PLANT /FACILITY LOCATION

Location can be defined as “a place to put something”. Facility location means a place to put the facility. Facility location decisions are strategic, long term, and non-repetitive in nature. Without sound location planning in the beginning, 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 organization'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. Thus, for long term benefits of the facility, a sound and careful location planning is required.

Location planning deals with determining the optimal location for one or more new facilities to serve a set of customers. This type of problem arises in many areas, such as location of manufacturing facility, storage facility, etc. Location planning may involve finding the best site for the plant, which is termed as plant location. Location planning may also involve deciding the location of each specific piece of machinery and equipment in a particular area of a facility .

When does a facility location (plant location) decision arise?

- It may arise when a new facility is to be located
- In some cases, a poor site restricts the facility or plant operations and subsequent expansions, thereby necessitating setting up the facility at a new site.
- The growing volume of a business makes it advisable to establish additional facilities in new territories.
- New economic, social, legal or political factors could suggest a change of the location of the existing plant.

Factors affecting the facility location study

Location studies are normally made in two phases,

(1) The general territory selection phase and

(2) The exact site selection phase

The important factors to be considered for the selection of territory and subsequent selection of a particular site are:

• Market: It is a very important factor with respect to both phases of location studies. If product is fragile and susceptible to spoilage, proximity of the facility to the market is critical. If the product is relatively cheap and transportation cost is high, a location close to the markets is desirable.

• Raw material and supplies: The facility in general should be near to the vendors / suppliers. This will further reduce the transportation cost of incoming materials and the lead-time of the inventory replenishment.

• Transportation facilities: Transportation facilities must be available.

• Climate: Climate is another important factor to be considered for the facility location especially in industries where special constraints are needed, for example the textile industry requires a high humidity zone.

• Site size: The plot of land must be large enough to hold the facilities required by the proposed facility. Sometimes a good site may not have the required area.

• Community attitude: Community attitude is difficult to evaluate. Normally communities provide the overwhelming support to new industries, because this generates significant employment opportunities to the local people. Moreover, infrastructure development of the city or town progresses very rapidly. In some cases, when there is a fear of generation of pollution, community attitude goes in the reverse.

Other factors that may also affect the facility location decisions are manpower availability, land cost, waste disposal, and pollution.

Requirements governing the choice of a plant in a city location

The requirements that govern the choice of a plant or a facility to be located in a city location include availability of adequate supply of labor force, high proportion of skilled employees, small plant site or multi-floor operations, good communication facilities, good banking and health care delivery system, and rapid contact with customers and suppliers.

Requirements governing the choice of a plant in a country location

The requirements that govern the choice of a plant or a facility to be located in a country location include large plant site, lesser effort required for anti-pollution measures, lower taxes, unskilled labor force requirement, and low wages.

PLANT LAYOUT

Facilities layout design refers to the arrangement of all equipment, machinery, and furnishings within a building envelope after considering the various objectives of the facility. The layout consists of production areas, support areas, and the personnel areas in the building

Need of Facilities Layout Design

The need for facilities layout design arises both in the process of designing a new layout and in redesigning an existing layout. The need in the former case is obvious but in the latter case it is because of many developments as well as many problems with in the facility such as change in the product design, obsolescence of existing facilities, change in demand, frequent accidents, more scrap and rework, market shift, introduction of a new product etc.

Objectives of Facilities Layout Design

Primary objectives of a typical facility layout include

(1) Overall integration and effective use of man, machine, material, and supporting services,

(2) Minimization of material handling cost by suitably placing the facilities in the best possible way,

(3) Better supervision and control,

(4) Employee's convenience, safety, improved morale and better working environment,

(5) Higher flexibility and adaptability to changing conditions and

(6) Waste minimization and higher productivity.

Types of Layout

The basic types of layouts are:

- Product layout
- Process layout
- Fixed position layout
- Cellular layout

Product layout

This type of layout is generally used in systems where a product has to be manufactured or assembled in large quantities. In product layout the machinery and auxiliary services are located according to the processing sequence of the product without any buffer storage within the line itself. A pictorial representation of a product type of layout is given in Figure

1. The advantages and disadvantages are given in Table 1.

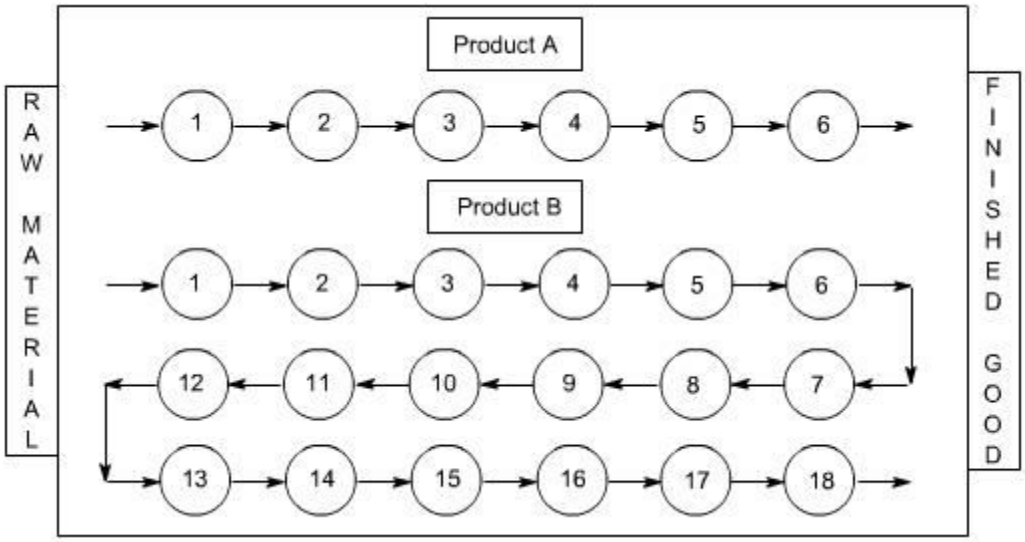

Figure 1: A Pictorial Representation of Product Type of Layout

Table 1: Advantages And Disadvantages of Product Type of Layout

ADVANTAGES	DISADVANTAGES
• Low material handling cost per unit • Less work in process • Total production time per unit is short • Low unit cost due to high volume • Less skill is required for personnel • Smooth, simple, logical, and direct flow • Inspection can be reduced • Delays are reduced • Effective supervision and control	• Machine stoppage stops the line • Product design change or process change causes the layout to become obsolete • Slowest station paces the line • Higher equipment investment usually results • Less machine utilization • Less flexible

Process layout

In a process layout, (also referred to as a job shop layout) similar machines and services are located together. Therefore, in a process type of layout all drills are located in one area of the layout and all milling machines are located in another area. A manufacturing example of a process layout is a machine shop. Process layouts are also quite common in non-manufacturing environments. Examples include hospitals, colleges, banks, auto repair

shops, and public libraries

A pictorial representation of a process type of layout is given in Figure 2. The advantages and disadvantages are given in Table 2.

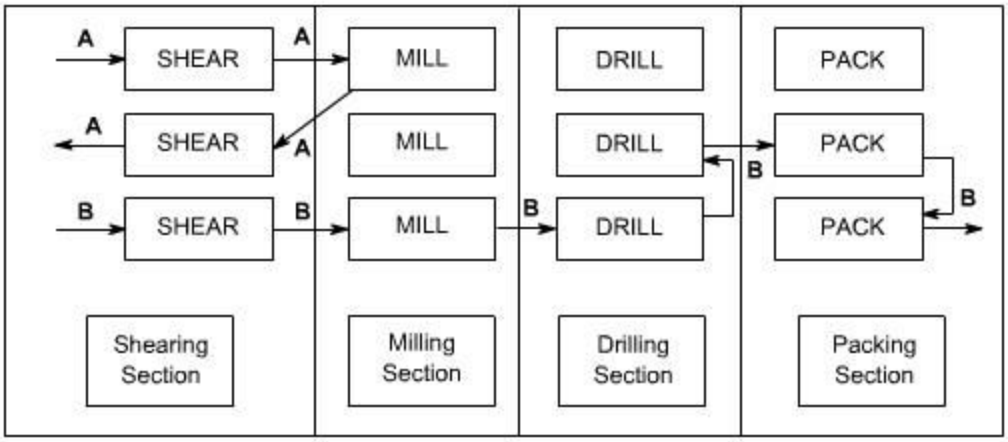

Figure 2: A Pictorial Representation of Process Type of Layout

Table 2: Advantages And Disadvantages of Process Type of Layout

ADVANTAGES	DISADVANTAGES
• Better machine utilization • Highly flexible in allocating personnel and equipment because general purpose machines are used. • Diversity of tasks for personnel • Greater incentives to individual worker • Change in Product design and process design can be incorporated easily • More continuity of production in unforeseen conditions like breakdown, shortages, absenteeism	• Increased material handling • Increased work in process • Longer production lines • Critical delays can occur if the part obtained from previous operation is faulty • Routing and scheduling pose continual challenges

Fixed location layout

In this type of layout, the product is kept at a fixed position and all other material; components, tools, machines, workers, etc. are brought and arranged around it. Then assembly or fabrication is carried out. The layout of the fixed material location department involves the sequencing and placement of workstations around the material or product. It is

used in aircraft assembly, shipbuilding, and most construction projects. A pictorial representation of a fixed location type of layout is given in Figure 3. The advantages and disadvantages are detailed in Table 3.

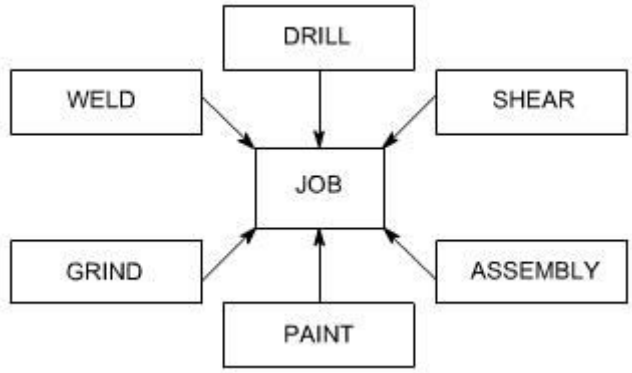

Figure 3: A Pictorial Representation of Fixed Location Type of Layout

Table 3: Advantages And Disadvantages of Fixed Location Type of Layout

ADVANTAGES	DISADVANTAGES
• Material movement is reduced • Promotes pride and quality because an individual can complete the whole job • Highly flexible; can accommodate changes in product design, product mix, and production volume	• May result in increase space and greater work in process • Requires greater skill for personnel • Personnel and equipment movement is increased • Requires close control and coordination in production and personnel scheduling

INTRODUCTION AND IMPORTANCE of MATERIAL HANDLING

Material handling is a necessary and significant component of any productive activity. It is something that goes on in every plant all the time. Material handling means providing the right amount of the right material, in the right condition, at the right place, at the right time, in the right position and for the right cost, by using the right method. It is simply picking up, moving, and lying down of materials through manufacture. It applies to the movement of raw materials, parts in process, finished goods, packing materials, and disposal of scraps. In general, hundreds and thousands tons of materials are handled daily requiring the use of large amount of manpower while the movement of materials takes place from one processing area to another or from one department to another department of the plant. The cost of material handling contributes significantly to the total cost of manufacturing.

In the modern era of competition, this has acquired greater importance due to growing need for reducing the manufacturing cost. The importance of material handling function is greater in those industries where the ratio of handling cost to the processing cost is large. Today material handling is rightly considered as one of the most potentially lucrative areas for reduction of costs. A properly designed and integrated material handling system provides tremendous cost saving opportunities and customer services improvement potential.

DEFINITIONS

There are many ways by which material handling has been defined but one simple definition is “Material handling is the movement and storage of material at the lowest possible cost through the use of proper method and equipment”.

Other definitions are:

- “Material handling embraces all of the basic operations involved in the movement of bulk, packaged, and individual products in a semisolid or solid state by means of machinery, and within limits of a place of business”.
- “Material handling is the art and science of moving, storing, protecting, and controlling material”
- “Material handling is the preparation, placing, and positioning of materials to facilitate their movement or storage”.

OBJECTIVES OF MATERIAL HANDLING

The primary objective of a material handling system is to reduce the unit cost of production. The other subordinate objectives are:

1. Reduce manufacturing cycle time
2. Reduce delays, and damage
3. Promote safety and improve working conditions
4. Maintain or improve product quality
5. Promote productivity

    i. Material should flow in a straight line
    ii. Material should move as short a distance as possible
    iii. Use gravity
    iv. Move more material at one time
    v. Automate material handling

6. Promote increased use of facilities

    i. Promote the use of building cube
    ii. Purchase versatile equipment
    iii. Develop a preventive maintenance program
    iv. Maximize the equipment utilization etc.

7. Reduce tare weight

8. Control inventory

Reduce Cost of Handling

The total cost of material handling per unit must decrease. The total cost per unit is the sum of the following:

1. Cost of material handling equipment – both fixed cost and operating cost calculated as the cost of equipment divided by the number of units of material handled over the working life of the equipment.
2. Cost of labor – both direct and indirect associated cost calculated in terms of cost per unit of material handled.
3. Cost of maintenance of equipment, damages, lost orders and expediting expenses, also calculated, in terms of cost per unit of material handled.

Reduced Manufacturing Cycle Time

The total time required to make a product from the receipt of its raw material to the finished state can be reduced using an efficient and effective material handling system. The movement of the material can be faster and handling distance could be reduced with the adoption of an appropriate material handling system.

LIMITATIONS OF AUTOMATED MATERIAL HANDLING SYSTEMS:

A good management practice is to weigh benefits against the limitations or disadvantages before contemplating any change. Material handling systems also have consequences that may be distinctly negative. These are:

1. Additional investment
2. Lack of flexibility
3. Vulnerability to downtime whenever there is breakdown
4. Additional maintenance staff and cost
5. Cost of auxiliary equipment.
6. Space and other requirements:

The above limitations or drawbacks of adopting mechanized handling equipment have been identified not to discourage the use of modern handling equipment but to emphasize that a judicious balance of the total benefits and limitations is required before an economically sound decision is made.

WHEN TO DESIGN A MATERIAL HANDLING SYSTEM?

The need to design a material handling system arises when:

1. A new product is being planned for manufacture
2. Change in the existing product design requiring a corresponding change in the layout
3. Obsolescence of facilities
4. Frequent accidents
5. Adoption of new safety standards

SCOPE OF MATERIAL HANDLING

The scope of material handling activity in any industry depends on the type and size of industry, the product manufactured, the value of the product, the value of the activity being performed, and the relative importance of material handling activity to the other activities. However, it should be emphasized that a sizable portion of total material handling activity is not in manufacturing but in the fields of distribution, service industries, agriculture, and construction. It is very important that both the beginning student and material-handling engineer be aware of the material handling applications in the following areas:

1. Industrial material handling
2. Transportation industries
3. Warehousing
4. Extractive industries
5. Process industries

PRINCIPLES OF MATERIAL HANDLING

The College-Industry Council on Material Handling Education (CICMHE), sponsored by Material Handling Institute Inc., adopted 20 principles of material handling.

These principles (Table 1.) represent the experience of designers who have been working in the design and operations of handling systems. These principles serve as rough guides or rules of thumb for material handling system design. The designers of material handling

systems are usually advised to follow the following principles. However, in some cases they might not be able to apply them to the fullest extent because of factors such as the limitation on capital, physical characteristics of the building, and capability of the equipment.

Table 1. Material Handling Principles

1. Planning Principle 2. Systems Principle 3. Material Flow Principle 4. Simplification Principle 5. Gravity Principle 6. Space Utilization Principle 7. Safety Principle 8. Standardization Principle 9. Maintenance Principle 10. Obsolescence Principle	11. Flexibility Principle 12. Mechanization Principle 13. Cost Principle 14. Ergonomic Principle 15. Energy Principle 16. Ecology Principle 17. Computerization Principle 18. Orientation Principle 19. Layout Principle 20. Unit Load Principle

FACTORS FOR CONSIDERATION IN MATERIAL HANDLING SYSTEM DESIGN

The material handling system design process is iterative. The analyzer has to go back and forth between the different steps until a satisfactory design has been obtained and can be implemented. The major factors for consideration in material handling system design are:

1. Material

   i. Form – gas, liquid, semi – liquid, solid
   ii. Nature – bulk, unit load, individual items, fragile, sturdy, bulky
   iii. Characteristics – chemical, electrical, mechanical
   iv. Quantity – pieces, pounds, gallons, other

2. Move

   i. Source and destination – receiving, stockroom, ware house, same floor, other floor, other department
   ii. Route – location , range, path, cross traffic
   iii. Distance – horizontal, vertical, inclined
   iv. Frequency – intermittent, uniform, regular, irregular, unpredictable

v. Speed

3. Methods

i. Unit or load – bulk, items, containers
ii. Manpower – one, several, many, none
iii. Equipment – conveyor, forklift truck, crane etc