i) Better machine utilisation
ii) Higher flexibility
iii) Greater incentive to individual worker
iv) More continuity of production in unforeseen conditions like breakdown, shortages, absenteeism etc.

Cellular or Group Layout

It is a special type of functional layout in which the facilities are clubbed together into cells. This is suitable for systems designed to use the concepts, principles and approaches of 'group technology'. Such a layout offers the advantages of mass production with high degree of flexibility. We can employ high degree of automation even if the number of products are more with flexible requirements. In such a system the facilities are grouped into cells which are able to perform similar type of functions for a group of products. A typical cellular layout is shown in Figure II (c).

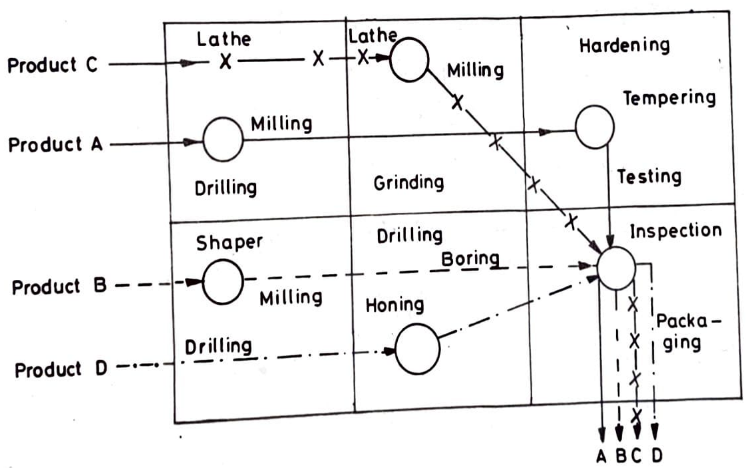


Figure II (c) Cellular Layout

Job-shop Layout

It is a layout for a very general flexible system that is processing job production. The preparation of such a layout is dependent on the analysis of the possible populations of orders and is a relatively, complex affair.

Project or Fixed Position Layout

This is the layout for project type systems in which the major component is kept at a fixed position and all other materials, components, tools, machines, workers etc. are brought and assembly or fabrication is carried out. This type of layout is now not used very commonly as the machines required for manufacturing work are big and complicated. The fixed position layout is used only when it is difficult to move the major component and fabrication is to be carried out e.g. production of ships.

Some of the major advantages of fixed position layout are as follows:

i) The handling requirements for major unit are minimised.
ii) Flexible with reference to the changes in product design.
iii) High adaptability to the variety of product and intermittent demand.
iv) The responsibility for quality can be pin-pointed.
v) The capital investment is minimum.

A typical fixed position layout is shown in Figure II (d).

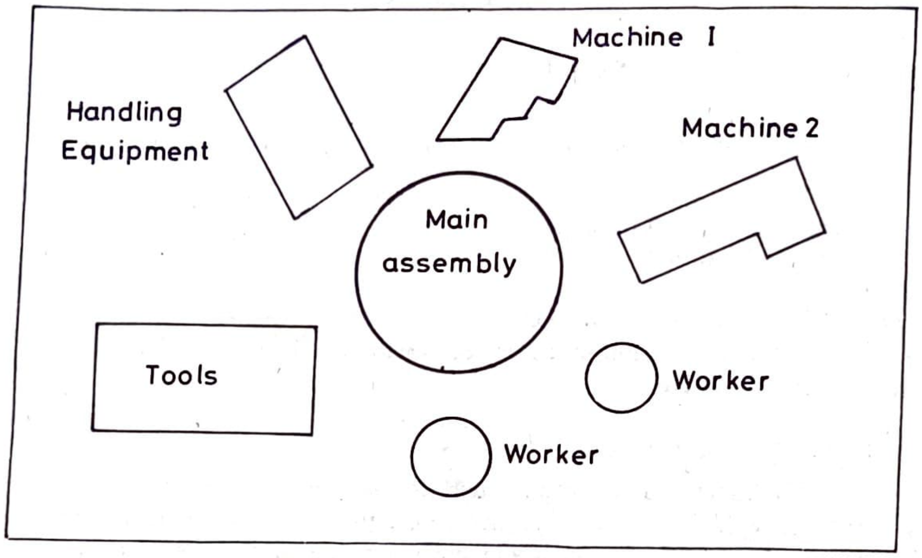


Figure II (d) Fixed Position Layout

Activity B

Can you identify the basic type of plant layout in the facility you work in? Is it optimal? Would some other type of layout than the one currently prevailing in your facility be better?

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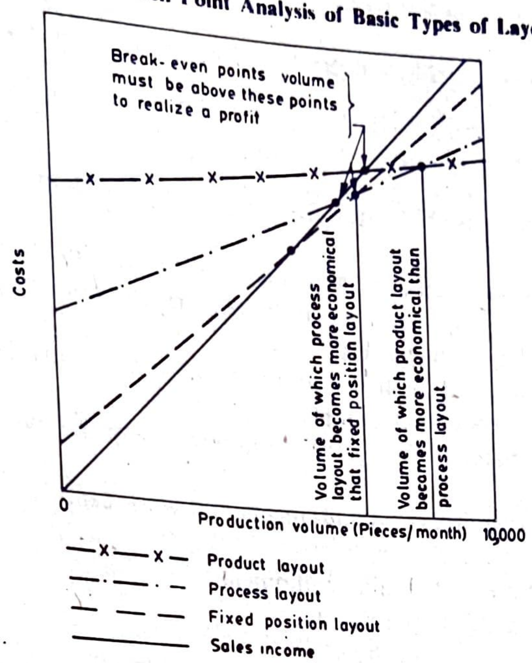
The fixed position layout is used ideally for a project situation i.e. for one product of a different type. As the quantity increases the production operations can be broken down into different work centres and material can be allowed to move rather than the machines.and a process layout is preferred. With further increase in volume i.e. with mass production the advantages of production line can be better derived and a product layout is desirable. The break-even analysis comprising the production volume of the three basic layouts i.e., product, process and fixed position layout is shown in Figure III.

Figure III: Break-even Point Analysis of Basic Types of Layouts



5.3 PLANT LAYOUT FACTORS

The design of any layout is governed by a number of factors and the best layout is the one that optimises all the factors. As discussed by Muther (1955) the factors influencing any layout are categorised into the following eight groups:

i) The material factor: Includes design, variety, quantity, the necessary operations, and their sequence.

ii) The man factor: Includes direct workers, supervision and service help, safety and manpower utilisation.

iii) The machinery factor: Includes the process, producing equipment and tools and their utilisation.

iv) The movement factor: Includes inter and intradepartmental transport and handling at the various operations, storages and inspections, the materials handling equipments.

v) The waiting factor: Includes permanent and temporary storages and delays and their locations.

vi) The service factors: Include service relating to employee facilities such as parking lot, locker rooms, toilets, waiting rooms etc. service relating to materials in terms of quality, production control, scheduling, despatching, waste control; and service relating to machinery such as maintenance.

vii) The building factor: Includes outside and inside building features and utility distribution and equipment.

viii) The change factor: Includes versatility, flexibility and expansion.

Each of the above mentioned factors comprise a number of features and the layout engineer must review these in the light of his problem. Usually the layout design process is a compromise of these various considerations to meet the overall objectives in the best possible manner.

5.4 LAYOUT DESIGN PROCEDURE

The overall layout design procedure can be considered to be composed of four phases viz.,

Phase I Location
Phase II General Overall layout
Phase III Detailed layout
Phase IV Installation

Evaluation of Layout

The evaluation may be done of an existing layout or of an alternative layout. The basis for evaluating the layout might include:

i) the objectives of layout planning
ii) cost comparison with other alternatives
iii) return on investment
iv) intangible factors which must be evaluated on the basis of judgment.
v) productivity evaluation
vi) space evaluation
vii) ranking
viii) pilot plant
ix) sequence demand-straight line-considering the sequence of operations on a variety of parts.
x) Factors analysis by weighing various factors according to their importance.

The optimising evaluation can also be done by using Operation Research Techniques such as

- Linear Programming
- Line Balancing
- Level Curve Concept

Mathematical models express the effectiveness of layout as a function of a set of variables which can be evaluated. Some other mathematical techniques of evaluation are:

- Monte Carlo Method
- Queuing Theory
- Engineering Economy
- Analogues

These are not discussed in details here.

Installation of Layout

The layout is presented in the following ways:

i) The Visual presentation of the layout itself, supplementary details and facts and supplementary charts and displays.

ii) An Oral report

iii) A Written report

When the final layout is approved it is installed in a number of phase, and it is needed to prepare

- detailed drawings
- precise specifications of production and materials handling equipment
- detailed listing of all equipment and utility requirements
- actual plans and schedule of construction and installation.

The techniques of project management such as CPM/PERT may be used for planning and monitoring the progress of the layout installation.

5.9 MATERIALS HANDLING SYSTEMS

We have discussed in previous sections the analysis of material flow and the design of layout based on it. We have referred to the selection of material handling equipment and area allocation for it. Materials handling is the art and science involving the movement, packaging and storing of substances in any form. In this section we will discuss about the objectives of the material handling system design, basic types of material handling systems and the procedure for the design and selection of material handling system while developing a plant layout.

Objectives and Functions

In order to perform the activities of materials handling the basic goal is to minimise the production costs. This general objective can be further subdivided into specific objectives as follows:

i) To reduce the costs by decreasing inventories, minimising the distance to be handled and increasing productivity.
ii) To increase the production capacity by smoothing the work flow.
iii) To minimise the waste during handling
iv) To improve distribution through better location of facilities and improved routing.
v) To increase the equipment and space utilisation.
vi) To improve the working conditions.
vii) To improve the customer service.

The analysis of materials handling requirements can be carried out by using travel charts and other quantitative techniques as outlined in section 7.5.

The basic materials handling function has to answer a number of questions as follows:

i) Why do this at all? Justifying the necessity of material handling.
ii) What material is to be handled? Giving the type (unit, bulk etc.), characteristics (shape, dimension etc.) and quantity.
iii) Where and when? Specifying the move in terms of source and destination, logistics, characteristics (distance, frequency, speed, sequence etc.) and type (transporting, conveying, positioning etc.)
iv) How? And Who? Specifying the method in terms of the handling unit (load support, container, weight, number etc.), equipment, manpower, and physical restrictions (column spacing, aisle width, conjestion etc.)

Basic Materials Handling Systems

The different material handling systems can be classified according to the type of equipment used, material handled, method used or the function performed.

Equipment-Oriented Systems: Depending upon the type of equipment used, there are several systems.:

i) Overhead systems
ii) Conveyer systems
iii) Tractor-trailor system
iv) Fork-lift truck and pallet system
v) Industrial truck systems
vi) Underground systems.

Material Oriented Systems: These may be of the following types:

i) Unit handling systems
ii) Bulk handling systems
iii) Liquid handling systems

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A unit load consists of a number of items so arranged that it can be picked up and moved as a single entity such as a box, bale, roll etc. Such a system is more flexible and requires less investment.

Method Oriented Systems: According to the method of handling and method of production, the material handling systems can be:

i) manual systems
ii) mechanised or automated systems
iii) job-shop handling systems, or
iv) mass-production handling systems

Function Oriented Systems: The systems can be defined according to the material handling function performed as follows:

i) Transportation systems
ii) Conveying systems
iii) Transferring systems
iv) Elevating systems

Selection and Design of Handling System

The selection and design of the material handling system should be done alongside the development of the layout as each one affects each other. Hence, an integrated approach to the design process is usable. A computerised technique known as COFAD (Computerised Facilities Design) has been developed for integrated handling system and layout design. The steps to be followed in the selection and design of handling systems are as follows:

i) Identification of system
ii) Review of design criteria and objectives of the handling system
iii) Data collection regarding flow pattern and flow requirements
iv) Identification of activity relationships
v) Determining space requirement and establishing material flow pattern
vi) Analysis of material and building characteristics
vii) Preliminary selection of basic handling system and generation of alternatives considering feasibility of mechanisation and equipment capabilities
viii) Evaluation of alternatives with respect to optimal material flow, utilising gravity, minimum cost, flexibility, ease of maintenance, capacity utilisation and other objectives of the system design considering various tangible and intangible factors
ix) Selection of the best suited alternative and checking it for compatibility
x) Specification of the system
xi) Procurement of the equipment and implementation of the system

5.10 MATERIALS HANDLING EQUIPMENT

After the simplification of the handling method the selection of equipment is important with respect to the different objectives of speed, efficiency-cost etc. There are both the manual and powered kind of handling equipments. Some of the typical handling equipments are shown in Figure VIII. Apple (1977) has classified the handling equipments into four basic types, viz., conveyers, cranes and hoists, trucks, and auxiliary equipment.

Conveyers

These are gravity or powered devices commonly used for moving uniform loads from point to point over fixed paths, where the primary function is conveying. Commonly used equipment under this category are:

i) Belt Conveyer
ii) Roller Conveyer
iii) Chain Conveyer
iv) Bucket Conveyer
v) Trolley Conveyer
vi) Screw Conveyer
vii) Pipeline Conveyer
viii) Vibratory Conveyer
ix) Chute.

Cranes, Elevators and Hoists

These are overhead devices used for moving varying loads intermittently between points within an area, fixed by the supporting and binding rails, where the primary function is transferring or elevating. Some common examples are:

i) Overhead travelling crane
ii) Gantry crane
iii) Jib crane
iv) Elevators
v) Hoists
vi) Stacker crane
vii) Winches
viii) Monorail

Industrial Trucks and Vehicles

These are hand operated or powered vehicles used for movement of uniform or mixed loads intermittently over various paths having suitable running surfaces and clearances where the primary function is manoeuvering or transporting. These include:

i) Fork lift truck
ii) Platform truck
iii) Industrial tractors and trailors
iv) Industrial cars
v) Walkie truck
vi) Two-wheeled hand truck or trolley
vii) Hand stacker

Auxiliary Equipment

These are devices or attachments used with handling equipment to make their use more effective and versatile. Some common examples are:

i) Ramps
ii) Positioners
iii) Pallets and skids
iv) Pallet loader and unloader
v) Lift truck attachments
vi) Dock boards and levelers
vii) Containers
viii) Below the hook devices
ix) Weighing equipment

Activity E

What is the materials handling system used in your organisation. Does it offer scope for improvement?

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5.11 SUMMARY

In this unit we have discussed different types of layout problems. The basic types of plant layouts have been identified as product layout, process layout, job shop layout, cellular layout and fixed position layout. The factors to be considered in designing plant layout are outlined as man, material, machine, movement or flow, service facilities, building and flexibility.