MEE1014 Industrial Engineering and Management

B.Tech (Mechanical)

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SMEC, VIT Chennai

Module-5

Plant Location and Plant Layout:

Plant location –need - Factors – comparison – quantitative methods for evaluation

Plant layout: objectives-principles – factors influencing – tools and techniques including computer based layout design – CRAFT, ALDEP, CORELAP. (7 Hours)

http://tancem.com

Plant Layout

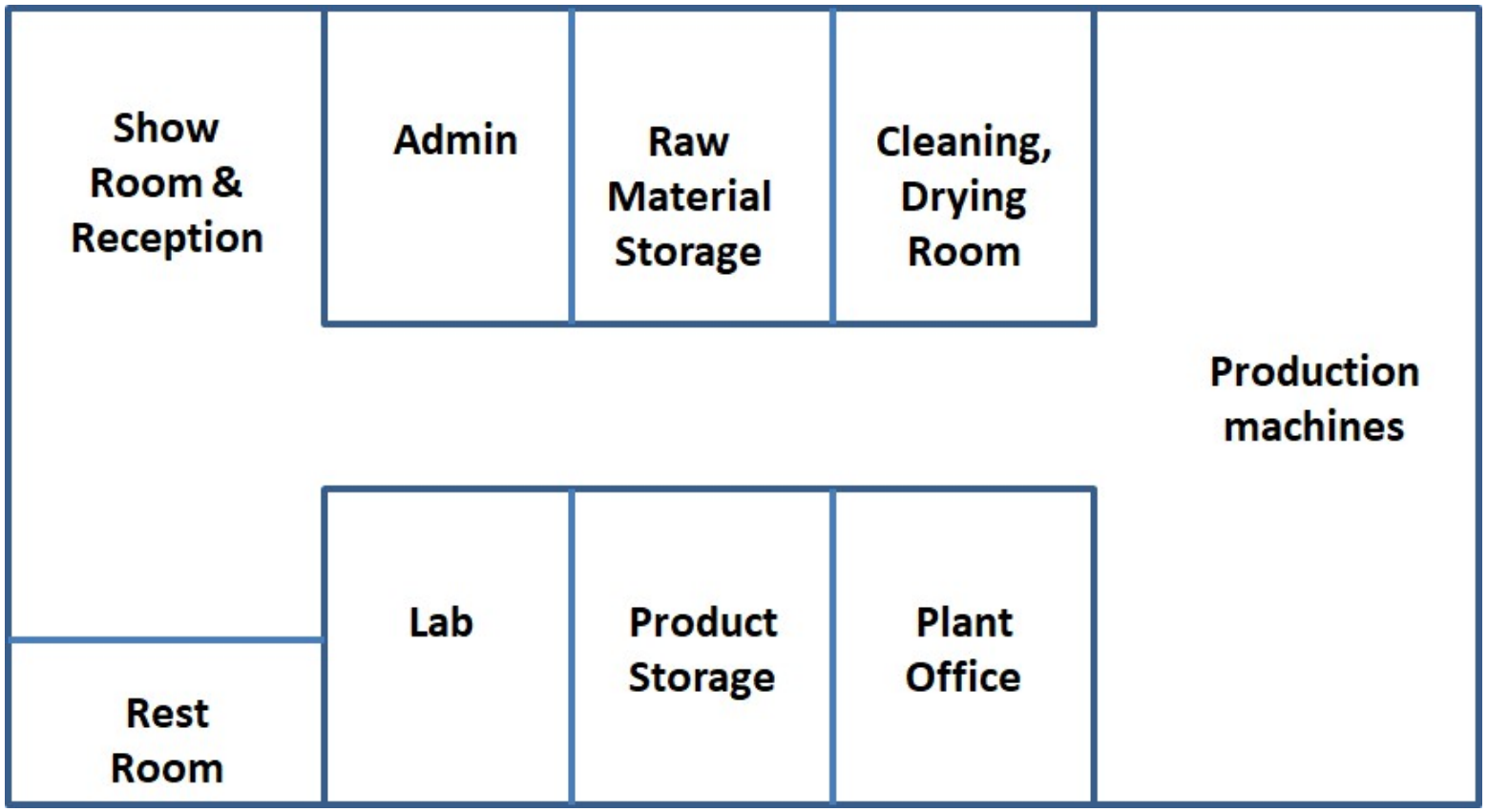

https://sail.co.in/rourkela-steel-plant/about-rourkela-steel-plant

Introduction

Introduction

What is Plant Layout?

- Physical arrangement of production facilities
- Floor plan of the physical facilities, which are used in production



Introduction

What is Plant Layout?

- According to **Moore**
  - Plant layout is a plan of an optimum arrangement of facilities including
    - *personnel,*
    - *operating equipment,*
    - *storage space,*
    - *material handling equipment and*
    - *all other supporting services* along with the design of best structure to contain all these facilities

Objectives of Plant Layout

Primary goal of the plant layout

- To maximize the profit by arrangement of all the plant facilities to the best advantage of total manufacturing of the product

Plant Layout - Objectives

- Effective utilization of men, equipment and space
- Make effective utilization of existing space
- Minimize materials handling and cost
- Minimize investment in equipment
- Minimize overall production time
- Provide convenience, safety and comfort to employees
- Streamline the flow of materials through the plant
- Facilitate the manufacturing process

Plant Layout - Objectives

- Flexibility of manufacturing operations and arrangements
- Maintain flexibility of arrangement and operation
- Facilitate the organizational structure
- Maintain high turnover of in-process inventory

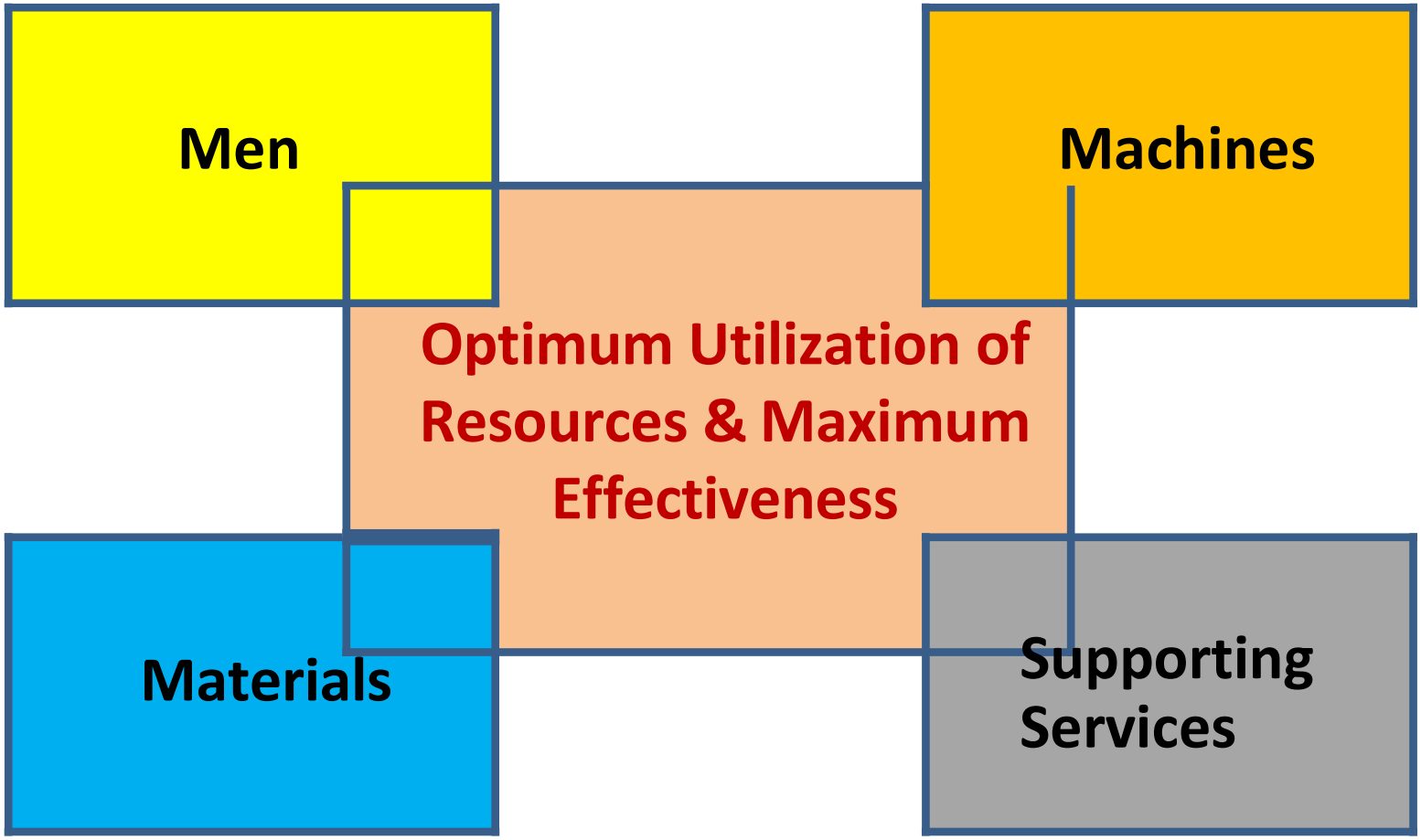
Principles of Plant Layout

Plant Layout - Principles

- Principle of Integration
- Principle of Minimum Distance
- Principle of Space Utilization
- Principle of Materials Flow
- Principle of Maximum Flexibility
- Principle of Safety, Security and Satisfaction
- Principle of Minimum Handling

Plant Layout - Principles

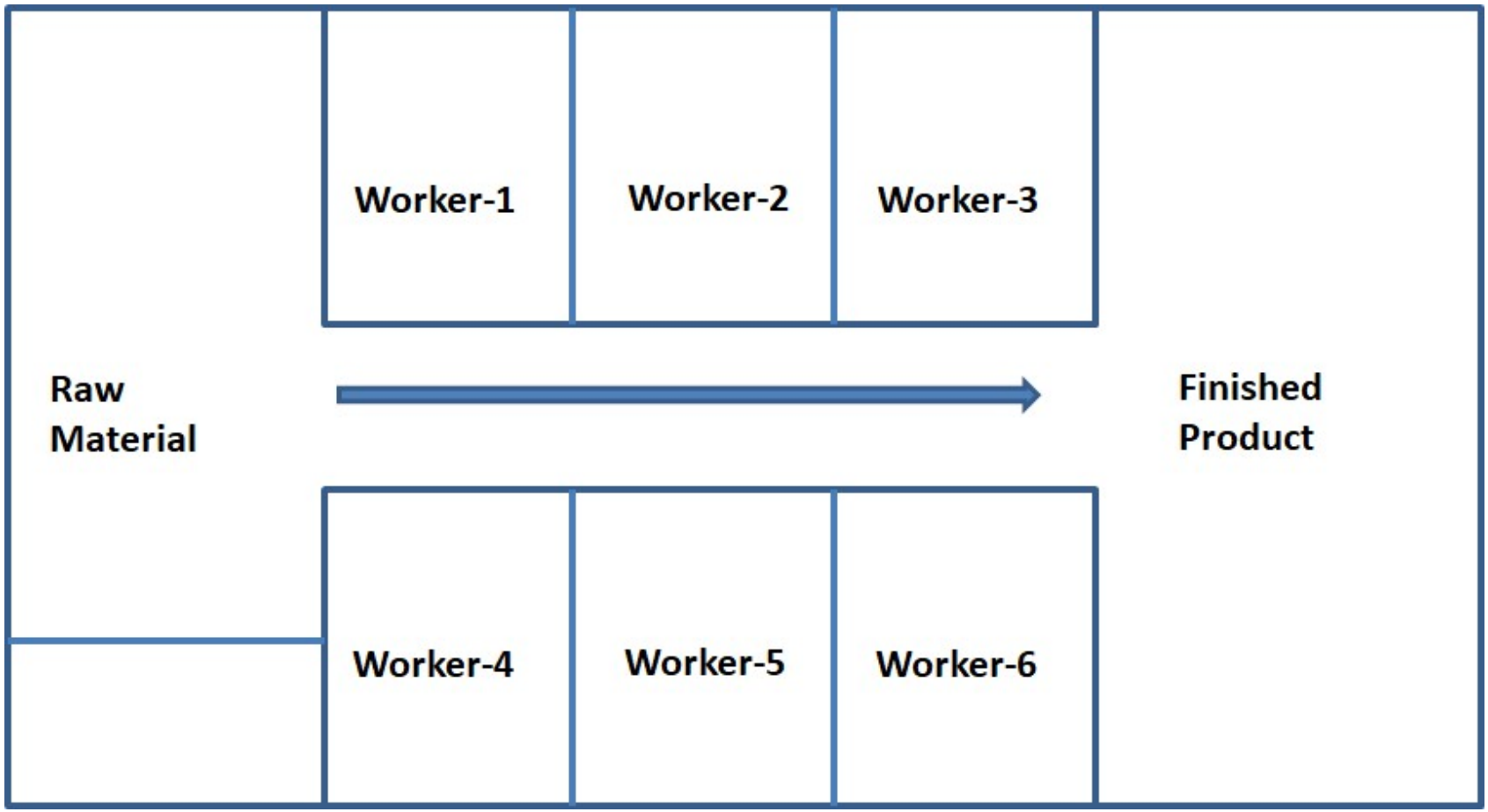
Principle of Integration



Plant Layout - Principles

Principle of Minimum Distance

- Concerned with the minimum travel/movement of Men and Materials
- Straight line movement should be preferred



Plant Layout - Principles

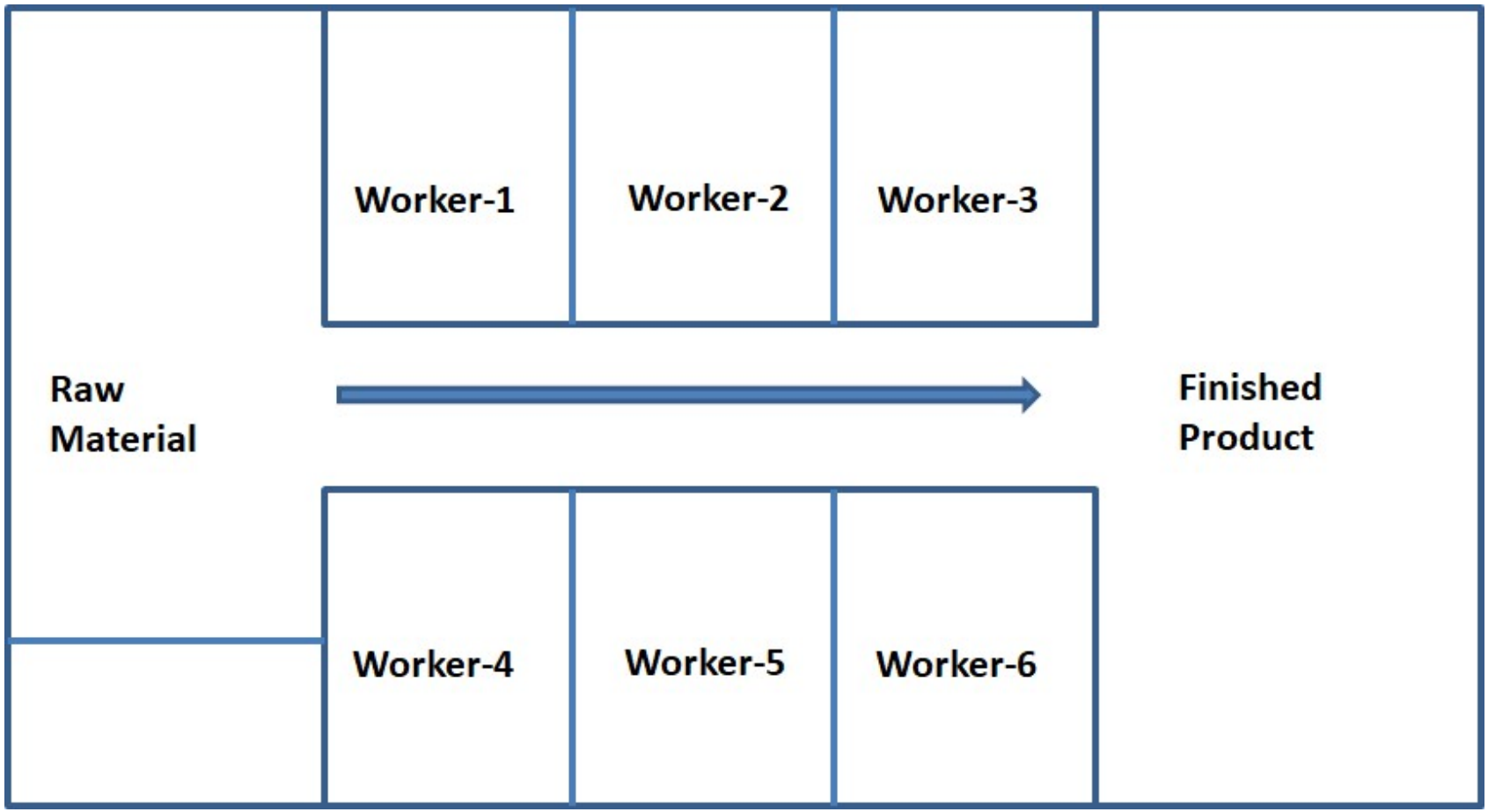
Principle of Space Utilization

- All the three dimensions should be utilized optimally

Plant Layout - Principles

Principle of Flow

- Materials to move in forward direction towards the final product stage
- No backtracking



Plant Layout - Principles

Principle of Maximum Flexibility

- Future requirements should be taken into account while designing the present layout
- Alteration in the present layout done without much cost and time

Plant Layout - Principles

Principle of Safety, Security and Satisfaction

- Provides safety to the workers
- Workers satisfaction
- Protect the plant and machinery from fire, theft. Etc.,

Plant Layout - Principles

Principle of Minimum Handling

- Reduces the materials handling to the minimum

Factors influencing Plant Layout

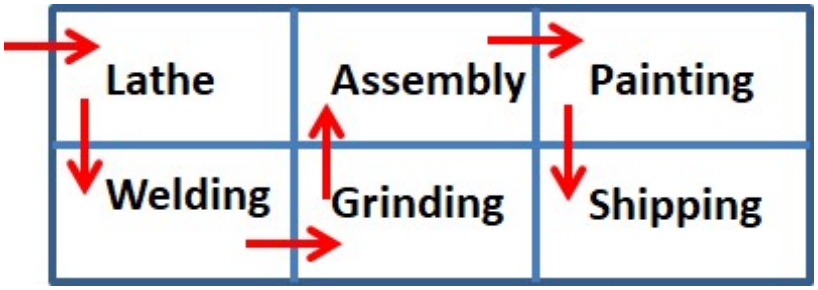
Plant Layout - Factors influencing

- Nature of the Product
- Volume of Production
- Location of the Plant
- Type of Machines
- Climate Conditions
- Service Facilities
- Type of Production
- Type of Process
- Management Policies

Classification of Plant Layout

Plant Layout - Classification

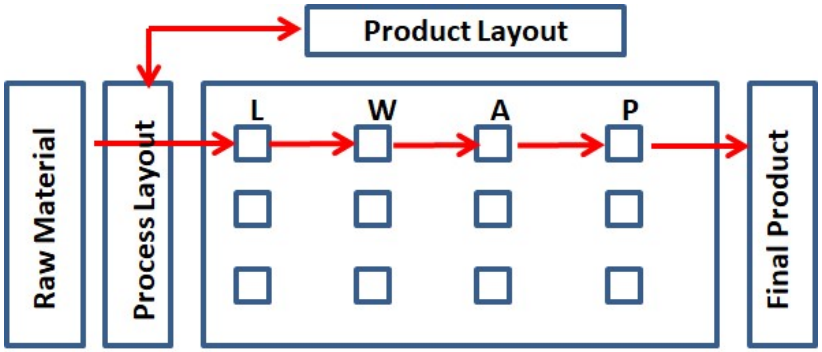
Process/ Functional Layout



Line/ Product Layout

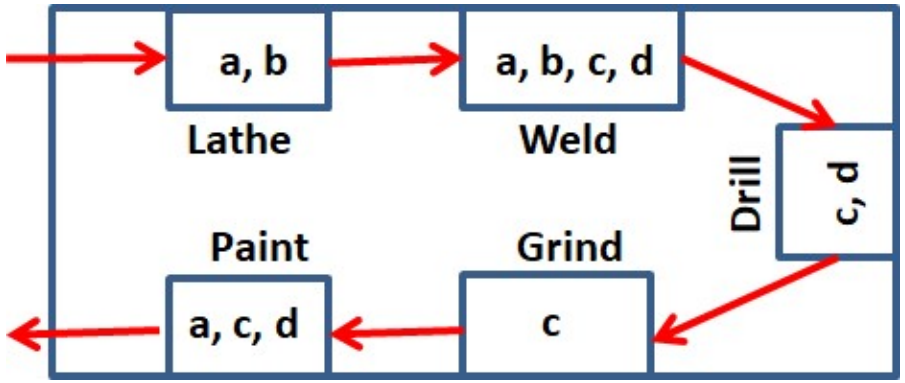
Fixed Position Layout

Combination Layout



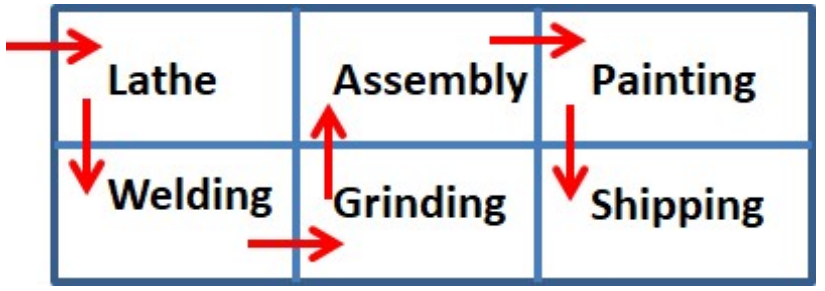
L: Lathe; W - Welding; A - Assembly; P: Painting

Group Layout or Cellular Layout



Plant Layout: Process/ Functional Layout

- It is for batch production
- Machines performing similar type of operations are grouped at one location



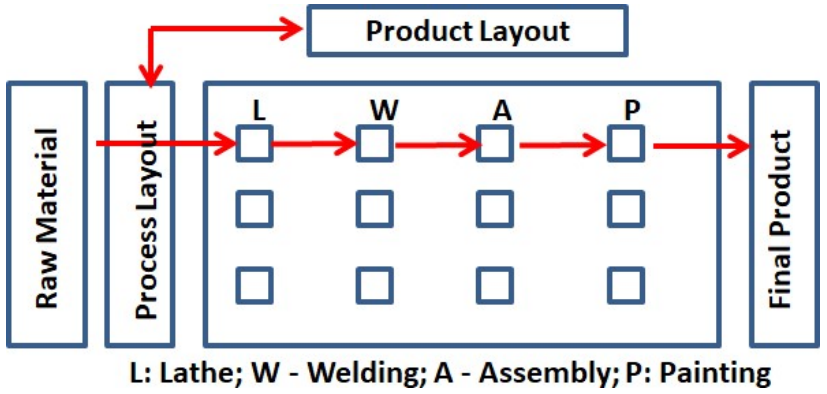
- Flow paths of materials through the facilities vary from product to product
- Flow paths are long
- Possibility of backtracking
- Suitable for variety of products manufactured
- Low Production Volume

Plant Layout: Line/ Product Layout

- Machines are located as per the processing sequence of the product
- Suitable when the production volume of the product is high
- Minimum material handling cost
- Breakdown of one machine in a product line affects the production
- Lack of flexibility
- Manufacturing cycle is short

Plant Layout: Combination Layout

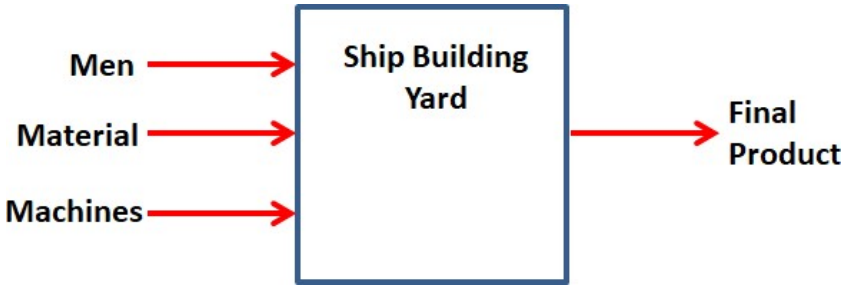
- Combination of process and product layouts
- It is suitable when an item is being made in different types and sizes



- Machinery is arranged in a process layout but the process grouping is then arranged in a sequence to manufacture various types and sizes of products
- Sequence of operations remains the same with the variety of products and sizes

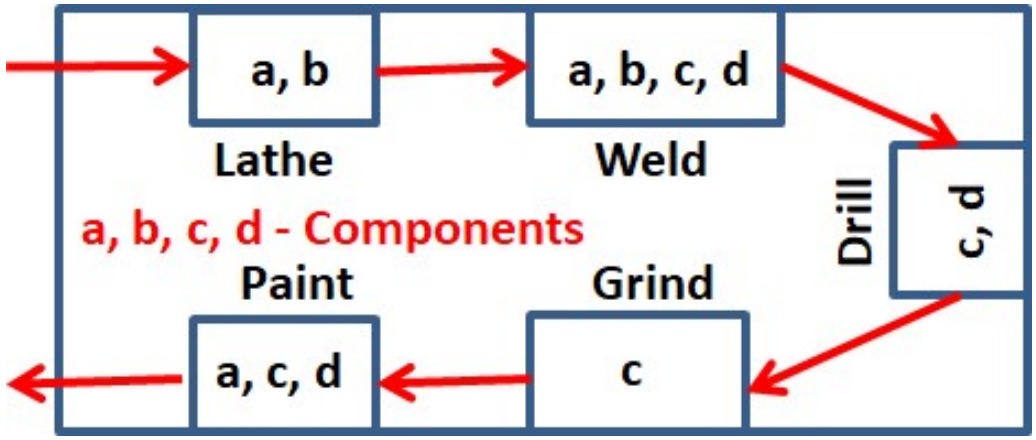
Plant Layout: Fixed Position Layout

- Also called as Project Type of layout



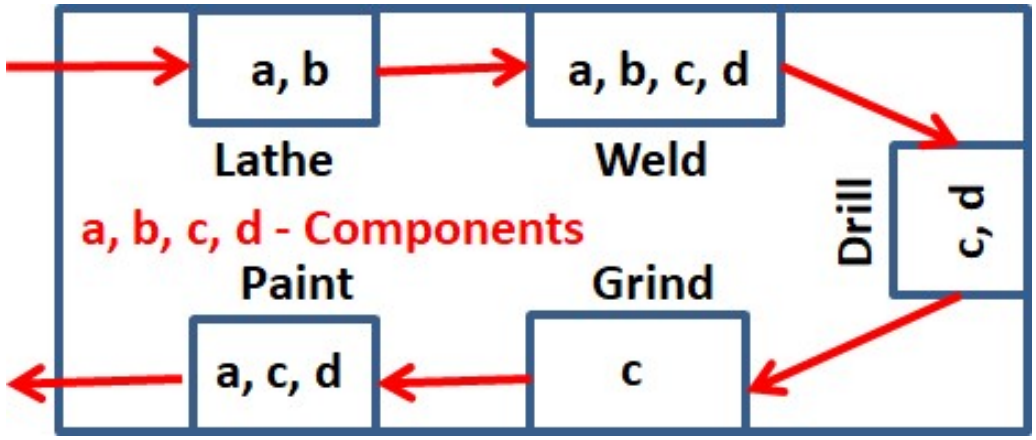
- Major components remain in a fixed location and the men, material and machines are brought to the location
- Suitable when one or few pieces of identical heavy products are to be manufactured
- Assembly consists of large number of heavy products
- Greater flexibility
- Lower layout capital investment

Plant Layout: Group Layout/ Cellular Layout



- It is a combination of Process layout and Product layout
- Combines the advantages of both the layouts
- **Process layout** - Cost of equipment is minimum
- **Product layout** - Cost of materials handling is minimum
- **Group layout** - Both equipment and materials handling cost are minimum
- Group layout is also called as **Multi-Objective layout**

Plant Layout: Group Layout/ Cellular Layout



- The basic aim of a group technology layout is to identify families of components that require similar of satisfying all the requirements of the machines are grouped into cells
- Each cell is capable of satisfying all the requirements of the component family assigned to it
- Effective machine operation and productivity
- **Drawback:** If the product mix is completely dissimilar, then we may not have meaningful cell formation

Computer Based Layout Design - CRAFT

CRAFT - Computerized Relative Allocation of Facilities Technique

Layout Design - CRAFT Algorithm

- Originally developed by Armour and Buffa
- It is an improvement algorithm
- Starts with an initial layout and improves the layout by interchanging departments pairwise → reduction in transport cost
- The algorithm continues until no further interchanges are possible to reduce the cost of transportation
- The result will be good and close to optimum in most of the cases

1	2	3
4	5	6

Initial Layout

1	5	6
4	2	3

Final Layout

Layout Design - CRAFT Requirements

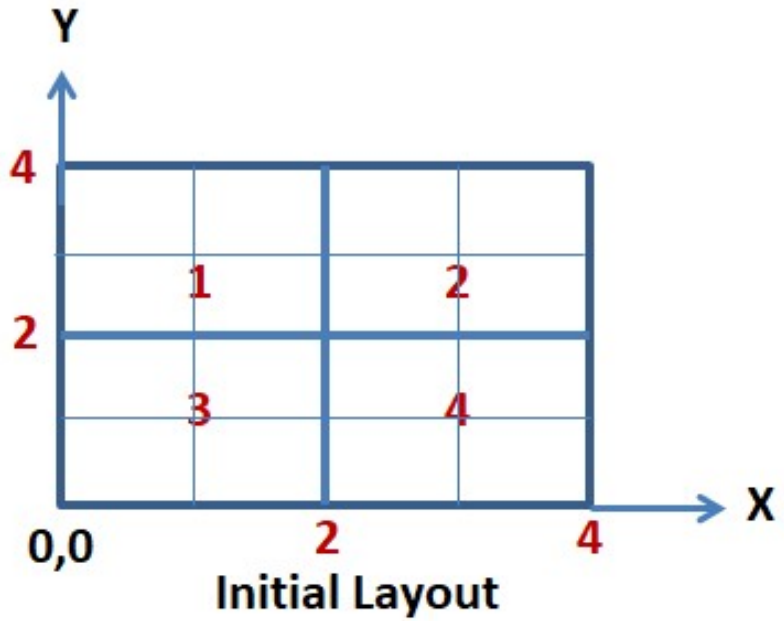
- Initial Layout
- Flow Data
- Cost per Unit Distance
- Total Number of Departments
- Number of Interchangeable Departments
- Area of departments

Layout Design - CRAFT Procedure

- **Step-1: Input**
  - ✓ Number of departments
  - ✓ Number of interchangeable departments
  - ✓ Initial layout
  - ✓ Cost matrix
  - ✓ Flow matrix
  - ✓ Area of departments

Layout Design - CRAFT Procedure

- **Step-1: Input**
  - ✓ **Number of departments = 4**
  - ✓ **Number of interchangeable departments = 4**
  - ✓ **Initial layout**
  - ✓ Cost matrix
  - ✓ Flow matrix
  - ✓ Area of departments



Initial Layout

Layout Design - CRAFT Procedure

- **Step-1: Input**
  - ✓ Number of departments = 4
  - ✓ Number of interchangeable departments = 4
  - ✓ Initial layout
  - ✓ **Cost matrix**
  - ✓ Flow matrix
  - ✓ Area of departments

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

In **Cost Matrix [C_{ij}],** the cell values represent costs per unit distance from department *i* to department *j*.

Layout Design - CRAFT Procedure

- **Step-1: Input**
  - ✓ Number of departments = 4
  - ✓ Number of interchangeable departments = 4
  - ✓ Initial layout
  - ✓ Cost matrix
  - ✓ **Flow matrix**
  - ✓ Area of departments

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

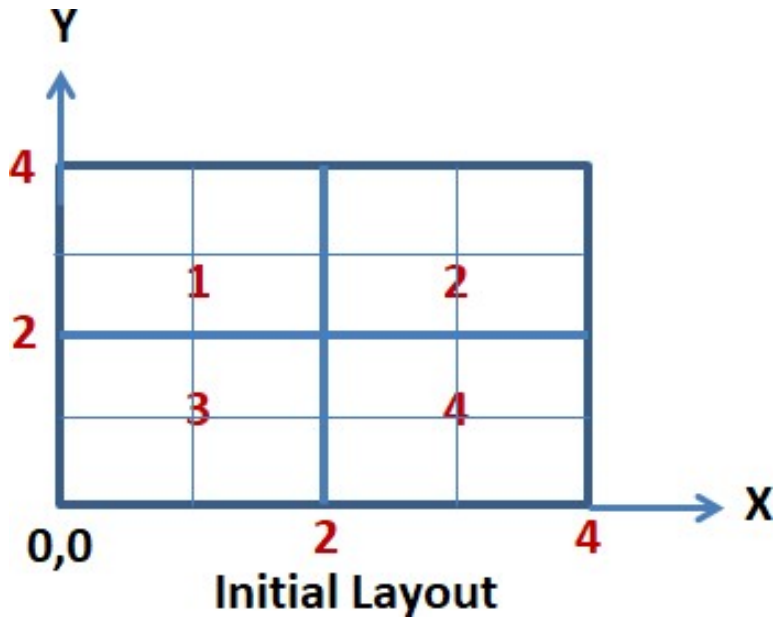
In **Flow Matrix [f_{ij}],** the cell values represent the flow in terms of number of trips in a given period of time from department *i* to department *j*.

Layout Design - CRAFT Procedure

- **Step-1: Input**
  - ✓ Number of departments = 4
  - ✓ Number of interchangeable departments = 4
  - ✓ Initial layout
  - ✓ Cost matrix
  - ✓ Flow matrix
  - ✓ **Area of departments**

Department	1	2	3	4
Area (Sq. Units)	4	4	4	4

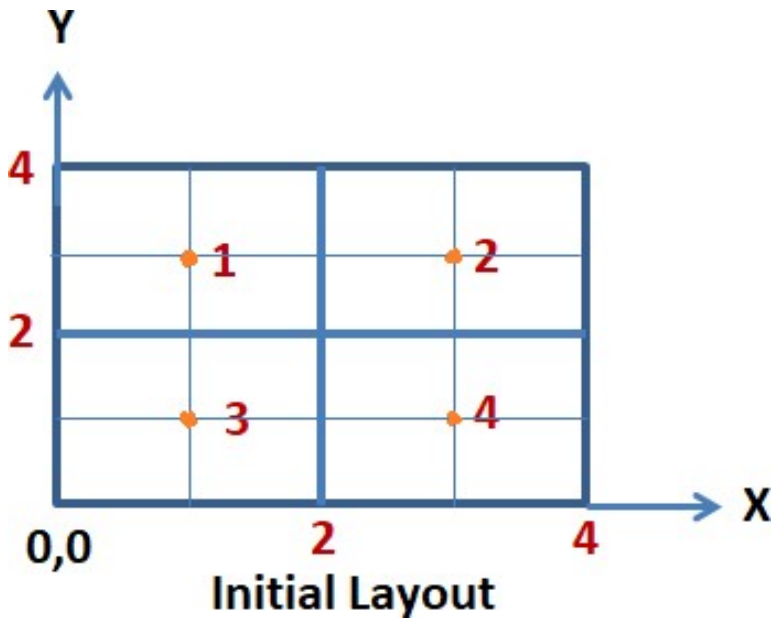
Area of Departments



Initial Layout

Layout Design - CRAFT Procedure

- **Step-2: Calculate the centroids of all the department in the initial layout**
  - ✓ $(X_1, Y_1) = 1, 3$
  - ✓ $(X_2, Y_2) = 3, 3$
  - ✓ $(X_3, Y_3) = 1, 1$
  - ✓ $(X_4, Y_4) = 3, 1$



Initial Layout

Layout Design - CRAFT Procedure

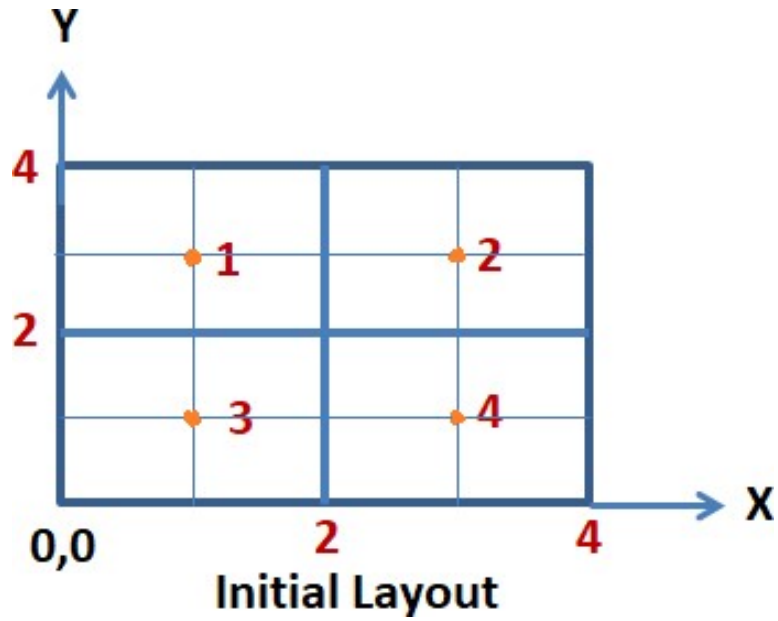
- **Step-3: Calculate the distance matrix [d_{ij}].** Distance matrix is the rectilinear distance between the centroids of two departments
  - ✓ $d_{ij} = |X_i - X_j| + |Y_i - Y_j|$

  where (X_i , Y_i) = centroid of i^{th} department

  (X_j , Y_j) = centroid of j^{th} department

From/To	1	2	3	4
1	0	2	2	4
2	2	0	4	2
3	2	4	0	2
4	4	2	2	0

Distance Matrix [d_{ij}]



Initial Layout

Layout Design - CRAFT Procedure

- **Step-4: Calculate the total cost of handling for the present layout**
  - ✓ **Total cost** $TC_{ij} = \sum_{i=1}^{4} \sum_{j=1}^{4} f_{i,j} \, X \, d_{i,j} \, X \, c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	2	2	4
2	2	0	4	2
3	2	4	0	2
4	4	2	2	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	10	4	16
2	0	-	8	10
3	4	0	-	0
4	12	0	2	-

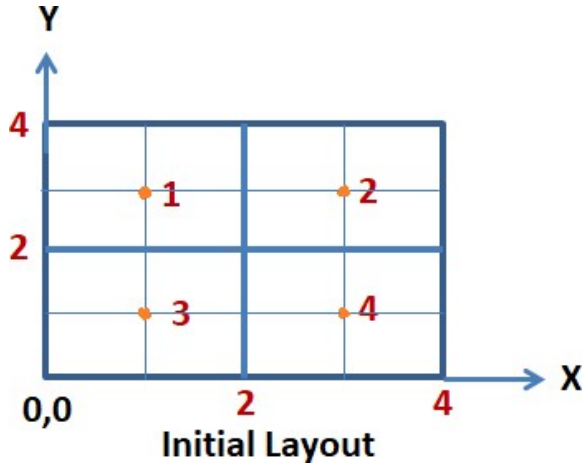
Total cost[TC_{ij}]

Total cost = 66

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Rule-1: Departments should have common border
  - Rule-2: Departments should have equal area
  - Consider only pairwise interchanges

Department Pairs	Remark
1 and 2	Interchange based on common border
1 and 3	Interchange based on common border
1 and 4	Interchange based on common area
2 and 3	Interchange based on common area
2 and 4	Interchange based on common border
3 and 4	Interchange based on common border

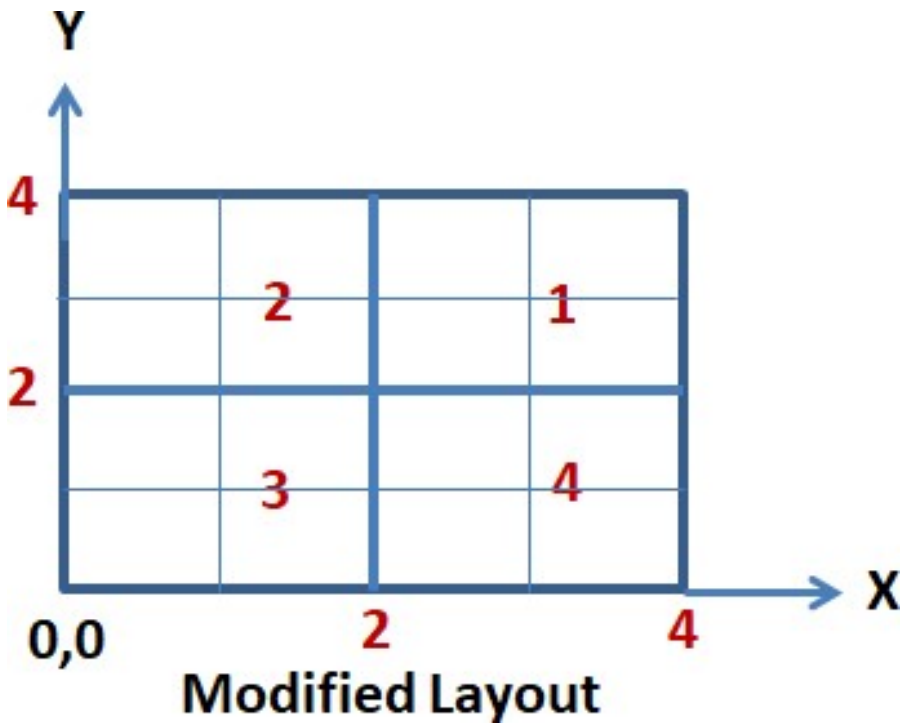


Initial Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Pairwise interchange → Interchange of Centroids
  - Calculate the distance matrix for each interchange
  - Based on that, calculate the total cost

- **Interchange between 1 & 2**
- **Calculate the centroids after interchange**
  - ✓ $(X_1, Y_1) = 3, 3$
  - ✓ $(X_2, Y_2) = 1, 3$
  - ✓ $(X_3, Y_3) = 1, 1$
  - ✓ $(X_4, Y_4) = 3, 1$

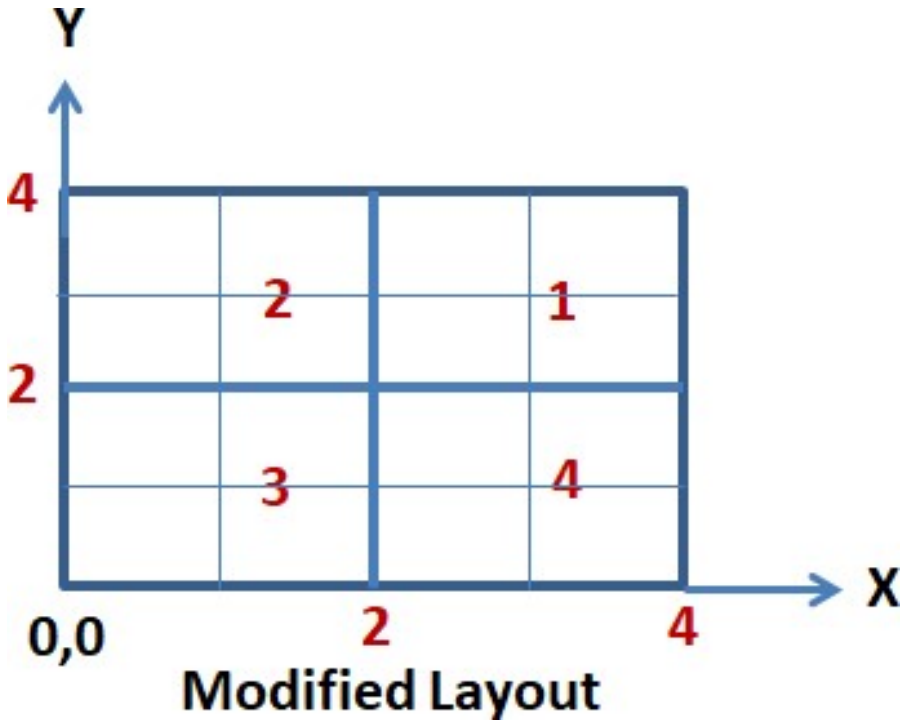


Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Distance matrix after interchange

From/To	1	2	3	4
1	0	2	4	2
2	2	0	2	4
3	4	2	0	2
4	2	4	2	0



Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (1&2)**
  - Calculate the total cost after interchange of 1 & 2
  - **Total cost TC_{ij} =** $\sum_{i=1}^{4}\sum_{j=1}^{4} f_{i,j} \; X \; d_{i,j} \; X \; c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	2	4	2
2	2	0	2	4
3	4	2	0	2
4	2	4	2	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	10	8	8
2	0	-	4	20
3	8	0	-	0
4	6	0	2	-

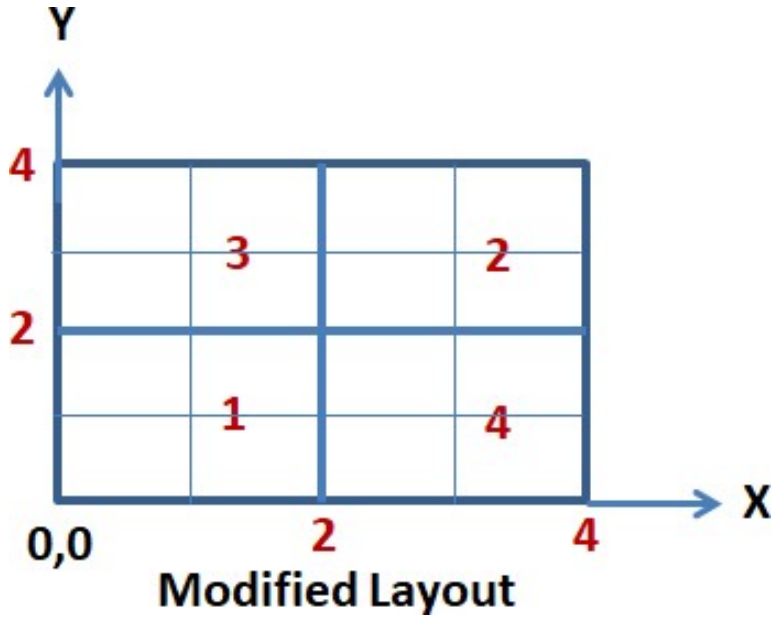
Total cost[TC_{ij}]

Total cost = 66

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Pairwise interchange → Interchange of Centroids
  - Calculate the distance matrix for each interchange
  - Based on that, calculate the total cost

- **Interchange between 1 & 3**
- **Calculate the centroids after interchange**
  - ✓ $(X_1, Y_1) = 1, 1$
  - ✓ $(X_2, Y_2) = 3, 3$
  - ✓ $(X_3, Y_3) = 1, 3$
  - ✓ $(X_4, Y_4) = 3, 1$

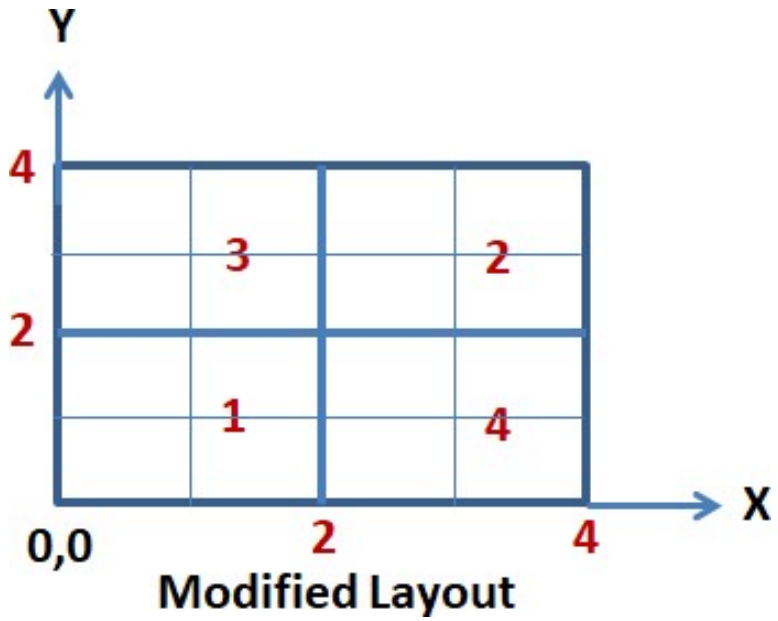


Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (1 & 3)**
  - Distance matrix after interchange

From/To	1	2	3	4
1	0	4	2	2
2	4	0	2	2
3	2	2	0	4
4	2	2	4	0



Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (1&3)**
  - Calculate the total cost after interchange of 1 & 3
  - **Total cost TC_{ij} =** $\sum_{i=1}^{4}\sum_{j=1}^{4} f_{i,j} \; X \; d_{i,j} \; X \; c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	4	2	2
2	4	0	2	2
3	2	2	0	4
4	2	2	4	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	20	4	8
2	0	-	4	10
3	4	0	-	0
4	6	0	4	-

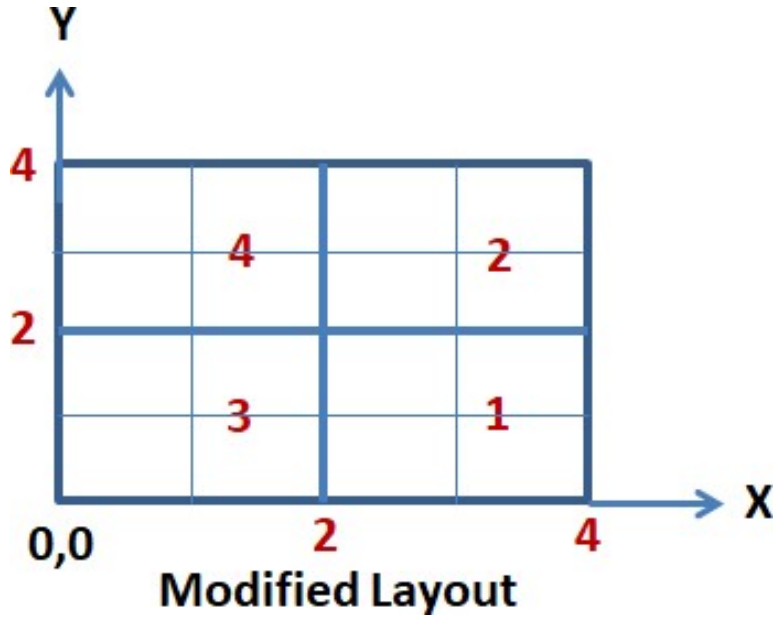
Total cost[TC_{ij}]

Total cost = 60

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Pairwise interchange → Interchange of Centroids
  - Calculate the distance matrix for each interchange
  - Based on that, calculate the total cost

- **Interchange between 1 & 4**
- **Calculate the centroids after interchange**
  - ✓ $(X_1, Y_1) = 3, 1$
  - ✓ $(X_2, Y_2) = 3, 3$
  - ✓ $(X_3, Y_3) = 1, 1$
  - ✓ $(X_4, Y_4) = 1, 3$

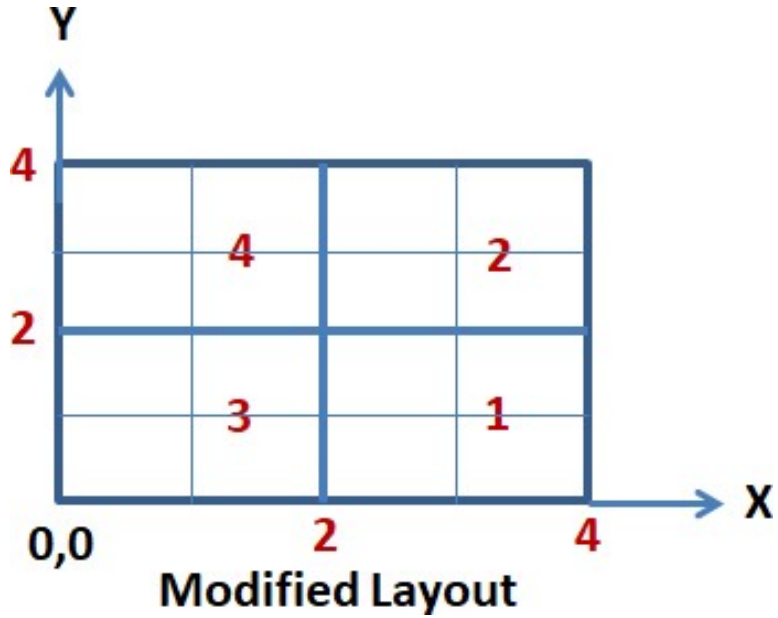


Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (1 & 4)**
  - Distance matrix after interchange

From/To	1	2	3	4
1	0	2	2	4
2	2	0	2	4
3	2	4	0	2
4	4	2	2	0



Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (1&4)**
  - Calculate the total cost after interchange of 1 & 4
  - **Total cost TC_{ij} =** $\sum_{i=1}^{4}\sum_{j=1}^{4} f_{i,j} \; X \; d_{i,j} \; X \; c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	2	2	4
2	2	0	2	4
3	2	4	0	2
4	4	2	2	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	10	4	16
2	0	-	4	20
3	4	0	-	0
4	12	0	2	-

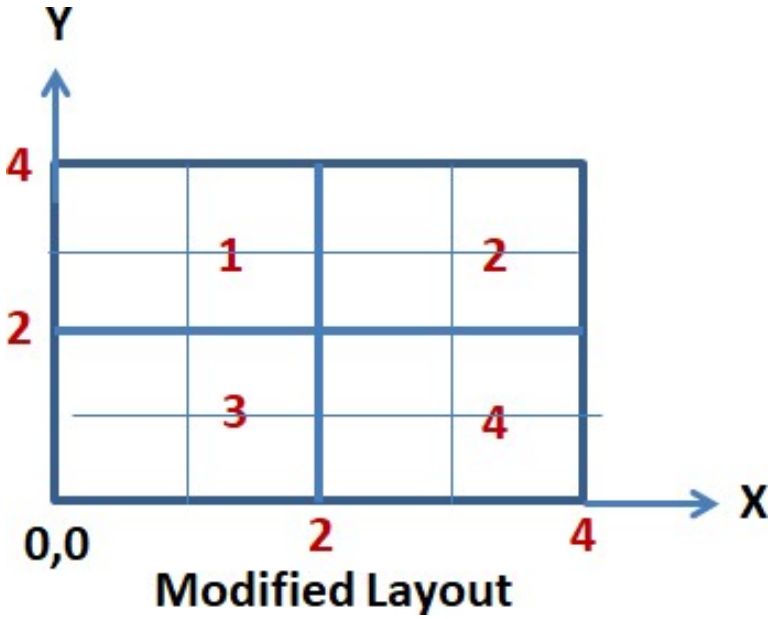
Total cost[TC_{ij}]

Total cost = 74

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Pairwise interchange → Interchange of Centroids
  - Calculate the distance matrix for each interchange
  - Based on that, calculate the total cost

- **Interchange between 2 & 3**
- **Calculate the centroids after interchange**
  - ✓ $(X_1, Y_1) = 1, 3$
  - ✓ $(X_2, Y_2) = 3, 3$
  - ✓ $(X_3, Y_3) = 1, 1$
  - ✓ $(X_4, Y_4) = 3, 1$

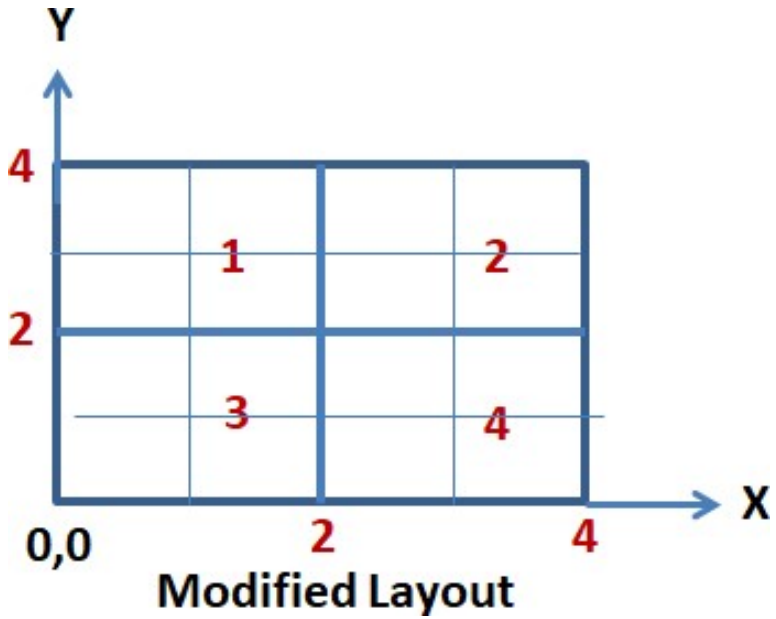


Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (2 & 3)**
  - Distance matrix after interchange

From/To	1	2	3	4
1	0	2	2	4
2	2	0	4	2
3	2	4	0	2
4	4	2	2	0



Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (2&3)**
  - Calculate the total cost after interchange of 2 & 3
  - **Total cost TC_{ij} =** $\sum_{i=1}^{4}\sum_{j=1}^{4} f_{i,j} \; X \; d_{i,j} \; X \; c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	2	2	4
2	2	0	4	2
3	2	4	0	2
4	4	2	2	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	10	4	16
2	0	-	8	10
3	4	0	-	0
4	12	0	2	-

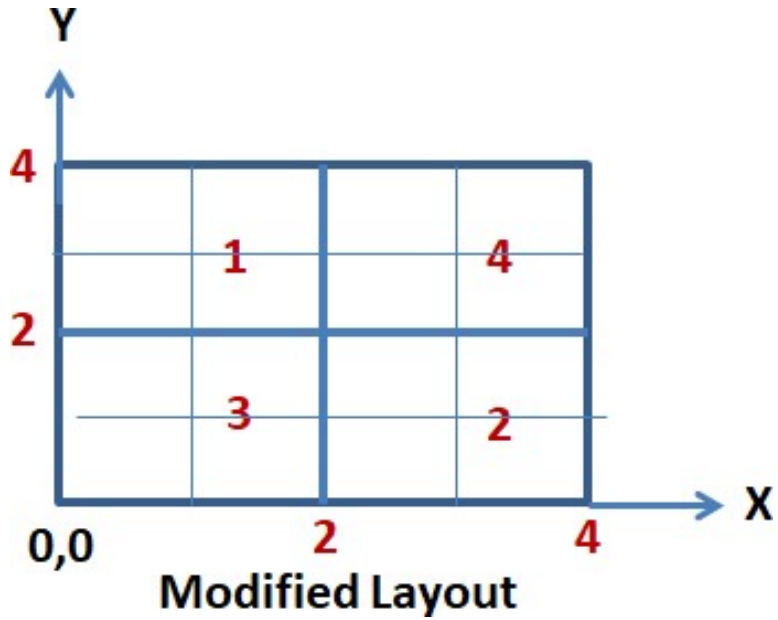
Total cost[TC_{ij}]

Total cost = 66

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Pairwise interchange → Interchange of Centroids
  - Calculate the distance matrix for each interchange
  - Based on that, calculate the total cost

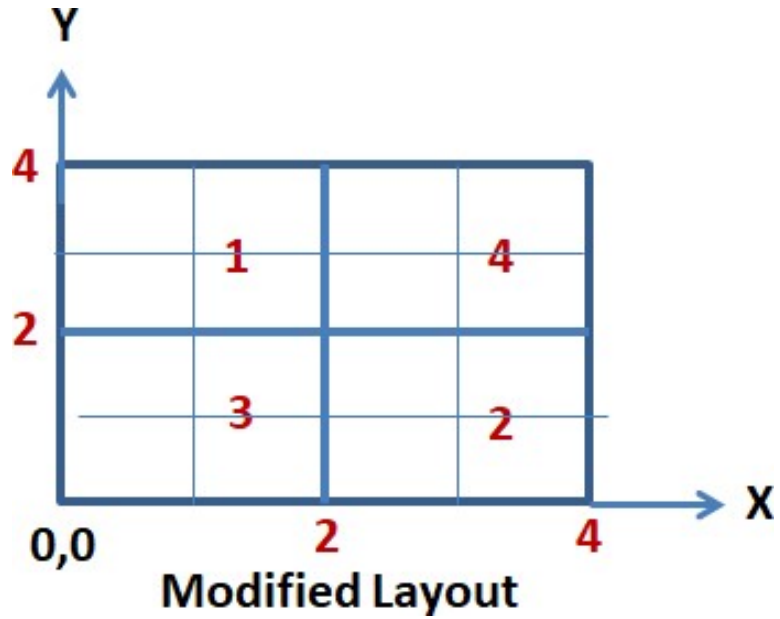
- **Interchange between 2 & 4**
- **Calculate the centroids after interchange**
  - ✓ $(X_1, Y_1) = 1, 3$
  - ✓ $(X_2, Y_2) = 3, 1$
  - ✓ $(X_3, Y_3) = 1, 1$
  - ✓ $(X_4, Y_4) = 3, 3$



Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (2 & 4)**
  - Distance matrix after interchange

From/To	1	2	3	4
1	0	4	2	2
2	4	0	2	2
3	2	2	0	4
4	2	2	4	0



Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (2&4)**
  - Calculate the total cost after interchange of 2 & 4
  - **Total cost TC_{ij} =** $\sum_{i=1}^{4}\sum_{j=1}^{4} f_{i,j} \; X \; d_{i,j} \; X \; c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	4	2	2
2	4	0	2	2
3	2	2	0	4
4	2	2	4	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	20	4	8
2	0	-	4	10
3	4	0	-	0
4	6	0	4	-

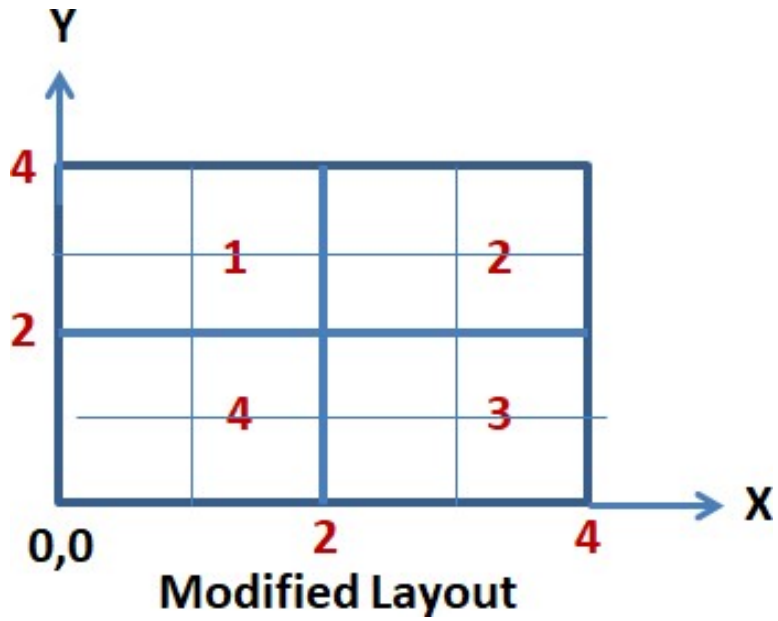
Total cost[TC_{ij}]

Total cost = 60

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Pairwise interchange → Interchange of Centroids
  - Calculate the distance matrix for each interchange
  - Based on that, calculate the total cost

- **Interchange between 3 & 4**
- **Calculate the centroids after interchange**
  - ✓ $(X_1, Y_1) = 1, 3$
  - ✓ $(X_2, Y_2) = 3, 3$
  - ✓ $(X_3, Y_3) = 3, 1$
  - ✓ $(X_4, Y_4) = 1, 1$

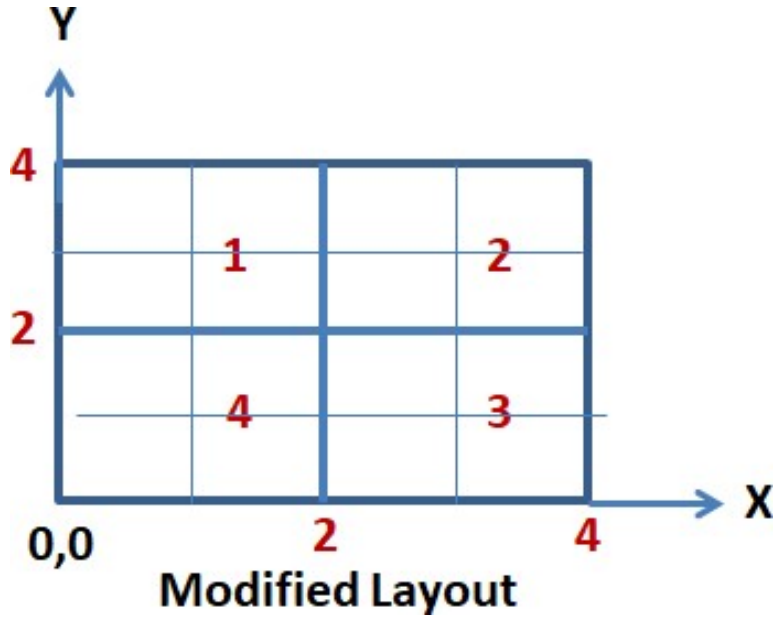


Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (3 & 4)**
  - Distance matrix after interchange

From/To	1	2	3	4
1	0	2	4	2
2	2	0	2	4
3	4	2	0	2
4	2	4	2	0



Modified Layout

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments (3&4)**
  - Calculate the total cost after interchange of 3 & 4
  - **Total cost TC_{ij} =** $\sum_{i=1}^{4}\sum_{j=1}^{4} f_{i,j} \; X \; d_{i,j} \; X \; c_{i,j}$

From/To	1	2	3	4
1	-	5	2	4
2	0	-	2	5
3	2	0	-	0
4	3	0	1	-

Flow Matrix [f_{ij}]

X

From/To	1	2	3	4
1	0	2	4	2
2	2	0	2	4
3	4	2	0	2
4	2	4	2	0

Distance Matrix [d_{ij}]

X

From/To	1	2	3	4
1	-	1	1	1
2	1	-	1	1
3	1	1	-	1
4	1	1	1	-

Cost Matrix [C_{ij}]

From/To	1	2	3	4
1	-	10	8	8
2	0	-	4	20
3	8	0	-	0
4	6	0	2	-

Total cost[TC_{ij}]

Total cost = 66

Layout Design - CRAFT Procedure

- **Step-5: Improve the layout by interchanging departments**
  - Summary of total cost after interchanging

Pairwise interchange	Total cost
1 and 2	66
1 and 3	**60**
1 and 4	74
2 and 3	66
2 and 4	**60**
3 and 4	66

Layout Design - CRAFT Procedure

- **Step-6: The interchange which has minimum total cost is considered for actual interchange in the layout**
  - Interchange between 1 and 3 as well as interchange between 2 and 4 have minimum total cost (=60 in this case)

Pairwise interchange	Total cost
1 and 2	66
1 and 3	**60**
1 and 4	74
2 and 3	66
2 and 4	**60**
3 and 4	66

Layout Design - CRAFT Procedure

- **Step-7: This cost (for 1&3/ 2&4) is compared with the cost of the present layout (i.e. initial layout). If the cost of the proposed interchange is less than the present layout cost, the interchange can be made. If not keep the present layout as the final layout**
  - Interchange between 1 and 3 as well as interchange between 2 and 4 have minimum total cost (=60 in this case)
  - Present layout cost = 66
  - Interchange is possible between 1 and 3

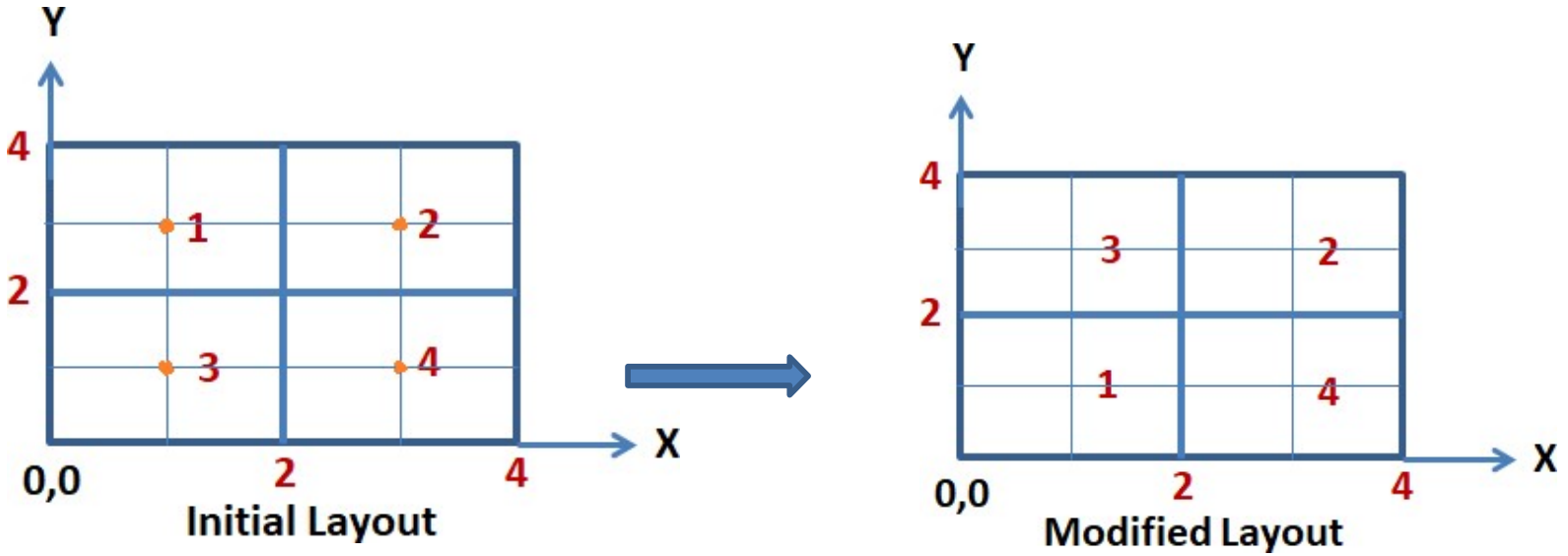
  or between 2 and 4 because of lower

  cost than the present layout cost

Pairwise interchange	Total cost
1 and 2	66
1 and 3	**60**
1 and 4	74
2 and 3	66
2 and 4	**60**
3 and 4	66

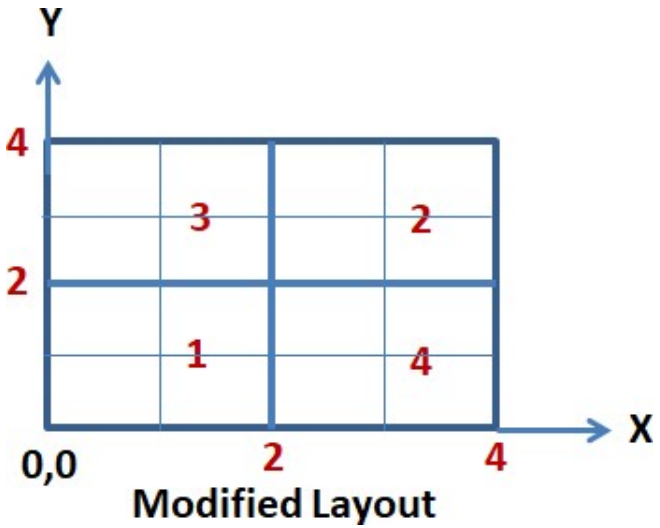
Layout Design - CRAFT Procedure

- **Step-8: Interchange can be made between 1 and 3. The layout after interchange is called the new layout**



Layout Design - CRAFT Procedure

- **Step-9: Check for further modifications. If not this new layout is called as FINAL Layout**



Final layout

Computer Based Layout Design - ALDEP

ALDEP - Automated Layout Design Program

Layout Design - ALDEP

- Construction type Algorithm
- Uses basic data on facilities and layout is developed by placing the layout using information available on relationship between departments
- Layout score is calculated
- Repeat the algorithm for specified number of iterations and for each iteration, layout score is calculated
- The best layout is selected based on the maximum score

Layout Design - ALDEP

Basic Data:

- Total number of departments
- Area of the departments
- Layout dimensions
- Closeness relationships among departments
- Total number of iterations

Layout Design - ALDEP

Closeness Ratings:

Closeness Notation	Stands for	Value
A	Absolutely Necessary	$4^3 = 64$
E	Excellent	$4^2 = 16$
I	Important	$4^1 = 4$
O	Ordinary	$4^0 = 1$
U	Unimportant	0
X	Not desirable	$-4^5 = -1024$

Layout Design - ALDEP Procedure

Problem: Consider the following inputs to design a best layout using ALDEP

- Total number of departments = 4
- Areas of Departments: Dept - 1: 24000 m^2 ; Dept-2: 6000 m^2; Dept-3: 12000 m^2; Dept-4: 18000 m^2
- Closeness Ratings:

From				
1	--			
2	A	--		
3	E	O	--	
4	I	E	U	--
To	1	2	3	4

- Total iterations = 2

Layout Design - ALDEP Procedure

- **Step-1:** Input
  - ✓ No. of Departments - 4
  - ✓ Area

Department	Area (m^2)	No. of Squares
1	24000	40
2	6000	10
3	12000	20
4	18000	30
Total	60000	100

Take Area/square = 600 m^2

$$\text{No. of squares} = \frac{Area\ of\ the\ Department}{Area\ per\ square\ (here\ it\ is\ 600)}$$

Layout Design - ALDEP Procedure

- **Step-1:** Input
  - ✓ Length x Width of the layout = 10 x 10 = 100 m^2
  - ✓ Closeness Ratings

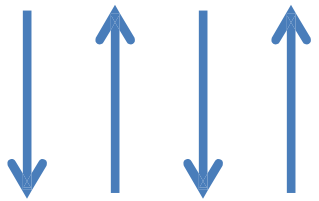
From				
1	--			
2	A	--		
3	E	O	--	
4	I	E	U	--
To	1	2	3	4

From/To	1	2	3	4
1	--	A	E	I
2	A	--	O	E
3	E	O	--	U
4	I	E	U	--
To	1	2	3	4

  - ✓ Total iterations = 2

Layout Design - ALDEP Procedure

- **Step-2:** Select the first department randomly to add into the layout. Let us start with Department "1"
- Fill the layout.
- After filling the layout looks like



Filling order

1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						
1	1	1	1						

Layout Design - ALDEP Procedure

- **Step-3:** Scan the closeness ratings chart for a department with A and E
- In this case, Department 2 is having A and Department 3 is having E ratings

From/To	1	2	3	4
1	--	A	E	I
2	A	--	O	E
3	E	O	--	U
4	I	E	U	--
To	1	2	3	4

Layout Design - ALDEP Procedure

- Dept 2 is having more rating. Now we have to fill the layout with Dept. 2

1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					
1	1	1	1	2					

Layout Design - ALDEP Procedure

- **Step-4:** Scan the closeness ratings chart for a department with A and E
- In this case, Department 1 is having A and Department 4 is having E ratings

From/To	1	2	3	4
1	--	A	E	I
2	A	--	O	E
3	E	O	--	U
4	I	E	U	--
To	1	2	3	4

Layout Design - ALDEP Procedure

- Dept 1 is having more rating. But already it was filled. Therefore we have to fill the layout with Dept. 4

1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		
1	1	1	1	2	4	4	4		

Layout Design - ALDEP Procedure

- **Step-5:** Only leftover department is 3. Fill the layout with Department 3.

1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3

Layout Design - ALDEP Procedure

- **Step-6:** Compute the score of the layout. The score is calculated based on the sum of the closeness ratings of all the neighbouring pairs of the departments in the filled layout

Neighbouring pairs of the department	Closeness Rating Grade	Closeness Rating Value
1-2	A	64
2-4	E	16
4-3	U	0
	Sum	80

1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3
1	1	1	1	2	4	4	4	3	3

From/To	1	2	3	4
1	--	A	E	I
2	A	--	O	E
3	E	O	--	U
4	I	E	U	--
To	1	2	3	4

Layout Design - ALDEP Procedure

- **Step-7:** This is treated as the current best layout. The score is 80
- **Step-8:** Do the second iteration. Calculate the score for it
- **Step-9:** Compare the two scores. The layout which is having more score will be the **best layout**

Computer Based Layout Design - CORELAP

CORELAP – COmputerized RElationship Layout Planning

Layout Design - CORELAP

- Construction type Algorithm (Graph Based Method)
- Adjacency Based Method (Closeness Values Based Method)
- Closeness Values are
  - ✓ **A = 6**
  - ✓ **E = 5**
  - ✓ **I = 4**
  - ✓ **O = 3**
  - ✓ **U = 2**
  - ✓ **X = 1**
- Selection of the department is based on the Total Closeness Rating (TCR)

Layout Design - CORELAP

- **Total Closeness Rating (TCR)** for a department is the sum of the numerical values assigned to the closeness relationships between the department and all other departments

$$TCR = \sum_{j=1, i \neq j}^{m} w_{ij}$$

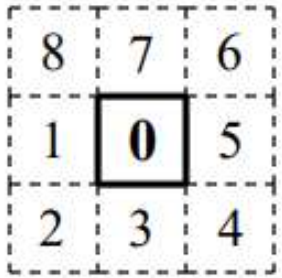
Layout Design - CORELAP

- **Department Selection**
- The first department placed in the layout is the one with the **greatest TCR value**. If there is a tie, then choose the one with more A's (E's, etc.).
- If a department has an **X relationship** with the first one, it is **placed last in the layout** and not considered. If a tie exists, choose the one with the smallest TCR value.
- The second department is the **one with an A (or E, I, etc.)** relationship with the first one. If a tie exists, choose the one with the greatest TCR value.
- The procedure continues until all departments have been placed
  ➔ Placement sequence

A = 6; E = 5; I = 4; O = 3; U = 2; X = 1

Layout Design - CORELAP

Department Placement



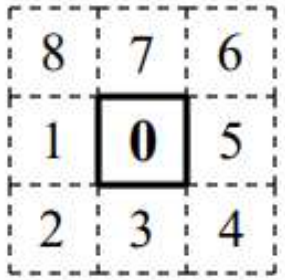
- **Department Neighbors**
  - Adjacent (in position 1, 3, 5 or 7) with department 0
  - Touching (in position 2, 4, 6 or 8) department 0
- **Placing rating (PR)** is the sum of the weighted closeness ratings between the department to enter the layout and its neighbors.

$$PR = \sum_{k} w_{ik} \text{ where } k = \{\text{departments already placed}\}$$

Layout Design - CORELAP

Department Placement

- Steps:
  - ✓ The first department selected is placed in the middle.
  - ✓ The placement of a department is determined by evaluating PR for all possible locations around the current layout
  - ✓ The new department is located based on the greatest PR value.



Layout Design – CORELAP

Example

- Given the **departmental dimensions** and **the relationship chart**, determine the sequence of the placement of the departments in the layout based on the CORELAP algorithm. Place the departments in the layout while evaluating each placement and also calculate the total score for the layout.

Department	Area (Sq.ft)	No. of Squares
1	12000	2
2	6000	1
3	6000	1
4	12000	2
5	6000	1
6	12000	2
7	12000	2
Total	66000	11

Layout Design – CORELAP

Example

- Given the **departmental dimensions** and **the relationship chart**, determine the sequence of the placement of the departments in the layout based on the CORELAP algorithm. Place the departments in the layout while evaluating each placement and also calculate the total score for the layout.

1	---						
2	E	---					
3	O	U	---				
4	I	E	U	---			
5	O	I	U	I	---		
6	U	I	O	U	A	---	
7	U	U	U	U	I	E	---
	1	2	3	4	5	6	7

Layout Design – CORELAP

- TCR Calculation and Identifying the 1st Placement Sequence

A = 6; E = 5: I = 4: O = 3; U = 2; X = 1

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	E	O	I	O	U	U	0	1	1	2	2	0	19	
2	E	---	U	E	I	I	U	0	2	2	0	2	0	22	
3	O	U	---	U	U	O	U	0	0	0	2	4	0	14	
4	I	E	U	---	I	U	U	0	1	2	0	3	0	19	
5	O	I	U	I	---	A	I	1	0	3	1	1	0	23	1
6	U	I	O	U	A	---	E	1	1	1	1	2	0	22	
7	U	U	U	U	I	E	---	0	1	1	0	4	0	17	

Placement order: 5

Layout Design – CORELAP

- The second department is the one with an A relationship with the first one (or E, I, etc.). If a tie exists, choose the one with the greatest TCR value. Any X relationships?

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	E	O	I	O	U	U	0	1	1	2	2	0	19	
2	E	---	U	E	I	I	U	0	2	2	0	2	0	22	
3	O	U	---	U	U	O	U	0	0	0	2	4	0	14	
4	I	E	U	---	I	U	U	0	1	2	0	3	0	19	
5	O	I	U	I	---	A	I	1	0	3	1	1	0	23	1
6	U	I	O	U	A	---	E	1	1	1	1	2	0	22	2
7	U	U	U	U	I	E	---	0	1	1	0	4	0	17	

Placement order: 5 – 6

Layout Design – CORELAP

- The next department is the one with an A (E, I, etc.). relationship with the already placed departments. If a tie exists, choose the one with the greatest TCR value. Any X?

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	E	O	I	O	U	U	0	1	1	2	2	0	19	
2	E	---	U	E	I	I	U	0	2	2	0	2	0	22	
3	O	U	---	U	U	O	U	0	0	0	2	4	0	14	
4	I	E	U	---	I	U	U	0	1	2	0	3	0	19	
5	O	I	U	I	---	A	I	1	0	3	1	1	0	23	1
6	U	I	O	U	A	---	E	1	1	1	1	2	0	22	2
7	U	U	U	U	I	E	---	0	1	1	0	4	0	17	3

Placement order: 5 – 6 – 7

Layout Design – CORELAP

- The next department is the one with an A (E, I, etc.). relationship with the already placed departments. If a tie exists, choose the one with the greatest TCR value. Any X?

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	E	O	I	O	U	U	0	1	1	2	2	0	19	
2	E	---	U	E	I	I	U	0	2	2	0	2	0	22	4
3	O	U	---	U	U	O	U	0	0	0	2	4	0	14	
4	I	E	U	---	I	U	U	0	1	2	0	3	0	19	
5	O	I	U	I	---	**A**	I	1	0	3	1	1	0	23	1
6	U	I	O	U	**A**	---	E	1	1	1	1	2	0	22	2
7	U	U	U	U	I	**E**	---	0	1	1	0	4	0	17	3

Placement order: 5 – 6 – 7 – 4

Layout Design – CORELAP

- The next department is the one with an A (E, I, etc.). relationship with the already placed departments. If a tie exists, choose the one with the greatest TCR value. Any X?

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	**E**	O	I	O	U	U	0	1	1	2	2	0	19	5
2	E	---	U	E	I	I	U	0	2	2	0	2	0	22	4
3	O	U	---	U	U	O	U	0	0	0	2	4	0	14	
4	I	E	U	---	I	U	U	0	1	2	0	3	0	19	
5	O	I	U	I	---	**A**	I	1	0	3	1	1	0	23	1
6	U	I	O	U	**A**	---	E	1	1	1	1	2	0	22	2
7	U	U	U	U	I	**E**	---	0	1	1	0	4	0	17	3

Same TCR and Area. So select department randomly

Placement order: 5 – 6 – 7 – 2 - 1

Layout Design – CORELAP

- The next department is the one with an A (E, I, etc.). relationship with the already placed departments. If a tie exists, choose the one with the greatest TCR value. Any X?

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	**E**	O	I	O	U	U	0	1	1	2	2	0	**19**	5
2	E	---	U	E	I	I	U	0	2	2	0	2	0	**22**	4
3	O	U	---	U	U	O	U	0	0	0	2	4	0	**14**	
4	I	**E**	U	---	I	U	U	0	1	2	0	3	0	**19**	6
5	O	I	U	I	---	**A**	I	1	0	3	1	1	0	**23**	1
6	U	I	O	U	**A**	---	E	1	1	1	1	2	0	**22**	2
7	U	U	U	U	I	**E**	---	0	1	1	0	4	0	**17**	3

Placement order: 5 – 6 – 7 – 2 – 1 – 4

Layout Design – CORELAP

- The next department is the one with an A (E, I, etc.). relationship with the already placed departments. If a tie exists, choose the one with the greatest TCR value. Any X?

Department	Department Relationships							Summary						TCR	Placement Sequence
	1	2	3	4	5	6	7	A	E	I	O	U	X		
1	---	**E**	O	I	O	U	U	0	1	1	2	2	0	**19**	5
2	E	---	U	E	I	I	U	0	2	2	0	2	0	**22**	4
3	O	U	---	U	U	O	U	0	0	0	2	4	0	**14**	7
4	I	**E**	U	---	I	U	U	0	1	2	0	3	0	**19**	6
5	O	I	U	I	---	**A**	I	1	0	3	1	1	0	**23**	1
6	U	I	O	U	**A**	---	E	1	1	1	1	2	0	**22**	2
7	U	U	U	U	I	**E**	---	0	1	1	0	4	0	**17**	3

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The first department is 5. It is placed in the centre of the 7 x 15 layout

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	**5**	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 5 = 1

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The second department is 6. It is placed adjacent to Department 5

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	**6**	**6**	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	**5**	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 6 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The next department to be placed is 7. The combinations are given here

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	7	7	0	0	0	0	0	0	0
3	0	0	0	0	0	0	6	6	7	0	0	0	0	0	0
4	0	0	0	0	0	7	7	5	7	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

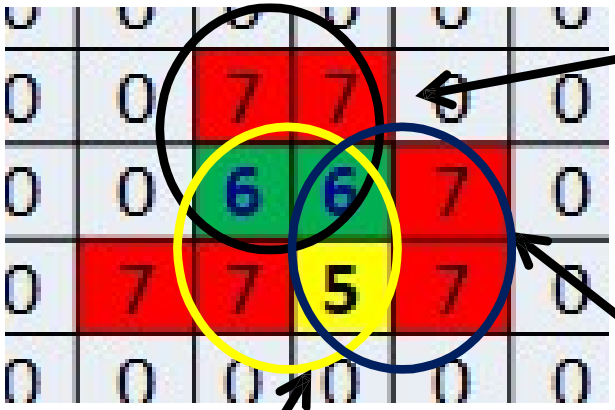
No. of Squares for department 7 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- To select the placement location of 7, calculate PR values



$PR = E_{6-7} = 5$

$PR = E_{6-7} + I_{5-7} = 5 + 4 = 9$

$PR = E_{6-7} + I_{5-7} = 5 + 4 = 9$

Select Randomly between these two (since both are equal)

Department	Department Relationships						
	1	2	3	4	5	6	7
1	---	E	O	I	O	U	U
2	E	---	U	E	I	I	U
3	O	U	---	U	U	O	U
4	I	E	U	---	I	U	U
5	O	I	U	I	---	A	I
6	U	I	O	U	A	---	E
7	U	U	U	U	I	E	---

A = 6; E = 5: I = 4: O = 3; U = 2; X = 1

Layout Design – CORELAP

Placement of departments in the layout

- The placement of 7 based on PR is as given below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	6	6	0	0	0	0	0	0	0
4	0	0	0	0	0	7	7	5	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 5 = 1

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The next department to be placed is 2. The combinations are given here

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	2	6	6	0	0	0	0	0	0	0
4	0	0	0	0	2	7	7	5	2	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

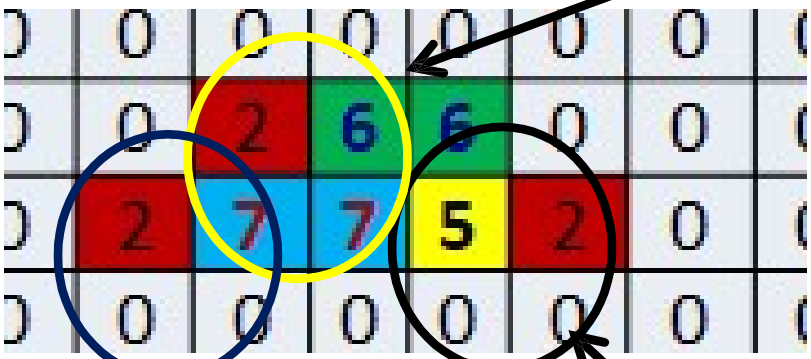
No. Of Squares for department 2 = 1

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- To select the placement location of 2, calculate PR values



High PR – Select this location

$PR = U_{7-2} + I_{6-2} = 6$

$PR = I_{5-7} = 4$

$PR = U_{7-2} = 2$

Department	Department Relationships						
	1	2	3	4	5	6	7
1	---	E	O	I	O	U	U
2	E	---	U	E	I	I	U
3	O	U	---	U	U	O	U
4	I	E	U	---	I	U	U
5	O	I	U	I	---	A	I
6	U	I	O	U	A	---	E
7	U	U	U	U	I	E	---

A = 6; E = 5: I = 4: O = 3; U = 2; X = 1

Layout Design – CORELAP

Placement of departments in the layout

- The placement of 2 based on PR is as given below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	2	6	6	0	0	0	0	0	0	0
4	0	0	0	0	0	7	7	5	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. of Squares for department 2 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The next department to be placed is 1. The combinations are given here

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
3	0	0	0	0	1	2	6	6	1	0	0	0	0	0	0
4	0	0	0	0	1	7	7	5	1	0	0	0	0	0	0
5	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. of Squares for department 1 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The placement of 1 based on PR is as given below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
3	0	0	0	0	0	2	6	6	0	0	0	0	0	0	0
4	0	0	0	0	0	7	7	5	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 1 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The next department to be placed is 4. The combinations are given here

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	4	1	1	0	0	0	0	0	0	0	0
3	0	0	0	0	4	2	6	6	4	0	0	0	0	0	0
4	0	0	0	0	4	7	7	5	4	0	0	0	0	0	0
5	0	0	0	0	0	4	4	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. of Squares for department 4 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The placement of 4 based on PR is as given below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	4	1	1	0	0	0	0	0	0	0	0
3	0	0	0	0	4	2	6	6	0	0	0	0	0	0	0
4	0	0	0	0	0	7	7	5	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 4 = 2

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The next department to be placed is 3. The combinations are given here

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	3	4	1	1	3	0	0	0	0	0	0	0
3	0	0	0	0	4	2	6	6	0	0	0	0	0	0	0
4	0	0	0	0	3	7	7	5	0	0	0	0	0	0	0
5	0	0	0	0	0	3	0	3	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 3 = 1

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

Placement of departments in the layout

- The placement of 3 based on PR is as given below

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	4	1	1	3	0	0	0	0	0	0	0
3	0	0	0	0	4	2	6	6	0	0	0	0	0	0	0
4	0	0	0	0	0	7	7	5	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

No. Of Squares for department 3 = 1

Placement order: 5 – 6 – 7 – 2 – 1 – 4 – 3

Layout Design – CORELAP

- Calculation of Total Score

Department	Department	Distance (1)	Closeness (2)	Score
1	2	0	----	----
1	3	0	----	----
1	4	0	----	----
1	5	2	3	6
1	6	0	----	----
1	7	1	2	2
2	3	2	2	4
2	4	0	----	----
2	5	2	4	8
2	6	0	----	----
2	7	0	----	----
3	4	2	2	4
3	5	1	2	2
3	6	0	----	----
3	7	2	2	4
4	5	3	4	12
4	6	1	2	2
4	7	1	2	2
5	6	0	----	----
5	7	0	----	----
6	7	0	----	----
			Total	46

Total score for this layout = 46.

We can repeat this procedure with different scales and pick up the best layout with the minimum score

Thank you