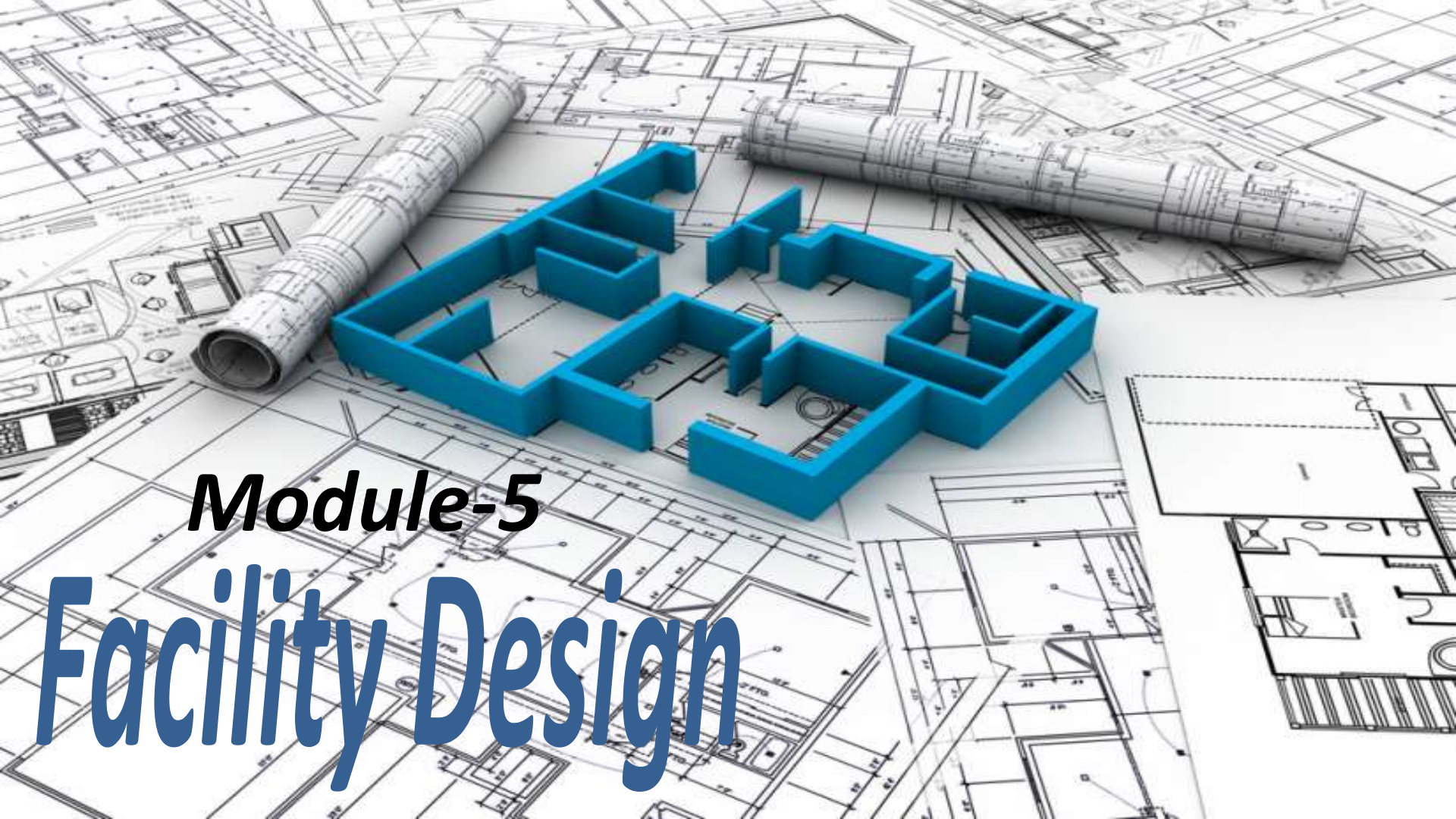

Module-5
Facility Design

BVCOENM - Vision & Mission

INSTITUTE

VISION: "Social transformation through dynamic education"

MISSION: To impart quality education to meet the needs of industry, profession and society; and to achieve excellence in teaching, learning and research.

DEPARTMENT

VISION: "To be recognized as leading mechanical engineering discipline by enhancing the knowledge and skills for the sustainable development."

MISSION:

Sociotechnological Skills: To educate students through various activities including technical education, research and social service.

Centre of Focus: To promote prevailing challenges based projects and activities for socio-economic development.

Competitiveness: To develop competency in graduates for their career development to sustain in challenging environment.

Content

1. Facility location factors
2. Evaluation of alternate locations
3. Types of plant layout and their evaluation
4. Computer aided layout design techniques
5. Assembly line balancing
6. Materials handling systems
7. Concepts of Group Technology
8. Cellular manufacturing

Course Outcome

1. Illustrate the need for optimization of resources and its significance
2. Develop ability in integrating knowledge of design along with other aspects of value addition in the conceptualization and manufacturing stage of various products.
3. Demonstrate the concept of value analysis and its relevance.
4. Manage and implement different concepts involved in method study and understanding of work content in different situations.
5. ***Describe different aspects of*** work system design and ***facilities design pertinent to manufacturing industries.***
6. Illustrate concepts of Agile manufacturing, Lean manufacturing and Flexible manufacturing

Introduction

- Facility Design includes
  - Facility Location
  - Facility Layout
- ***Facility location*** *is the process of identifying the best geographic location for a service or production facility*
- ***Facility layout*** *means a technique for the location of machines, utilities, employee workstations, customer's services area, restrooms etc. to obtain greatest possible output with better quality at lowest possible overall cost.*

Facility Location

- Facility location means a place to put the facility.
- Traditionally, location theorists have dealt with industrial plant/factory location. However, the concept of **plant location** has now been generalized 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 fertilizer, 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 center, central repair workshop etc.
- Facility location decisions are strategic, long term, and non-repetitive in nature.

Facility Location

- 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 Location Decision Arise ?

1. It may arise when a new facility is to be established.
2. 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.
3. The growing volume of business makes it advisable to establish additional facilities in new territories.
4. Decentralization 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.
5. It could happen that the original advantages of the plant have been outweighed due to new developments.
6. New economic, social, legal or political factors could suggest a change of location of the existing plant.

Facility location factors

- There are two types of factors (or criteria) on which location decisions are based:
  - quantitative (or objective) factors and
  - qualitative (or subjective) factors.
- The objective factors involve cost of land, transportation costs, utilities rates etc.
- The subjective factors include labour availability, climate, community environment, quality of life, local politics etc.
- Also, the factors affecting plant location are considered as general location factors which include controllable and uncontrollable factors for all types of organizations.
- Controllable Factors are proximity to the markets, supply of raw materials, transportation facilities, infrastructural facilities and availability of labour and wages
- Uncontrollable factors are government policy, climatic conditions, supporting industries and services, community and labour attitudes and Community infrastructure

Facility location factors

Transportation Factors	Utilities Factors	Labour Factors	Climate, Community, Environment etc.	States and Local Political Factors
• Proximity to raw material • Closeness to markets • Modes of transportation • Transportation costs	• Power • Water • Fuel • Waste disposal	• Labor supply • Labor management relations • Availability of skilled labor • Labor costs	• Climate and living conditions • Education • Community attitude • Religious factors	• Taxation policies • Tax structure

Facility location factors

Proximity to the markets

A. Location of facilities closes to the market-
   - Provide goods and services at time and at reasonable price
   - Reduce the transportation cost

B. Location of facilities closes to the market (based on the product)
   - Delicate and susceptible to spoilage
   - Services are promptly required very often
   - Self life of the product is low

Supply of raw material
   - In right quality and at right time in order to have an uninterrupted production.
   - Availability of raw materials nearer to the plant location decreases the transportation cost.
   - Examples of such industries- sugar industry, cement industry, jute and cotton industry

Facility location factors

Transport facility

- Transportation facilities are very important for bringing raw materials to the factory
- Transport facilities are also important to transport the finished goods to the market.
- A place which is well connected by rail, road, air and water is suitable for setting up of a plant.

Infrastructure

- The basic infrastructure facilities are power, water and waste disposal.
- Certain types of industries are strongly power dependent for example, aluminum and steel.
- Process industries like paper chemical cement require continuous supply of water in large amount and in good quality
- A waste disposal facility for process industries is an important factor which influences the plant location

Facility location factors

Availability of labour and wages

- Adequate number of labour and with specific skills
- Cheap manpower needs training programs which need extra funding
- Now-a-days influence of skilled labour on plant has lost because of mobility.
- The prevailing wage pattern, cost of living, industrial relations and bargaining power of the employee's union also plays an important role

Government policies

- The policies of the state governments and the local bodies concerning the labour laws, building codes, safety are the factors that demand attention.
- Certain incentives given by the government to the entrepreneurs in certain location
- Exemption from sales tax and excise duties
- Soft loans from the government approved financial institutions
- Subsidy in electrical charges
- Investment subsidy

Facility location factors

Supporting industries and services

- Now -a- days manufacturing organization will not make all the components and parts by itself
- The source of supply of component parts will be one of the factors that influences the location
- The various services like communication banking services professional consultancy services and other civil amenities will play a vital role in selection of a location.

Steps in Location Planning

1. Determine the criteria to evaluate location alternatives
2. Identify the factors relevant to the facility being planned
3. Select Better location option using various techniques (Factor Rating / Break Even Analysis)
4. Find out location with least transportation cost using various techniques (Simple Median Model / Center of Gravity Model / Transportation Model)
5. Select best location

Evaluation of alternate locations

1. Cost volume analysis
2. Factor rating method
3. Center of gravity method
4. Transportation models

Cost volume analysis

Steps :-

- Determine fixed and the variable costs
- Plot the total cost
- Determine lowest total cost

Assumptions:-

- The fixed costs are constant
- The variable costs are linear
- The output can be closely estimated
- Only one product is involved

Cost volume analysis- Example

Fixed and variable cost for 4 potential locations are given in the table below to produce 10000 products

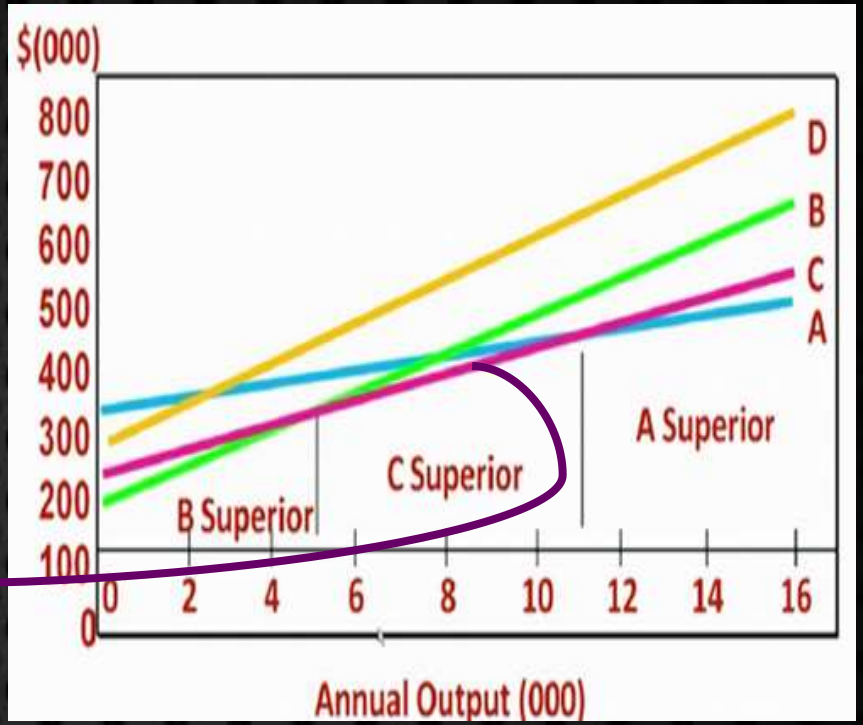
Location	Fixed Cost (Rs.)	Variable Cost (Rs.)
A	2,50,000	11
B	1,00,000	20
C	1,50,000	30
D	2,00,000	35

Cost volume analysis- Solution

For 10,000 products the variable cost will change

Location	Fixed Cost (Rs.)	Variable Cost (Rs.)	Total cost (Rs.)
A	2,50,000	11(10,000)	3,60,000
B	1,00,000	20(10,000)	4,00,000
C	1,50,000	30(10,000)	3,50,000
D	2,00,000	35(10,000)	5,50,000

The pink color line representing C at 10000 is giving us the minimum total cost



Factor rating method

- Most widely used location technique
- Useful for service and industrial location
- Rates locations using factors
- Decisions based quantitative and qualitative inputs
  - Intangible (qualitative) factor

    Example : education quality, labour skills
  - Tangible (quantitative) factors

    Example : short-term and long-term cost
- Based on the weighted average

Factor rating method

Steps

1. List relevant factors
2. Assign importance weight to each factor (0 to 1)
3. Make sum of weights as unity
4. Set a scale for scoring each factor (1 to 10 or 1 to 100)
5. Score each location using the factor scale
6. Multiply score by weights for each factor and add
7. Select the location with maximum total score

Factor rating method

- Three locations A, B and C, Four factors
- Assign weights to each factor
- Score each location on each factor
- Multiply the weight and the score and sum for each location

Factor	Weight	A	B	C
Cost	0.3			
Proximity to the source	0.2			
Taxes	0.1			
Labour	0.4			

Factor rating method

Factor	Weight	A	B	C
Cost	0.3	10	9	7
Proximity to the source	0.2	7	3	10
Taxes	0.1	7	5	10
Labour	0.4	6	8	5
		7.5	7	7.1

Center of gravity method

- Decision is based on the minimum distribution costs
- To find out a location of a single facility serving several destinations.
- Used for services and distribution centers

Requires

- Location of the existing destinations.
- Volume or the quantity to be shipped
- Shipping distance or cost

Center of gravity method

- Fix x and y coordinates for all the destinations
- Can use an arbitrary coordinate grid
- Calculate center of gravity location for facility as weighted average of x and y coordinates
- Minimizes the transportation cost approximately
- Location is not necessarily optimal, but it is usually close to the ideal scenario

Center of gravity method

- X coordinates

$$C_x = \frac{\sum_i d_{ix} W_i}{\sum_i W_i}$$

- Y coordinates

$$C_y = \frac{\sum_i d_{iy} W_i}{\sum_i W_i}$$

Where

d_{ix} = x coordinate of location i

W_i = Volume of goods moved to or from location i

d_{iy} = y coordinate of location i

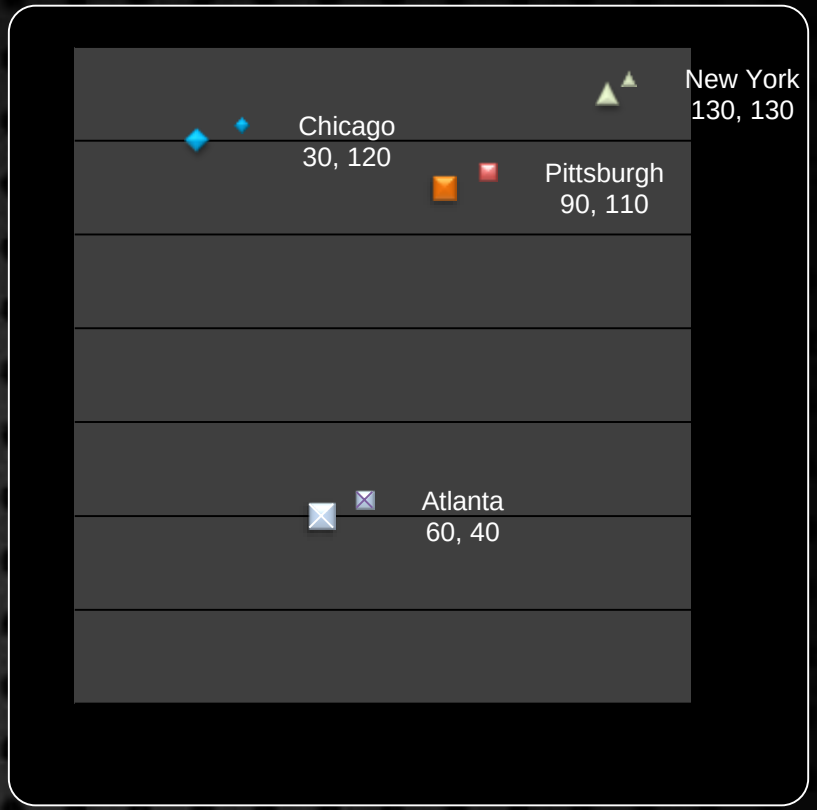
Center of gravity method - Example

- Four cities with the volume of demand and (x, y) coordinates are given
- Find location for a warehouse minimizing total distance to supply these cities

Location	Volume
Chicago	200
Pittsburgh	100
New York	100
Atlanta	200

Center of gravity method - Example

Location	Volume	X coordinates	Y coordinates
Chicago	200	30	120
Pittsburgh	100	90	110
New York	100	130	130
Atlanta	200	60	40



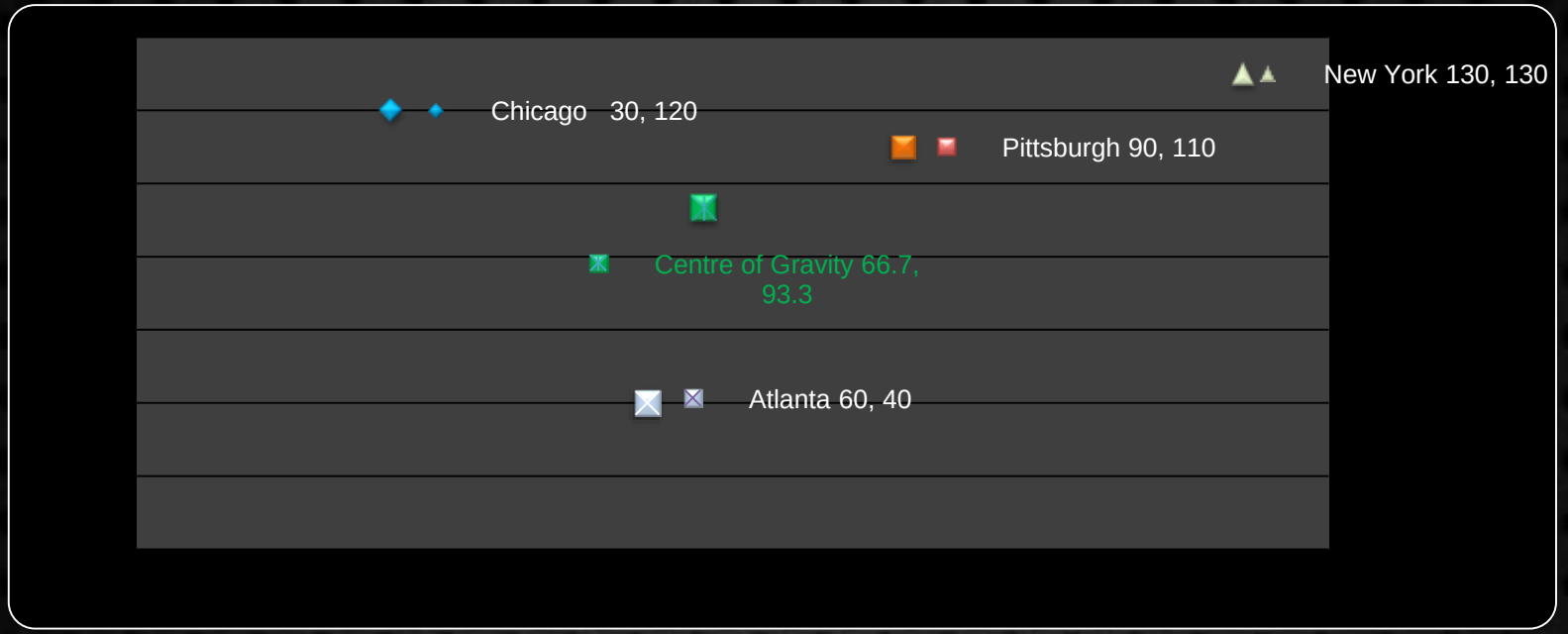
Center of gravity method

X coordinate of warehouse:

- Cx= (200 x 30 + 100 x 90 + 100 x 130 + 200 x 60)/(200+100+100+200) = 66.7

Y coordinate of warehouse:

- Cy= (200 x 120 + 100 x 110 + 100 x 130 + 200 x 40)/(200+100+100+200) = 93.3



Transportation models

- The transportation problem is concerned with the distribution of goods or services from various sources to various destinations.
- The transportation problem can be formulated as a linear programming problem.
- The total transportation cost at various locations can be calculated and the location with the least total transportation cost can be chosen

Transportation models

Requirements:

- List of origins and each one's capacity
- List of destinations and each one's demand
- Unit cost of shipping
- Assumptions:
- Items to be shipped are homogeneous
- Shipping cost per unit is the same
- Only one route is there between the origin and the destination

Transportation models

- m = number of sources/factories
- N = number of destinations/warehouses
- Ai = the supply at source I,
- bj = the demand at destination j
- cij = cost of transportation per unit from source I to destination j
- Xij = the number of units to be transported from the source I to destination j

		1	3		j		n	Supply
SOURCES	1	**C11**	**C12**		**C1j**		**C1n**	a1
	2							a2
	i	Ci1	Ci2		Cij		Cin	an
	m	Cm1	Cm2		Cmj		Cmn	am
Demand		b1	b2		bj		bn	

Transportation models

Solving Methods

- Row minima method
- Column minima method
- Least cost method
- Vogel's approximation method
- Northwest corner method

Facility/Plant Layout

Definition

- *Facility layout means a technique for the location of machines, utilities, employee workstations, customer's services area, restrooms etc. to obtain greatest possible output with better quality at lowest possible overall cost.*
- The layout consists of production areas, support areas, and the personnel areas in the building
- 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 within 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.

Facility/Plant Layout

Main Objectives of Layout

- Better quality of product
- Maximum utilization of space, labour and machine
- Lower scrap and waste
- Minimum production delays
- Provision for space for future expansion
- Avoidance of unnecessary changes
- Proper production control
- Minimum wasteful efforts and speeding of production
- Fewer accidents
- Easy supervision
- Overall integration and effective use of man, machine, material, and supporting services,
- Minimization of material handling cost by suitably placing the facilities in the best possible way,
- Better supervision and control,
- Employee's convenience, safety, improved morale and better working environment,
- Higher flexibility and adaptability to changing conditions and
- Waste minimization and higher productivity.

Types of Plant Layout

The basic types of layouts are:

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

Facility Layout

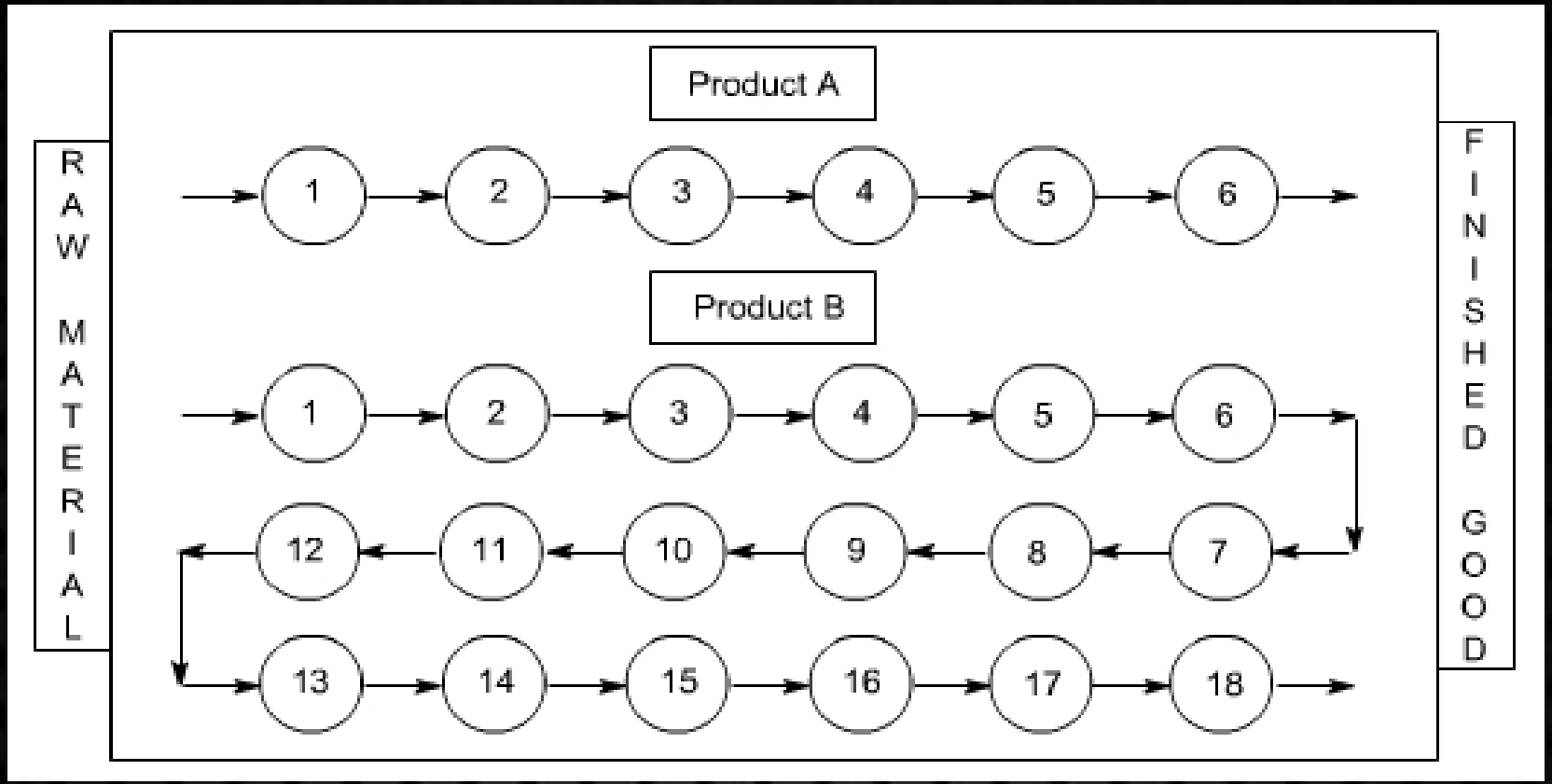
Factors Affecting Facility Pattern within the Department

- External transport facilities.
- Number of products to be handled.
- Number of operations on each product.
- Number of units to be processed.
- Number of sub-assemblies made up ahead of assembly lines.
- Size and shape of available land.
- Necessary flow between work areas.

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.
- Product layouts are designed to accommodate only a few product designs.
- Such layouts are designed to allow direct material flow through the facilities for products.
- This type of layout is very popular in mass production, i.e. only one product or one type of product is produced in such type of layout.
- The necessary condition for the profitability in such layout is to manufacture the items in huge quantities.
- The machines in such layout are laid in such a manner that the operation is performed in sequence.
- This arrangement of layout is also known as “synthetic system” of manufacture.

Product Layout



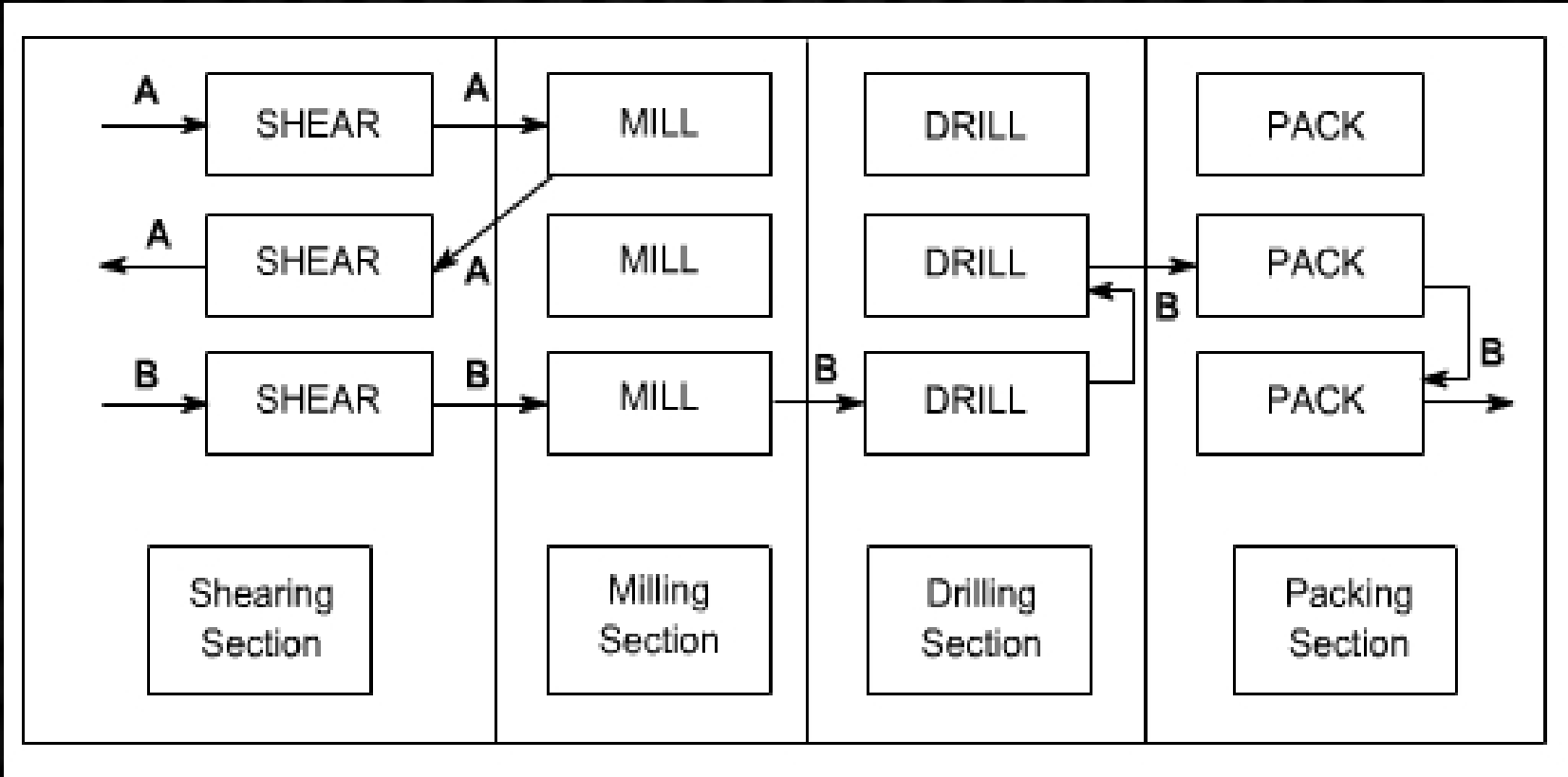
Product Layout

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.
- 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.
- Process layout, functional layout or job shops are designed to accommodate the variety of product designs.
- This layout is generally used for producing a variety of products in relatively small batches. Under this arrangement each department or section is responsible for carrying out a particular process, irrespective of type of product as in the case of product layout.
- In such layout, similar operations are carried out in each department or section. The factories using this layout have no standard products, and if any, they are few.
- Therefore, machine in this type of layout are generally arranged on functional basis. This type is also called analytical layout.
- 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

Process Layout



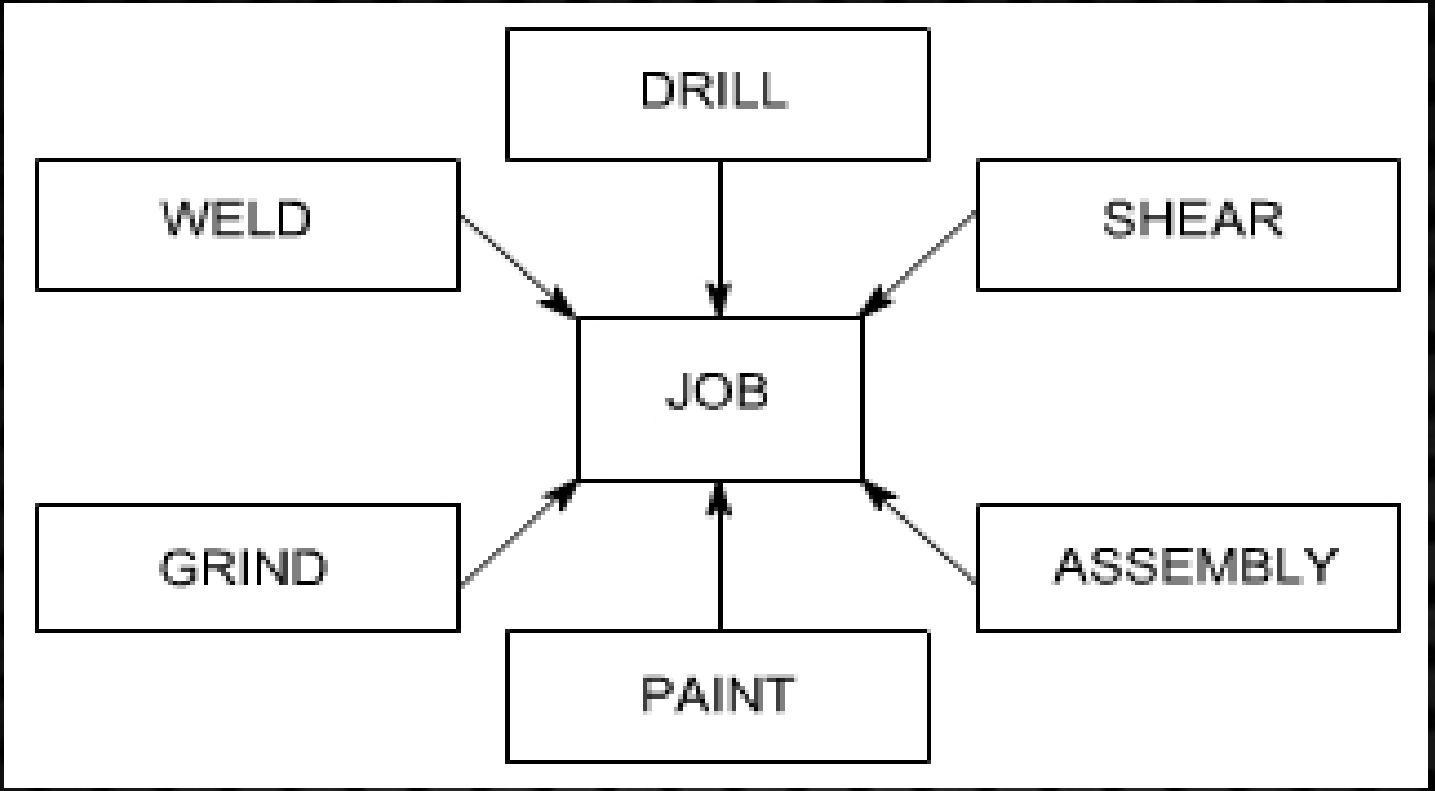
Process Layout

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 Position 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.

Fixed Position Layout



Fixed Position Layout

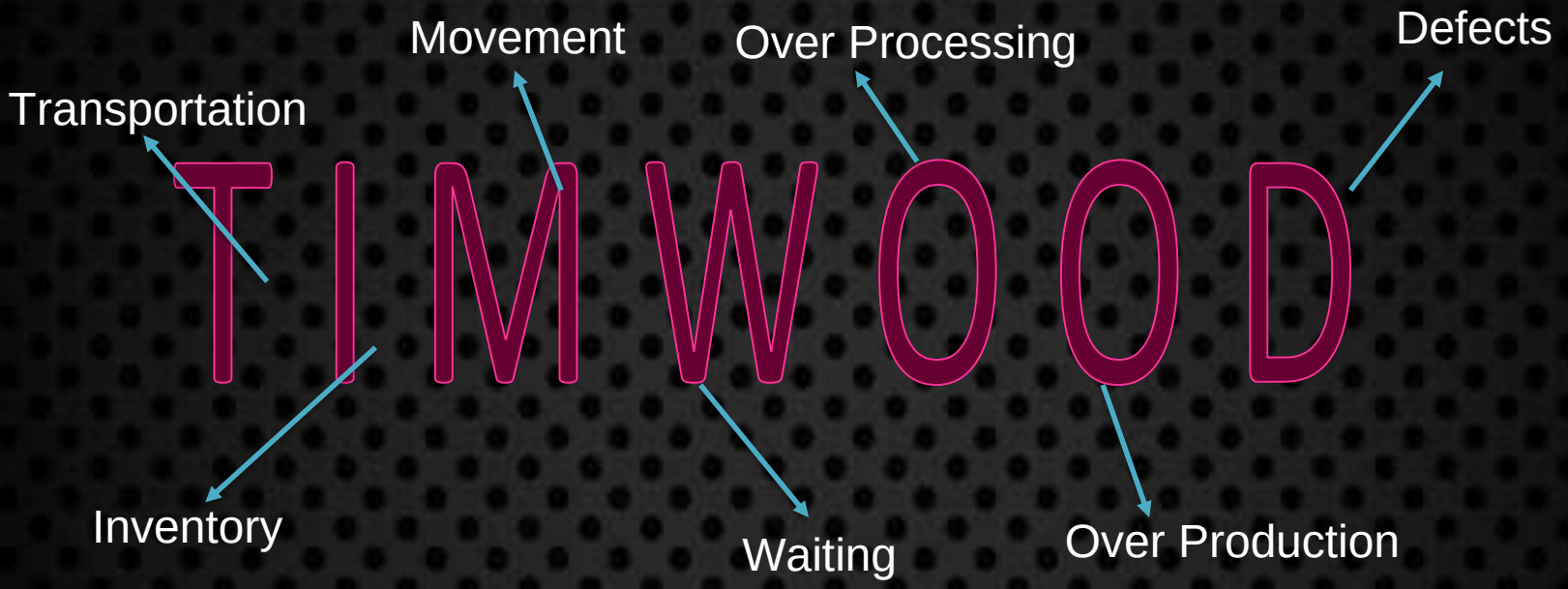
ADVANTAGES	DISADVANTAGES
• Material movement is reduced • Promotes pride and quality because an individual can complete the whole job • Highly flexible; can accommodate changes in product design, product mix, and production volume	• May result in increase space and greater work in process • Requires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

Cellular Layout

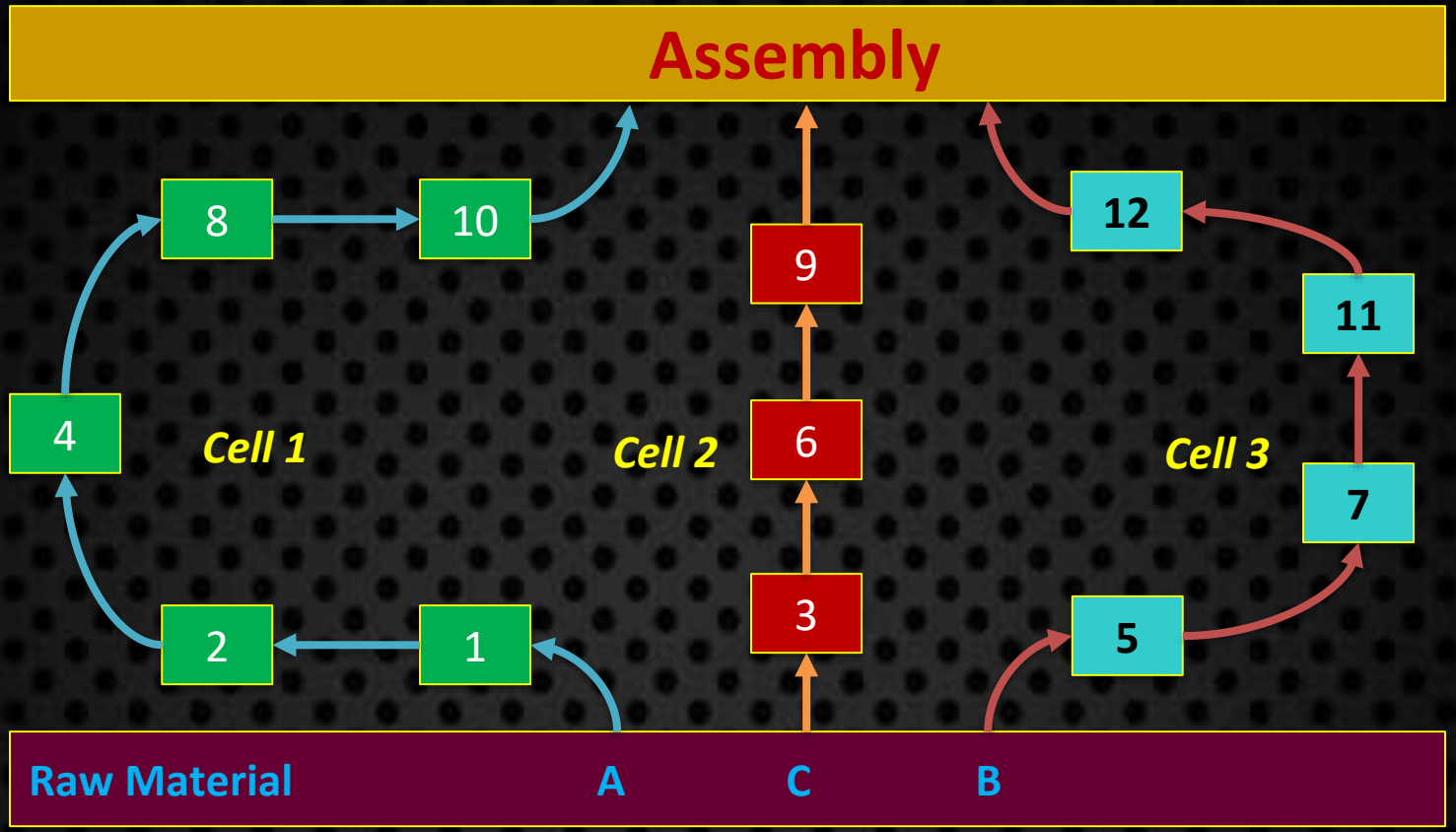
- Recognizing people and machines into a group so that they can focus on making a single product or a group of related products.
- Each team works in a small area, or cell, equipped with everything that it needs to function as a self-contained unit. Machines are sometimes configured in a U-shape, with people working inside the U. Because team members often share duties, they're trained to perform several different jobs. Teams monitor both the quantity and the quality of their own output. This arrangement often results in faster completion time, lower inventory levels, improved quality, and better employee morale.
- Cellular manufacturing is used by large manufacturers, such as Boeing, Raytheon, and Pratt & Whitney, as well as by small companies, such as Little Enterprise, which makes components for robots.
- Every cell contains a group of machines which are dedicated to The production of a family of parts.
- One of the problems is to identify a family parts that require the Same group of machines.
- These layouts are also called as group technology layouts.

Cellular Layout

Objective : ELIMINATION OF WASTE (MUDA)



Cellular Layout



Cellular Layout

ADVANTAGES	DISADVANTAGES
• Reduced material handling and transit time • Reduced setup time • Reduced work-in-process inventory • Better use of human resources • Better scheduling, easier to control and automate • Less floor space required • Reduced direct labour • Heightened sense of employee participation • Increased use of equipment & machinery • Reduced investment on machinery & equipment	• Sometimes cells may not be formed because of inadequate part Families • Some cells may have a high volume of production and others very Low. This results in poorly balanced cells • When volume of production changes, number of workers are adjusted, and workers are reassigned to various cells. To cope With this type of reassignments, workers must be multi-skilled and Cross-trained • Sometimes, machines are duplicated in different cells. This Increases capital investment

Plant Layout Evaluation

The different techniques that are available and useful for layout planning are

- 1. Templates
- 2. Operations Sequence Analysis.
- 3. Line balancing.

Plant Layout Evaluation

1. Templates

- It is a two-dimensional technique which is the most commonly used.
- Templates are the design patterns which consists of a thin plate, made up of wood or metal and which serve as a gate for performing mechanical activities.
- It constitutes the scaled representation of the physical object of the layout.
- Templates are fixed for preparing plans, for drawing several possible layouts. The best possible option can be explored by eliminating the unnecessary handling and backtracking of materials.
- It is usually employed for re-designing the existing department/building - For verifying the layout design configuration decided by other layout technique.

Plant Layout Evaluation

2. Operation Sequence analysis

- It is an early approach to process type layout. It develops a good plan for arranging the departments graphically so that the layout problem get an optimal solution.
- Through the operations sequence analysis, the relative locations of operating department with respect to one another can be predicted.

Plant Layout Evaluation

3. Line Balancing

- It is an important activity of an assembly line operation, which is mainly used for the equitable distribution of work among the employees so that total number of employees can be greatly reduced.
- Line balancing is not an easy task because there are different alternative methods that can be far more easily applied than line balancing for the decision of work.
- Some of the methods used by operation researchers to study line balancing problems include linear programming, dynamic programming and other optimal methods.

Computer Aided Layout Design Techniques

- Automated layout design program (ALDEP)
- Computerized Relation ship Layout planning (CORELAP)
- Computerized Relative Allocation of Facilities Technique. (CRAFT)
- Computerized Plant Layout and Evaluation Technique. (PLANET).
- Computerized Facilities Design (COFAD)

Computer Aided Layout Design Techniques

COMPUTERIZED RELATIVE ALLOCATION OF FACILITIES TECHNIQUE (CRAFT) :

- CRAFT is the first improvement algorithm which is most widely used in plant layout design. This algorithm minimizes the material handling cost between the departments.
- CRAFT not only helps in designing layout by considering material handling cost, but also provide advancement in designing layout by considering the interpretation not material flow.
- Initially CRAFT performs the evaluation of given layout, hence considers the effects on design layout by interchanging the departments.
- A pair wise exchange criterion gives an optimum result, to minimize the transportation cost between the departments.
- The interchanging of the departments continues to extreme limit, where no further improvements can be made. In these locations are exchanged w.r.t similar are or with common border. It allows some departments to be fixed in position so that there is no chance of exchanging the locations.

Computer Aided Layout Design Techniques

INPUT REQUIREMENTS OF CRAFT

- Total number of Departments
- Number of interchangeable departments
- Number of fixed departments with their location.
- Location of those departments.
- Area of each department.
- Initial Layout
- Flow data (matrix which shows no of unit loads moving between all departments
- Cost per unit distance (cost matrix)

Computer Aided Layout Design Techniques

STEPS INVOLVED IN CRAFT:

- Step-1: note the input requirements.
- Step-2: compute centroids of all the departments in the present layout.
- Step-3: Form the distance matrix by using centroids.
- Step-4:. Given data on flow, distance and cost, compute the total handling cost of the present layout.
- Step-5: Find all the possible pair wise interchanges of departments based on concept of common border or equal area.
- Step-6: for each possibility, interchange the corresponding centroids and compute approximate costs.
- Step-7: Find the pair of departments corresponding to minimum handling cost from among all the possible pair of interchanges.
- Step-8: Is the cost in the previous is less than the total cost of the present layout?. If yes, go to step-8. If not go to step-11.
- Step-8: Inter change the selected pair of departments. Call this as the NEW-LAYOUT. Compute centrods, distance matrix and total cost.
- Step-9: is the cost of new layout is less than the cost of the present layout? If yes go to step-10. If not go to step-11.
- Step-10: The new layout is here after considered as the present layout. The data on centroids, layout matrix and the total cost is retained. Go to step-5.
- Step-11: Print the present layout as the FINAL LAYOUT.
- Step-12: stop the process.
- The above algorithm is schematically represented with help of flow chart.

Computer Aided Layout Design Techniques

ADVANTAGES OF CRAFT :

- Possibility of changing the input shapes
- CRAFT allows fixing of special locations.
- Computation speed of RAFT is fast and economical in operations.
- It can perform Mathematical operations easily.
- It is possible o check earlier interactions to run the program.
- It can be used for office layouts.

Computer Aided Layout Design Techniques

DISADVANTAGES OF CRAFT :

- Due to the need of initial layout, the program is strictly applied only to modify the already existing layout or to plan the new layout where borders (outline) are known.
- Distance between the departments is represented as a straight line.
- It requires manual adjustments.
- It does not provide the assurance of having lowest possible cost layout.
- It is difficult to improve the program produced by heuristic and sub-optimal procedure (CRAFT)
- While feeding the input data in a program, it requires an attentive construction.
- It requires better adaptation for resettlements.
- The solution obtained from CRAFT program mainly depends on the path
- It considers the unpleasant relationships.
- CRAFT is restricted to 40 departments.

Computer Aided Layout Design Techniques

COMPUTERIZED RELATION SHIP LAYOUT PLANNING (CORELAP)

- Computerized Relationship Layout Planning algorithm is a chart for construction of layout. The layout in CORELAP can be generated by locating the rectangular shaped departments, if departmental area and layout scale allows their representation in a rectangular form. CRELAP has the capacity to manage up to 70 number of departments.
- It uses the *A-E, I,* 0, *U* closeness ratings, space requirements and maximum building length to width ratio to develop a layout.

Computer Aided Layout Design Techniques

INPUT REQUIREMENTS OF CORELAP

- The number of departments in the layout.
- Area of each department.
- Length and width of layout.
- The closeness Relationship value based on
- Relationship chart. (REL chart)
- Scale of output
- Building length to width ratio
- Department pre-assignment.

Computer Aided Layout Design Techniques

STEP-BY-STEP PROCEDURE OF CORELAP

- STEP-1 : Provide basic input data in the following manner.
  - The number of departments in the layout.
  - Area of each department.
  - Length and width of layout.
  - The closeness Relationship values based on Relationship chart. (REL chart)
  - Scale of output
  - Building length to width ratio
  - Department pre-assignment

Computer Aided Layout Design Techniques

- STEP-2: Consider scale as 1 square = 600 sq.m Compute no. of square units for all the departments. no of squares = dept. area /Area per square in layout
- **STEP-3**: By using R EL- chart, compute total closeness rating for all the departments
- **STEP-4:**Select department with highest TCR value. The selected department occupy 1 square and it is placed in the centre of layout matrix.
- **STEP-5.** Check the closeness relationship of first selected dept with other departments. And note the corresponding closeness value . now select maximum REL value dept. Select that department which has maximum REL Value as 3rd selected dept.
- **STEP-6:** Repeat the above procedure with unassigned departments
- Apply above procedure till all the departments are selected. Select 1st priority dept as a first in placement order
- Select 2nd priority dept as a second in placement order
- Select 3rd priority department as a third in placement order
- Select 4th priority dept. as a fourth in placement order.
- Select 5th priority dept as a fifth in placement order
- • • • • •

Computer Aided Layout Design Techniques

AUTOMATED LAYOUT DESIGN PROGRAM (ALDEP)

- ALDEP belongs to the construction type program, which builds the layout with out using the existing layout.
- It also considered as an improvement program due to the evaluation process of accepting or rejecting the given layout. It builds the layout by placing the most related departments, size required and based on the closeness rating (ie, A or E) of A, E, I, O, U, X. it adds continuously the other departments till the placement of all activities has been completed. This process is continued till all the departments are placed in the layout and no department should be available for placing with high closeness rating. At this stage , score is computed for layout in terms of numerical values.
- This procedure is repeated for several times and evaluates the best layout with maximum layout score.

Computer Aided Layout Design Techniques

INPUT REQUIREMENTS OF ALDEP:

- The number of departments in the layout.
- Area of each department.
- Length and width of layout
- The values of closeness for the pairs of department based on Relationship chart.
- Minimum Department Preference (MDP) value
- Sweep width.
- The least possible score for an acceptable layout.
- Total number of layouts to be generated.
- Building outline and scale of layout printout.
- The location and size of each prohibited area (if present)

Computer Aided Layout Design Techniques

STEP BY STEP PROCEDURE OF ALDEP ALGORITM

- STEP-1: Give the input in following manner.
  - The number of departments in the layout.
  - Area of each department.
  - Length and width of layout
  - The values of closeness for the pairs of department based on Relationship chart.
  - Minimum Department Preference (MDP) value
  - Sweep width.
  - Number of iterations to be carried out (N)
  - Current iteration number (I)
  - Location and sie of fixed department (if present)
  - Score of the current layout.
  - The least possible score for an acceptable layout.
  - Total number of layouts to be generated.
  - Building outline and scale of layout printout.
  - The location and size of each prohibited area if present

Computer Aided Layout Design Techniques

- STEP-4: check for the availability of non selected department in category –B
  - If it is non empty, then choose a non selected department in category –B itself corresponding to maximum REL value and place that dept in the layout.
  - If it is empty, then select a department randomly from category –A, and place it in the layout.
- STEP-5: check for e placement of all departments n the layout. If an department is found to be unplaced, follow the STEP-3, otherwise determine the score for the layout.
- STEP-6: check whether the computed score of the layout is higher than the current best layout
  - If yes, call the new layout as the current best layout and save corresponding score.
  - If no , cancel the new layout.
- STEP-7: check for the current iteration number ie I=N.
  - If yes , print the current best layout as final layout and its corresponding score as a final score.
  - If no, increase the iteration number as (I=I+1) and follow step

Computer Aided Layout Design Techniques

ADVANTAGES OF ALDEP:

- It can affix the particular locations which are available under certain limits.
- The solution or result obtained from ALDEP is available with in t definite area.
- The possibility of developing several replacements in order to obtain the optimum solution of layout.
- The possibility to have majority of inter-relationships.
- The capacity of degenerating multiple level of layouts

DISADVANTAGES OF ALDEP:

- It does not calculate the movement cost.
- Honor can not be given to unpleasant relationships.
- The method of determining score is suspicious or undefined.
- The process of evaluating production is complicated.
- It does not consider the mandatory space configuration.
- Restricted to only upto 63 departments.

Computer Aided Layout Design Techniques

- There are number of other techniques like—
  - PLANET (Plant Layout Analysis and Evaluation Technique)
  - COFAD (Computerized facilities Design)
  - PREP (Computerized Relationship Layout Planning)
  - FLAG (Facility Layout Algorithm using Graphics)
- Computerized layout analysis increases the speed and accuracy of evaluation of various alternatives.

Assembly Line Balancing

Assembly line balancing is associated with a product layout in which products are processed as they pass through a line of work centres. An assembly line can be considered as a "PRODUCTION SEQUENCE" where parts are assembled together to form an end product. The operations are carried out at different workstations situated along the line.

Advantages of Assembly Line (or flow line)

- 1. Uniform rate of production.
- 2. Les's material handling.
- 3. Less work-in-process.
- 4. Easy production control.
- 5. Effective use of facilities/labour.
- 6. Less congestion.

Disadvantages

- **1.** More capital intensive *(i.e.,* demands larger investments).
- 2. Low flexibility.
- 3. Monotony of work for operators.

Assembly Line Balancing

- Line balancing is the distribution of load on different workstations to minimize the idle time. All the different activities of a task or an assembly has different processing times that lead to idle time on the workstations having shorter processing time. Line balancing is concerned with the way assigning of activities so that the idle time can be minimized.
- **The Problem of Line Balancing arises due to the following factors**
  - 1. The finished product is the result of many sequential operations.
  - 2. There is a difference in production capacities of different machines (The output from different machines is not identical).
- Line balancing is the apportionment of sequential work activities into workstations in order to gain a high utilisation of labour and equipment so as to minimise the idle time.

Assembly Line Balancing

Some Definitions

1. Workstation: A work station is a location on assembly line where given amount of work is performed.
2. Cycle time: It is the amount of time for which a unit that is assembled is available to any operator on the line or it is the time the product spends at each work station.

   Cycle time (CT) = Available time period /Output units required/period = AT/Output
3. Task: The smallest grouping of work that can be assigned to a workstation.
4. Predecessor task: A task that must be performed before performing another (successor) task.
5. Task time (ti): Standard time to perform element task.
6. Station time (sk): Total standard work content of specific workstation.
7. Balance Delay (BD): Percentage of total idle time on the line to total time spent by the product from beginning to end of line.

$$B.D. = \frac{n.CT - \sum_{k=1}^{n} sk \times 100}{n \times CT}$$

8. *B. D.* = Balance delay, *n* = number of work stations, *CT* = Cycle time, *sk* = Station time

Assembly Line Balancing

- The work to be performed at a workstation is equal to the sum of the tasks assigned to that workstation. The assembly line balancing problem is related to assigning all the tasks to be performed in a series of workstations so that each workstation has no more than can be done in the workstation cycle time, and so that the idle time across all workstations is minimized. The problem is complicated due to precedence relationship among the work elements or tasks. There are certain rules of line balancing as given below:

1) Identify the cycle time and determine the minimum number of workstations using the following formulas:
   - Cycle time, C =Production time per day/Total number of units required per day
   - Theoretical number of workstations, Nt = Sum of task time (T)/Cycle time (C)
2) Tasks are assigned to work stations moving left to right through the precedence diagram.
3) Before each assignment, use the following criteria to determine which tasks are eligible to be assigned to a workstation
   a) All proceeding tasks should be arranged in the sequence.
   b) The task time does not exceed the time remaining at the workstation, if no task is eligible, move to the next workstation.

Assembly Line Balancing

4) After each task assignment, determine the time remaining at the current workstation by subtracting the sum of task times already assigned to it from the cycle time.
5) Break ties, if any, using the following rules:
   a) Assign the task with the longest task time.
   b) Assign the task with the greatest number of followers.
   c) If there is still a tie, choose one task arbitrarily.
6) Continue until all tasks have been assigned to work stations.
7) Compute appropriate measures (per cent idle time and efficiency) for the set of assignments.
   Efficiency =Sum of task time (T)/Actual number of work stations (*Na*) × Cycle time (C)
8) If efficiency is unsatisfactory, rebalance using a different decision rule.

Assembly Line Balancing - Example

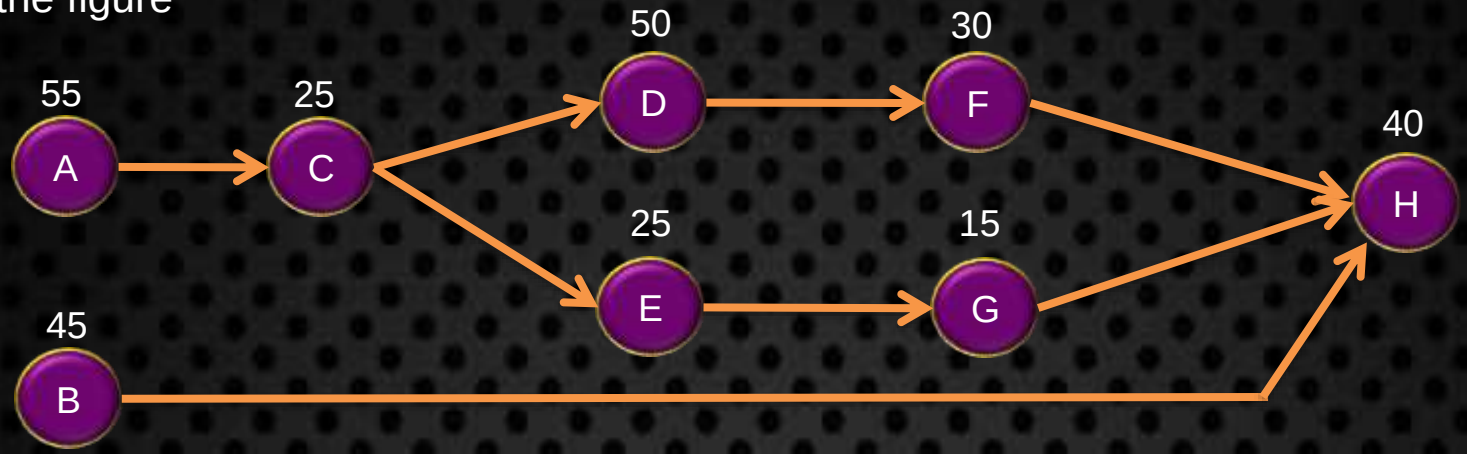
The following tasks must be performed on an assembly line in the sequence and times specified in Table below:

Task	Task time (in seconds)	Predecessor
A	55	—
B	45	—
C	25	A
D	50	C
E	25	C
F	30	D
G	15	E
H	40	B, F, G

- (a) Draw the schematic precedence diagram.
- (b) What is the theoretical minimum number of stations required to meet a forecast demand of 500 units per 8-hour day?
- (c) Use the longest-task-time rule and balance the line in the minimum number of stations to produce 500 units per day.
- (d) Find the efficiency.

Assembly Line Balancing - Example

(a) Precedence diagram (Network diagram) as per sequence of operations is shown in the figure



(b) Cycle time, *C* =Production time per day/Total number of units required per day

= (8X60X60)/500 = 57.6 Seconds per unit

Theoretical number of workstations, *Nt* = Sum of task time (T)/Cycle Time (C)

= 285/ 57.6 = 4.94 ≈ 5

Assembly Line Balancing - Example

(c) To assign the task on the work stations, at first assign the task of largest activity time considering the sequence of operations. The sequence of operations should not be disturbed. Suppose two tasks have same activity time than see the total number of followers (activities) and assign the activity first on the workstation having largest number of followers. Here, followers mean the activities linked to the said activity till the end and to be completed. The assignment of tasks on the five workstations and idle time on the workstations are shown below as:

Work Station 1 : Task A = 57.6 - 55 = 2.6 (Idle time)
Work Station 2 : Task B = 57.6 - 45 = 12.6 (Idle time)
Work Station 3 : Task C = 57.6 - 25 = 32.6
Task E = 32.6 - 25 = 7.6 (Idle time)
Work Station 4 : Task D = 57.6 - 50 = 7.6
Work Station 5 : Task F = 57.6 - 30 = 27.6
Task G = 27.6 - 15 = 12.6 (Idle time)
Work Station 6 : Task H = 57.6 - 40 = 17.6 (Idle time)

(d) Efficiency = Sum of task time (T)/ [Actual number of work stations (*Na*)× Cycle time (C)]
= 285/6X57.6 = 82.46%

Materials Handling Systems

It is the art and science involving movement, packaging and storing of materials in any form by means of gravity, manual effort or power-activated machinery.

— ***American Materials Handling Society***

- Material handling is a very important area of concern for industrial engineers. This is due to following reasons:

1. More than 90% of the time in material spends on shop-floor is either in waiting or for being transported. This is a non-value added activity. Nearly 20-30% of this non-value added time is consumed in material handling. Therefore, efficient handling will save some of this non-value added time.
2. Safe handling of material is important in the plant. This reduces wastage, breakage, loss, scrapes, etc.
3. Efficient material handling is needed for less congestion, timely delivery and reduced idle time of machine due to non-availability of material.
4. Cost-efficient material handling is an important issue. Material movement usually accounts for 10 to 90% of total factory cost, whose average is, as per one estimate, about 25%. Therefore, a careful study of alternative modes of material transportation is very important.
5. Better material handling is helpful in good house-keeping.

Principles Of Material Handling

1. Reduce unnecessary movement: This calls for selecting shortest path to reach the destination.
2. Reduce congestion and bottlenecks: This calls for eliminating obstruction and congestions in the material handling.
3. Scientific factory layout: This is to minimise the overall material movement, reduced number of trips, and reduced costs associated with transportation.
4. Use of standard material handling equipments: This facilitates easy maintenance of material handling equipment, as spares are readily available.
5. Plan minimum number of loading/unloading: This reduces the chances of breakage. It also reduces loading/unloading time and cost.
6. Use *gravity to transport material.*
7. Use mechanized material handling equipment: This reduces dependence on human labour.
8. Use *specialized equipment,* if needed.
9. Use *flexible equipments,* if the part variety is more or unstable.

Principles Of Material Handling

10. Use *simple and safe equipments* for material handling. Operator safety should be of prime importance. Blinkering light and bell/sound may be attached to material handling equipments to warn the persons, working nearby.
11. To minimise the downtime of the equipments, use *preventive maintenance* of all equipments.
12. If labour is cheap and parts are lighter, *human labour* for transporting material in trolley may be employed.
13. Loading on material handling equipment should not exceed its designed capacity.
14. *Standard size* of material should be transported to reduce time and increase efficiency.
15. *Concept of unit size load* should be employed. This is done by aggregating material into a longer unit/container or pallet of standard size.
16. Efficient planning and control should be ensured for efficiency.
17. The material handling equipment should preferably be dispatched if it is full of its capacity. This reduces number of trips.

Principles Of Material Handling

18. The material handling equipment should not be very bulky. The ratio of its load carrying capacity and its own dead weight should be high.
19. Concept of *straight line flow* should be employed as zig-jaw flow causes more congestion and more time.
20. Load should preferably be carried both ways. This means while coming back some material may be picked-up for delivery to an intermediate and originating point.
21. *Part orientation principle* should be employed so that, while unloading, the material position should be as per the need of the destination point. During transportation also, parts should be oriented in such a way that maximum material is accommodated with least chances of damage.
22. *System principle* should be employed so that material handling system is integrated with other facilities, such as inspection, receiving, storage, assembly packaging etc.
23. Backtracking of parts movement should be avoided

Materials Handling Equipments

Relationship between Plant Layout and Material Handling - There is a close relationship between plant layout and material handling. A good layout ensures minimum material handling and eliminate re-handling.

1. Material movement does not add any value to the product so, the material handling should be kept at minimum though not avoid it. This is possible only through the systematic plant layout. Thus a good layout minimizes handling.
2. The productive time of workers will go without production if they are required to travel long distance to get the material tools, etc. Thus a good layout ensures minimum travel for workman thus enhancing the production time and eliminating the hunting time and travelling time.
3. Space is an important criteria. Plant layout integrates all the movements of men, material through a well-designed layout with material handling system.
4. Good plant layout helps in building efficient material handling system. It helps to keep material handling shorter, faster and economical. A good layout reduces the material backtracking, unnecessary workmen movement ensuring an effectiveness in manufacturing.

Selection Of Materials Handling Systems

Selection of MH equipment is an important decision as it affects both cost and efficiency of handling system. Some of the factors are to be taken into account while selecting material handling equipment are:

1. **Nature of Operations**
   - I. Whether handling is temporary or permanent.
   - II. Whether the flow is continuous or intermittent.
   - III. Material flow pattern-vertical or horizontal.
   - IV. Type of layout-process layout, product layout or combination layout.
2. **Material to be Handled**
   - I. Size and shape of the material.
   - II. Quantity and weight of the material.
   - III. Material characteristics.
   - IV. Susceptibility to damage during handling.
3. 3. **Distance over which the material is to be moved**
   - I. Fixed distance.
   - II. Long distance.
   - III. Work station.

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Selection Of Materials Handling Systems

4. **Installation and operating costs**
   I. Initial investment.
   II. Operating and maintenance costs.
5. **Plant facilities**
   I. Types of buildings.
   II. Floor load capacity.
6. **Safety considerations**
7. **Engineering factors**
   I. Door and ceiling dimensions.
   II. Floor conditions and structural strength.
   III. Traffic safety.
8. **Equipment reliability**
   I. Use of standard components.
   II. Service facilities.
   III. Supplier reputation.

Types Of Material Handling Equipment

- The material handling equipment are classified based on:

1. Types of services required:
    1. Lifting, 2. Moving, 3. Stacking, and 4. Positioning
2. Types of equipment
3. Relative mobility of equipment:
    1. Travel between fixed points, and
    2. Travel over wide areas
4. Movement of equipment.
    1. On the floor.
    2. Above the floor.
    3. Overhead.
    4. Underground.
5. Categories of equipment
    1. Conveyers
    2. Cranes and hoists.
    3. Industrial trucks.

Material Handling

UNIT LOAD CONCEPT

- Material handling efficiency is proportional to the size of the load handled *i.e.* number of units handled per unit time. It is economical and faster to handle small parts by grouping them into one unit (called unit load) than moving them individually. James R. Bright defines unit load as-"**A number of items or bulk material, so arranged or restrained that the mass can be picked up and moved as a single object too large for manual handling and which upon being released will return its initial arrangement for subsequent movement."**
- **Unit load should-**
  - 1. Perform a minimum number of handling and eliminate manual handling.
  - 2. Assemble materials into unit load for economy of handling and storage.
  - 3. Make the unit load as large as possible considering the limitations of building, handling equipment. Production areas, volume of material required and common carrier dimensions and capacity.

Material Handling

Common types of unit load are:

1. Part bins
2. Pallet box
3. Bulk container
4. Cargo container.

Advantages

1. Permits handling of larger loads.
2. Reduces handling cost.
3. Faster movement of goods.
4. Reduced time for loading and unloading.
5. Maximize use of cubic space.
6. Reduce pilferage in transit and storage.

Disadvantages

- Cost of unitising.
- Problem of returning empty containers.
- Lack of flexibility.

Material Handling

TYPES OF MATERIAL HANDLING SYSTEMS

1. **Equipments oriented systems**
   1. Convey or Systems
   2. Tractor transfer system
   3. Fork lift. Truck
   4. Industrial truck system
   5. Underground system
2. **Material Oriented Systems**
   1. Unit handling system
   2. Bulk handling system
   3. Liquid handling system
3. **Methods oriented system**
   1. Manual systems
   2. Automated systems
   3. Job shop handling system
   4. Mass production system
4. **Function oriented system**
   1. Transportation systems
   2. Conveying systems
   3. Transferring systems
   4. Elevating systems

Material Handling Equipments

Types of Materials Handling Equipment

1. Conveyers- Belt Conveyor, Chain Conveyor, Roller Conveyor
2. Cranes, Elevators and Hoists
3. Industrial Trucks
4. Auxiliary Equipments

Material Handling Equipments

Industrial Trucks

Elevators

Containers and Racks

Auxiliary Equipments

Concepts Of Group Technology

- Group Technology (GT) is a manufacturing philosophy in which similar parts are identified and grouped together to take advantage of their similarities in manufacturing and design.
- It provides an integration of the design and manufacturing activities and helps to improve the productivity in batch manufacturing industries.
- GT implies the notion of recognizing and exploiting similarities in three different ways:
  - (a) by performing the like activities together,
  - (b) by standardizing the similar tasks and
  - (c) by efficiently storing and retrieving the information about recurring problems.

Concepts Of Group Technology

Part Family

- The part family is a collection of parts which are similar either because of geometric shape and size or because of similar processing steps required in their manufacture. By grouping work-parts into families, we may use group layout instead of process-type layout
- There are three main approaches for grouping parts into families and implementing GT in a plant. These three approaches are mentioned below as:
  - 1. Visual inspection method
  - 2. Classification and coding by examination of design and production data
  - 3. Production flow analysis
- ***Visual inspection method:*** It is less sophisticated and the least expensive method. It involves arranging a set of parts into part families by visually inspecting the physical characteristics of the parts or their photographs. Although this method is the least accurate one among the three, this method is very popular.

Concepts Of Group Technology

- ***Parts classification and coding:*** This is a time-consuming and complicated method. A classification and coding system should be custom-engineered for a given company or an industry. Production flow analysis: In production flow analysis, the parts or products are classified on the basis of production flow, i.e. sequence of operations on different workstations.

Types of classification and coding Systems

- Parts classification systems fall broadly into one of the following two categories:
  - 1. Systems based on part design attributes
  - 2. Systems based on part manufacturing attributes
- ***Part design attributes:*** There are various design attributes which form the basis for part classification and coding. These attributes are basic external and internal shapes, length/diameter ratio, material type, part function, major dimensions, minor dimensions, tolerances and surface finish.
- ***Part manufacturing attributes:*** The different manufacturing attributes for part classification and coding are major process, minor operations, major dimension, length/diameter ratio, surface finish, machine tool, operation sequence, production time, batch size, annual production, fixtures needed and cutting tools.

Concepts Of Group Technology

Type of Codes

- Monocode or hierarchical code: In this code structure, the interpretation of each succeeding symbol depends on the value of the preceding symbols.
- Polycode or chain code: Code symbols are independent of each other. Each digit in a specific location of the code describes a unique property of the work piece.
- Mixed code: It has the advantages of both mono- and polycodes. Most coding systems use this code structure.

Concepts Of Group Technology

opitz classification System

- It was developed at the Technical University of Aachen in Germany.
- It is best known and widely used classification system and can be applied to machined parts, non-machined parts and purchased parts.
- It requires both design and manufacturing information. The following digit sequence is used: 12345 6789 ABCD
- *Form code:* It includes the first five digits and describes the primary design attributes of the part.
- *Supplementary code:* It indicates some of the attributes that is used in manufacturing (dimensions, work material, starting raw piece shape and accuracy).
- *Secondary code:* It identifies the production operation type and sequence and can be designed by the firm to serve its own particular needs.
- The complete coding system is too complex.

Concepts Of Group Technology

problems in Implementation of GT

The problems that have prevented the widespread application of GT are given below:

1. The problem of identifying part families among the many components produced by a plant.
2. The expense of parts classification and coding.
3. Rearranging the machines in the plant into the appropriate machine cells.
4. The general resistance when changeover to a new system is decided.

Concepts Of Group Technology

Advantages of GT

A. Engineering Design
   1. Reduction in new parts design.
   2. Reduction in the number of drawings through standardization.
   3. Reduction of drafting effort in new shop drawings.
   4. Reduction of number of similar parts, easy retrieval of similar functional parts and identification of substitute parts.

B. Layout Planning
   1. Reduction in production floor space required.
   2. Reduced material-handling effort.

C. Equipment, Tools, Jigs and Fixtures
   1. Standardization of equipment.
   2. Reduced number of tools, pallets, jigs and fixtures.
   3. Significant reduction in costs of releasing new parts.

D. Process Planning
   1. Reduction in set-up time and production time.
   2. Improved machine loading and shortened production cycles.
   3. Reduction in number of machining operations and numerical control (NC) programming time.

Concepts Of Group Technology

D. Production Control

1. Reduced work-in-process inventory.
2. Easy identification of bottlenecks.
3. Improved material flow and reduced warehousing cost.
4. Faster response to schedule changes.
5. Improved usage of jigs and fixtures, pallets, tools, material handling and manufacturing equipment.

E. Quality Control

1. Reduction in number of defects leading to reduced inspection effort.
2. Reduced scrap generation.
3. Better output quality.

F. Purchasing

1. Coding of purchased parts leading to standardized rules for purchasing.
2. Reduced number of parts and raw materials.
3. Economies in purchasing because of accurate knowledge of raw material requirements.
4. Simplified vendor evaluation procedures leading to just-in-time purchasing.

G. Customer Satisfaction

1. Accurate and faster cost estimates.
2. Efficient spare parts management, leading to better customer services.

Cellular Manufacturing

- Cellular manufacturing is an application of GT in manufacturing in which all or a portion of a firm's manufacturing systems have been converted into cells.
- A manufacturing cell is a cluster of machines or processes located in close proximity and dedicated to the manufacture of a family of parts.

Objective of Cellular Manufacturing

- Primary objectives in implementing a cellular manufacturing system are to reduce the following:
  - 1. Set-up times
  - 2. Flow times
  - 3. Inventory
  - 4. Market response time

Cellular Manufacturing

A. ***Machine cell design :- Machine cells can be classified as follows:***

1. Single machine cell: It consists of one machine, supporting fixtures and tooling. One or more part families with one basic type of process (such as milling) can be processed.
2. Group machine cell with manual handling: This type of cell is often organized into a U-shaped layout. It includes more than one machine to process one or more part families. Material handling is performed by the human operators who run the cell.
3. Group machine cell with semi-integrated handling: A mechanized handling system, such as a conveyor, is used to move parts between machines in the cell. If the parts made in the cell have identical routings, in-line layout is selected. If the routings vary, loop layout is more appropriate.
4. Flexible manufacturing system: This is highly automated machine cell. It combines automated processing stations with a fully integrated handling system.

Cellular Manufacturing

B. ***Structural issues in cell design: There are following structural issues in cell design:***
   1. Selection of part families and grouping of parts into families.
   2. Selection of machine and process populations and grouping of these into cells.
   3. Selection of tools, fixtures and pallets.
   4. Selection of material-handling equipments.
   5. Choice of equipment layout.

C. ***Operational issues in cell design:*** The operational issues in cell design are stated as follows:
   1. Detailed design of jobs.
   2. Organization of supervisory and support personnel around the cellular structure
   3. Formulation of maintenance and inspection policies.
   4. Procedures' design for production planning, scheduling, control and acquisition of related software and hardware.
   5. Modification of cost control and reward systems.
   6. Outline of procedures for interfacing with the remaining manufacturing system.

Cellular Manufacturing

D. ***Evaluation of structural issues: The following points should be strictly adhered to during the evaluation of structural issues:***
   1. Equipment and tooling investment (low)
   2. Equipment relocation cost (low)
   3. Inter- and intra-cell material-handling costs (low)
   4. Floor space requirements (low)
   5. The extent to which parts are completed in a cell (high)
   6. Flexibility (high)

E. ***Evaluation of operational issues:*** The following points should be kept in mind during the evaluation of operational issues:
   1. Equipment utilization (high)
   2. Work-in-process inventory (low)
   3. Queue lengths at each workstation (short)
   4. Job throughput time (short)
   5. Job lateness (low)

Cellular Manufacturing

F. ***Best Machine arrangement :-*** The important factors to determine the type of machine cell and the best arrangement of equipment in the cell include the following:

1. *Volume of work to be done in the cell:* It includes the number of parts per year and the amount of work required per part. Number of machines in the cell, total cost of operating the cell and the amount of investment needed are required.
2. *Variations in process routings of the parts:* It determines the type of workflows such as straight line or U-shape or loop flows.
3. *Part size, shape, weight and other physical attributes:* It determines the size and type of material handling and processing equipment that can be used.

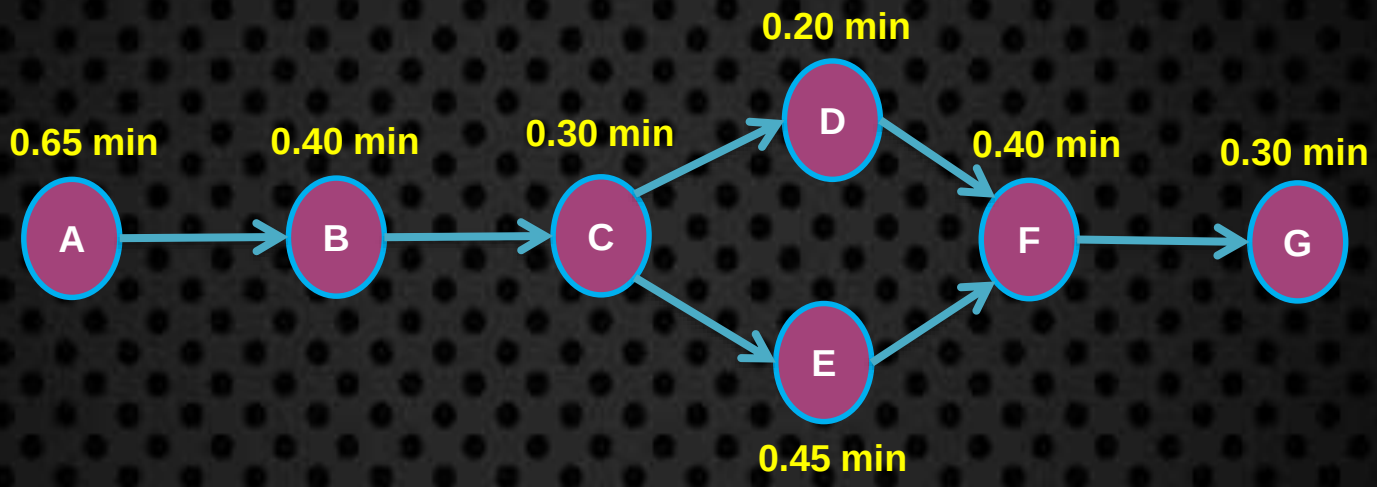
University Questions

1. What is the importance of plant layout? Explain types of plant layout with their advantages and disadvantages.
2. Short note-Symptoms of poor layout
3. What is facility location decision? Describe the factors which influence the location decisions while setting up a mall.
4. What are the factors influencing plant layout
5. What are the different types of plant layout? What are their advantages and disadvantages?
6. Short note- Assembly line balancing, BPR, PMTS, Plant layout and planning
7. Short note- Group technology, CRAFT, Assembly line balancing-
8. What is material handling system ? What are the important principles of material handling?
9. Define plant layout. Enumerate and explain various factors to be considered in the design of plant layout.
10. Why plant location is of great concern to the management? How plant location is important to its profitability? What are the factors influencing plant location?
11. What is the importance of Material handling? What are the different types of material Handling equipments?

University Questions- Numerical

The precedence diagram for activity A to G is shown below. The element time required for the activity are shown in the diagram. the line operates for 7 hours per day and the output of 550 units are desired.

1. Calculate the cycle time and theoretical minimum number of work stations required.
2. Group the tasks in appropriate number of workstations
3. Calculate the balance efficiency.



University Questions- Numerical

1. Cycle time =Production time per day/Total number of units required per day = 7X60/550

   = 0.76 min

- Theoretical minimum number of work stations required= Total Task Time/ Cycle Time = 2.7/0.76 = 3.55

  = 4 work stations

Element	Task Time
A	0.65
B	0.40
C	0.30
D	0.20
E	0.45
F	0.40
G	0.30
TOTAL	2.7 min

University Questions- Numerical

2. Group the tasks in appropriate number of workstations
   - Work Station 1 : Task A = 0.76-0.65 =0.11
   - Work Station 2 : Task B = 0.76-0.40 =0.36
   - Work Station 2 : Task C = 0.36-0.30 =0.06
   - Work Station 3 : Task D = 0.76-0.20 =0.56
   - Work Station 3 : Task F = 0.56-0.40 =0.16
   - Work Station 4 : Task E = 0.76-0.45 =0.31
   - Work Station 4 : Task G = 0.31-0.30 =0.01
3. Efficiency = Sum of task time/ [Actual number of work stations× Cycle time] = 2.7/[4X0.76]= 88%