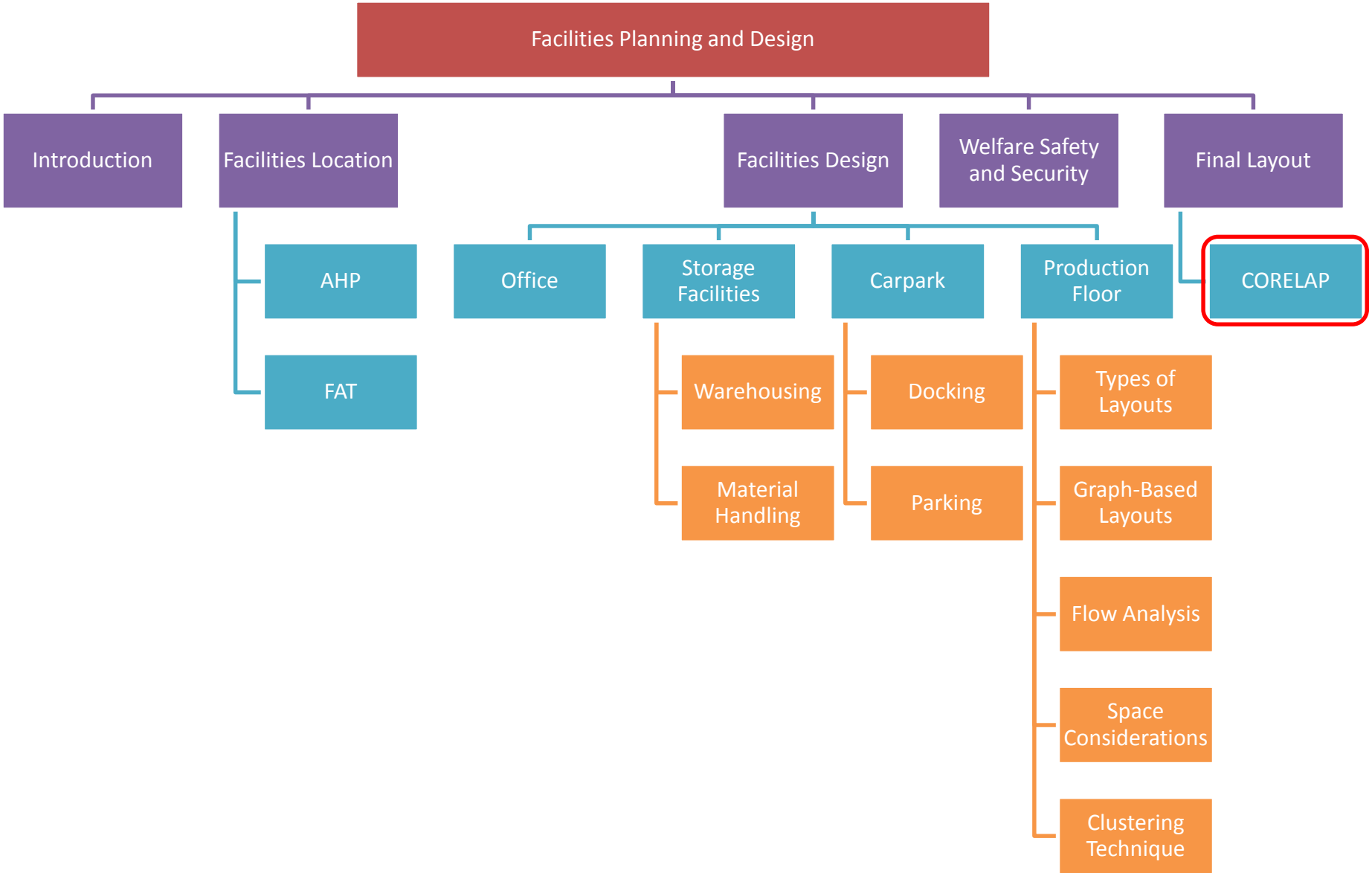
Problem 13
The Grand Finale

E212 – Facilities Planning and Design

SCHOOL OF ENGINEERING

E212 Facilities Planning & Design - Topic Tree



Learning Objectives

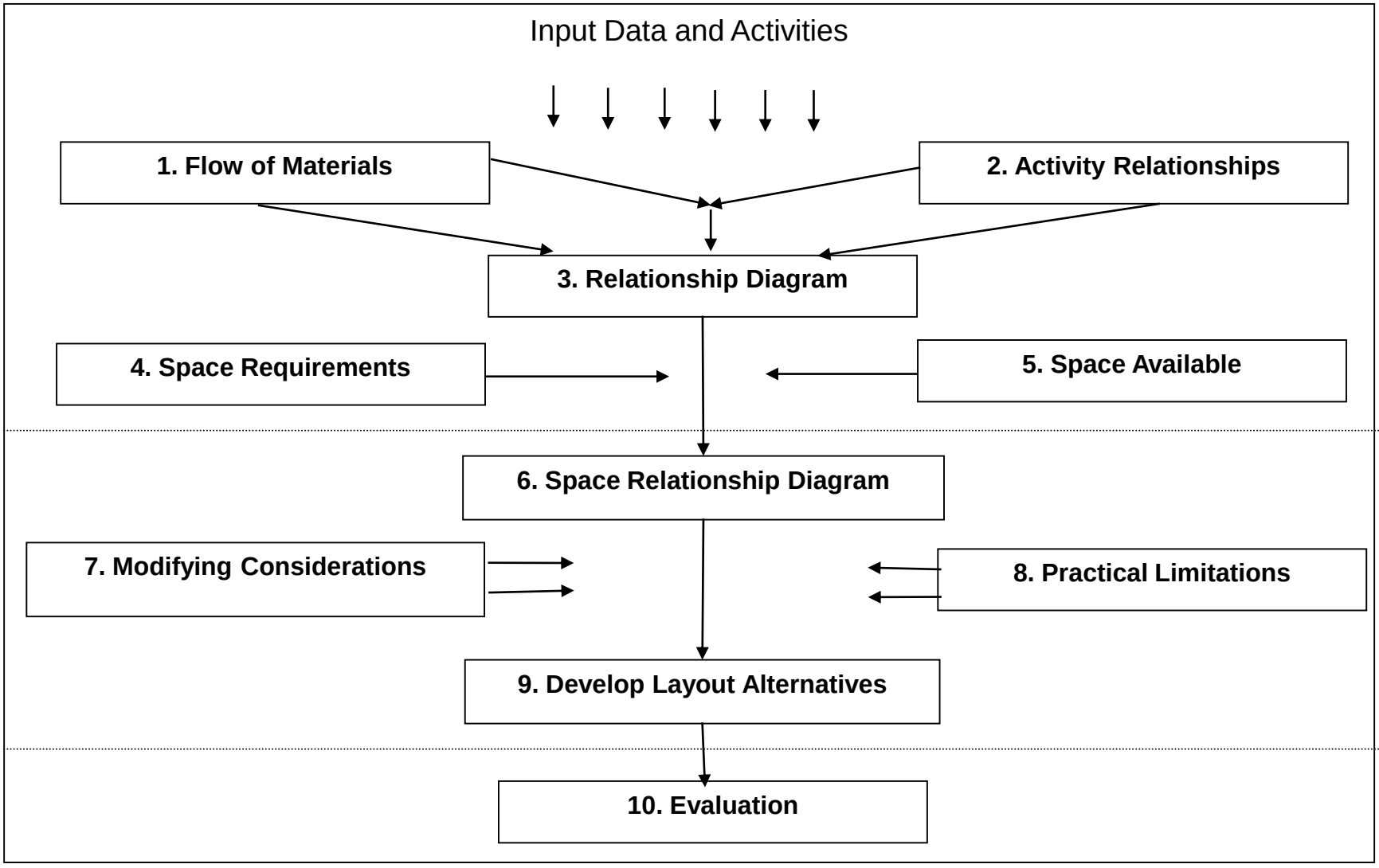
1. Perform the layout of different departments in based on importance of activities between the employees
2. Use initial square block layout by manual CORELAP algorithm
3. Construct the initial (process) layout using REL chart, CORELAP algorithm
4. Describe the strength, limitation and application of CORELAP
5. Create a TCR Table for a facility
6. Draft out a facility layout using AutoCAD

Layout Decisions (Recall)

- The need for layout decisions:
  - Support new product or service introduction
  - Support change in the design of products or services
  - Remove inefficient operations, e.g. high-cost process
  - Remove safety hazards

- A good layout design is able to:
  - Support changes in volume of output or mix of products
  - Support changes in equipment or work methods
  - Address environmental, legal and other statutory requirements

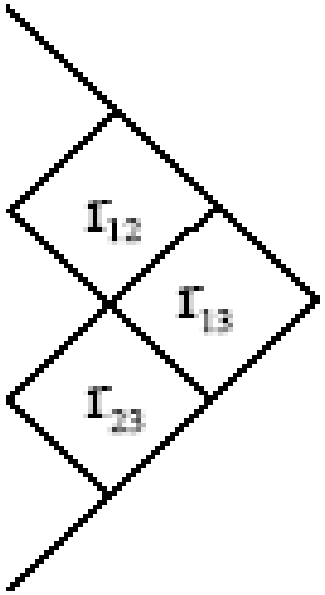
Systematic Layout Planning (Muther's)



Relationship (REL) Chart

- A number of factors other than material handling flow (cost) might be of primary concern in layout.
- A Relationship (REL) Chart represents M(M-1)/2 symmetric qualitative relationships, i.e.

  (M = number of departments)



$r_{ij} \in \{A, E, I, O, U, X\}$: Closeness Value (CV) between activities i and j; r_{ij} is an ordinal value

Assignment of Importance – Closeness Ratings

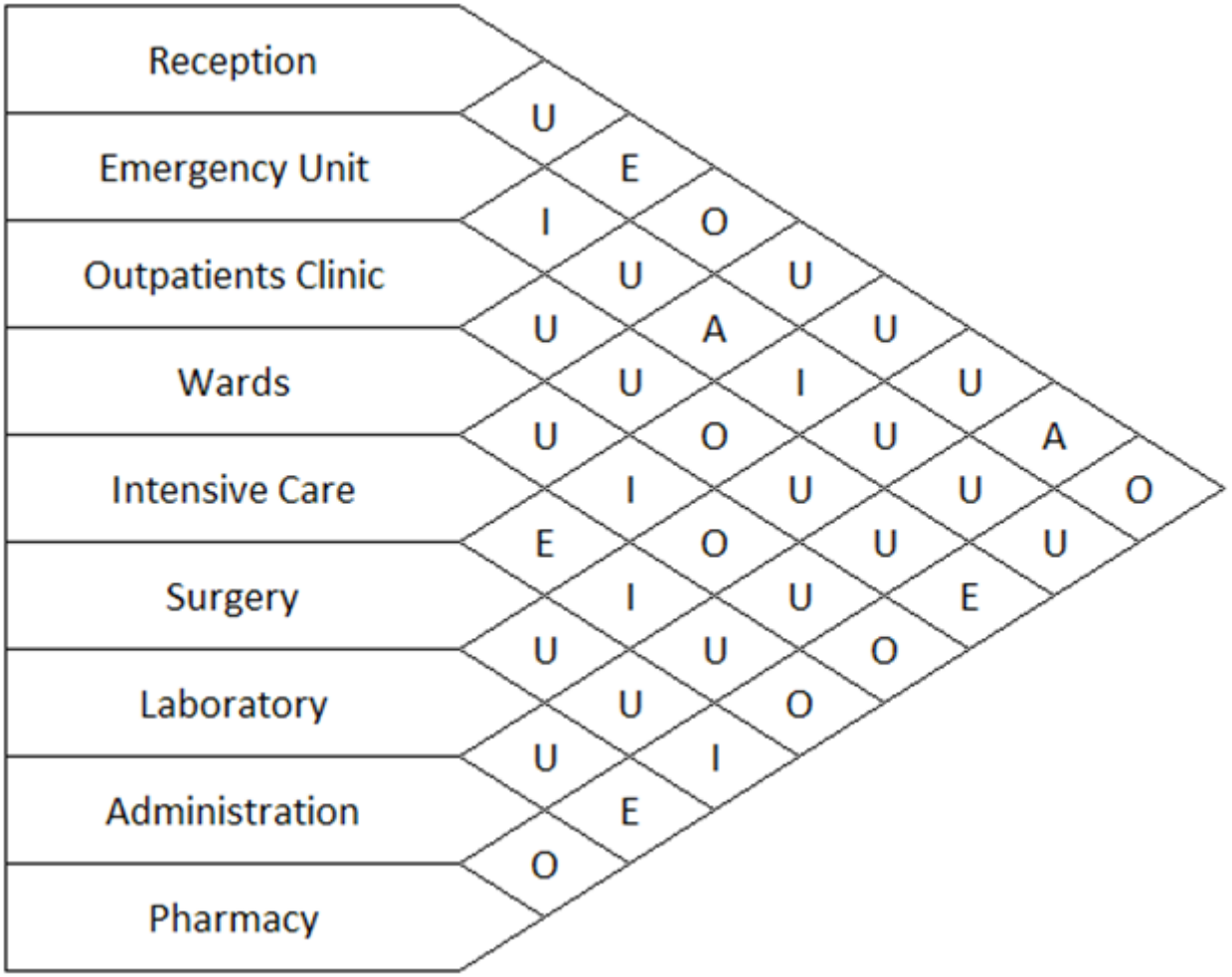
Assign the relationship with the ratings shown.

The percentage is a guideline to how much of each rating should be assigned with respect to the total number of relationships in the REL chart, in order for the REL chart to be appropriate.

A = absolutely necessary ≤ 5 %
E = especially important ≤ 10 %
I = important ≤ 15 %
O = ordinary closeness ≤ 20 %
U = unimportant ≥ 50 %
X = undesirable ≤ 5 %

In some cases, due to real-life circumstances (i.e.: safety considerations), it may not be possible to follow the guideline strictly. However, if the REL chart is just slightly inappropriate, most likely it will still be usable.

Example of REL Chart for a Hospital



Closeness Values

- $V(r_{ij})$ = arbitrary closeness value assigned to r_{ij},

  For example,

  V(A) = 125

  V(E) = 25

  V(I) = 5

  V(O) = 1

  V(U) = 0

  V(X) = -125

- The closeness values chosen are purely arbitrary, however it is recommended that the assigned closeness values have sufficiently large differences between different ratings

Total Closeness Rating

- For each department, the Total Closeness Rating (TCR) is the sum of the values of the relationships with other departments

- For example:

Department	Department									Summary							
	1	2	3	4	5	6	7	8	9	A	E	I	O	U	X	TCR	Order
1. Reception		U	E	O	U	U	U	A	O	1	1	0	2	4	0	152	2
2. Emergency Unit	U		I	U	A	I	U	U	U	1	0	2	0	5	0	135	3
3. Outpatients Clinic	E	I		U	U	O	U	U	E	0	2	1	1	4	0	56	6
4. Wards	O	U	U		U	I	O	U	O	0	0	1	3	4	0	8	9
5. Intensive Care	U	A	U	U		E	I	U	O	1	1	1	1	4	0	156	1
6. Surgery	U	I	O	I	E		U	U	I	0	1	3	1	3	0	41	7
7. Laboratory	U	U	U	O	I	U		U	E	0	1	1	1	5	0	31	8
8. Administration	A	U	U	U	U	U	U		O	1	0	0	1	6	0	126	4
9. Pharmacy	O	U	E	O	O	I	E	O		0	2	1	4	1	0	59	5

Manual CORELAP Algorithm

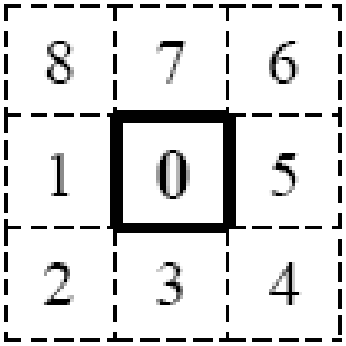
- The manual CORELAP algorithm is an initial process layout method which makes use of the REL chart
- The departments to be placed are selected based on a set of criteria
- The departments are then placed one by one based on the procedures to place departments
- The departments are assumed to be squares of uniform sizes, i.e. actual shape and size are not taken into consideration when following the manual CORELAP algorithm

Selection of Departments to Place

1. First department to be placed is the one with the greatest TCR value.
   - If a tie exists, choose the department with more A's
2. If a department has an X relationship with the first one, it is placed last in the layout
   - If a tie exists, choose the one with the smallest TCR value
3. Second department is the one with an A relationship with the first one
   - If a tie exists, choose the one with the greatest TCR value
4. If a department has an X relationship with the second one, it is placed next-to-the-last or last in the layout
   - If a tie exists, choose the one with the smallest TCR value
5. The third department is the one with an A relationship with one of the placed departments.
   - If a tie exists, choose the one with the greatest TCR value
6. The procedure continues until all departments have been placed.

Procedure to Place Departments

- Consider the figure on the right.
- Assume that a department is placed in the middle (position 0).
  - Positions 1, 3, 5 or 7 are "fully adjacent" with that department
  - Positions 2, 4, 6 or 8 are "partially adjacent" with that department



- The first department selected would be placed at location 0.
- The sum of the numerical values for all pairs of adjacent departments, called the Weighted Placement (WP), is then calculated for each square around the placed department.
- The next department is placed at the location with the highest WP.

Important Notes

- Once the department is placed, it is called a permanent facility while the department yet to be located is called a temporary facility.

- In choosing an entering department, it is based on
  - A, E, I, O, U
  - If ties exist, choose the department with the largest TCR value
  - If ties still persist after that, choose the department with the largest area (space requirement)

- WP is also called PR (Placement Rating) and is defined by the sum of the numerical values assigned to the closeness ratings between the entering facility and adjacent permanent ones.

- We try to maximize WP in the final block layout. If ties exist, consider
  - largest boundary length
  - arbitrary assignment

Problem 13
Suggested Solution

Problem Objectives

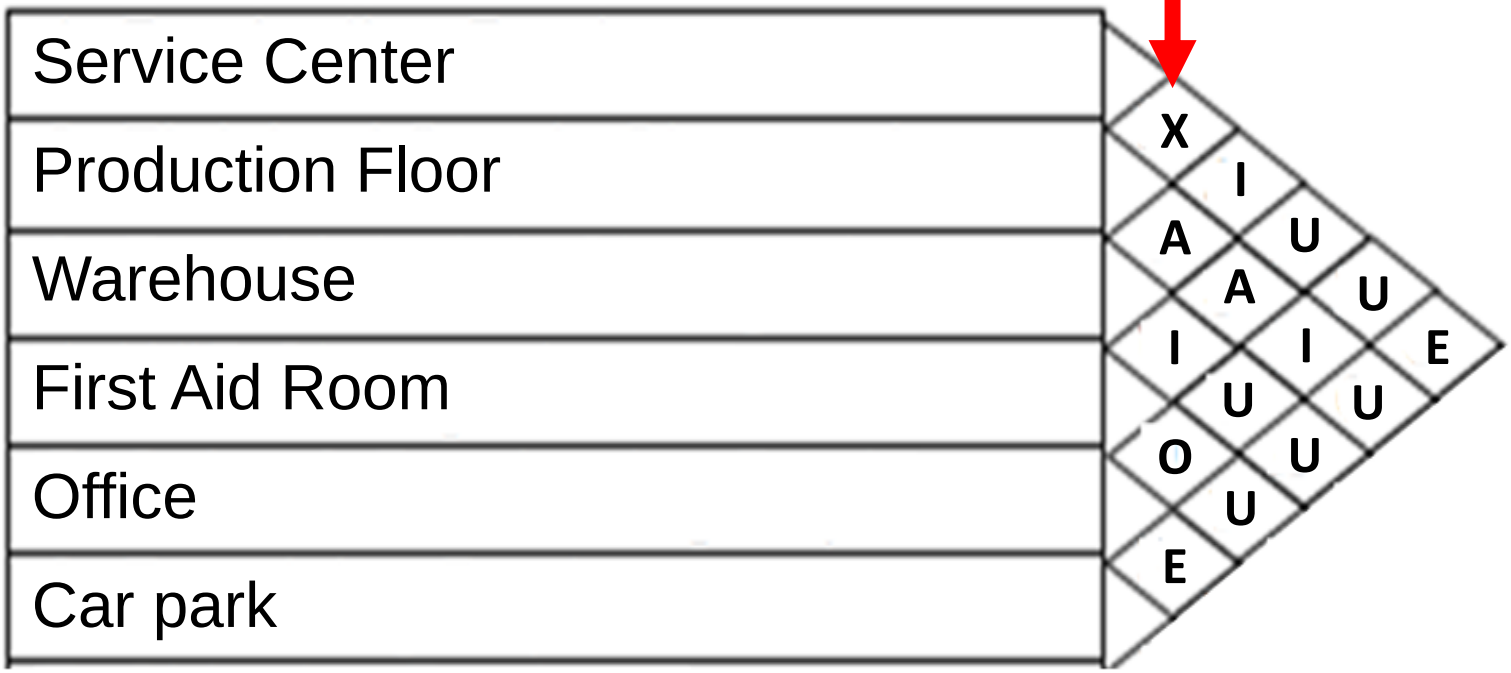
- Establish relationships between departments

- Layout different departments within a facility based on importance of relationships between department
  - REL chart
  - Manual CORELAP algorithm

- Layout should be able to:
  - Facilitate lean flow
  - Reduce unnecessary / non value-added movements.
  - Improve co-ordination efficiency among various departments.
  - Improve safety

Relationship Chart for the Facility

Example: Service Center shouldn't be near Production Floor*



*(*based on the interview script)*

Example: TCR Value Computation

Closeness Values	
V (A)	1000
V (E)	100
V (I)	10
V (O)	1
V (U)	0
V (X)	-1000

Partial Adjacency (α): 0.5

Choose the department with highest TCR (Department 3) to start the layout

Process activities	Process activities						Summary						Total Closeness Rating (TCR)	TCR Rank
	1	2	3	4	5	6	A	E	I	O	U	X		
1. Service Center	-	X	I	U	U	E	0	1	1	0	2	1	-890	6
2. Production Floor	X	-	A	A	I	U	2	0	1	0	1	1	1010	3
3. Warehouse	I	A	-	I	U	U	1	0	2	0	2	0	1020	1
4. First Aid Room	U	A	I	-	O	U	1	0	1	1	2	0	1011	2
5. Office	U	I	U	O	-	E	0	1	1	1	2	0	111	5
6. Car Park	E	U	U	U	E	-	0	2	0	0	3	0	200	4

Example: 1st and 2nd Dept. Placement

1. Dept. 3 with the highest TCR value is placed first.
2. Dept. 2 have A closeness rating with Dept. 3. We choose Dept. 2 next.

500	1000	500
1000	3	1000
500	1000	500

Since Dept. 2 has an **A** closeness rating with Dept. 3, the box which is directly adjacent to Dept. 3 has WP of 1000.

Assuming a partial adjacency factor α = 0.5

The WP of the boxes partially adjacent to Dept. 3 is 1000 x 0.5 = 500

Department 2 would be placed at the any of the locations with highest WP.

Closeness Values	
V (A)	1000
V (E)	100
V (I)	10
V (O)	1
V (U)	0
V (X)	-1000

Partial Adjacency (α): 0.5

500	1000	500.
1000	3	1000
500	1000	500

We choose Dept. 2 to be placed here

Example: 3rd Dept. Placement

3. Dept. 4 has A (the highest) closeness rating with Dept. 2. So Dept. 4 will be placed next.

5	510	1005	500
10	3	2	1000
5	510	1005	500

e.g. Directly adjacent to Dept. 2 and partially adjacent to Dept. 3

Dept. 4 has A closeness rating with Dept. 2, add 1000 to WP

Dept. 4 has I closeness rating with Dept. 3, add 10 x 0.5 = 5 to WP

WP = 1000 + (10 x0.5) = 1005

Closeness Values	
V (A)	1000
V (E)	100
V (I)	10
V (O)	1
V (U)	0
V (X)	-1000

Partial Adjacency (α): 0.5

Dept. 4 would then be placed at any of the location with the highest WP (i.e. 1005)

We choose to place Dept. 4 here

5	510	1005	500
10	3	2	1000
5	510	1005	500

4. Depts. 5 has O (the highest) closeness rating with Dept. 4. So choose Dept. 5 to be placed next.

Example: Subsequent Dept. Placements

5) Placing Department 5

0	5	10	5
0	3	2	10.5
0	6	4	6
	0.5	1	0.5

6) Placing Department 6

0	0	50	100	50
0	3	2	5	100
0	0	4	100	50
	0	0	0	

7) Placing Department 1

5	-490	-995	-500	0
10	3	2	5	50
5	-490	4	6	100
	0	50	100	50

Closeness Values	
V (A)	1000
V (E)	100
V (I)	10
V (O)	1
V (U)	0
V (X)	-1000

Partial Adjacency (α): 0.5

Initial Layout

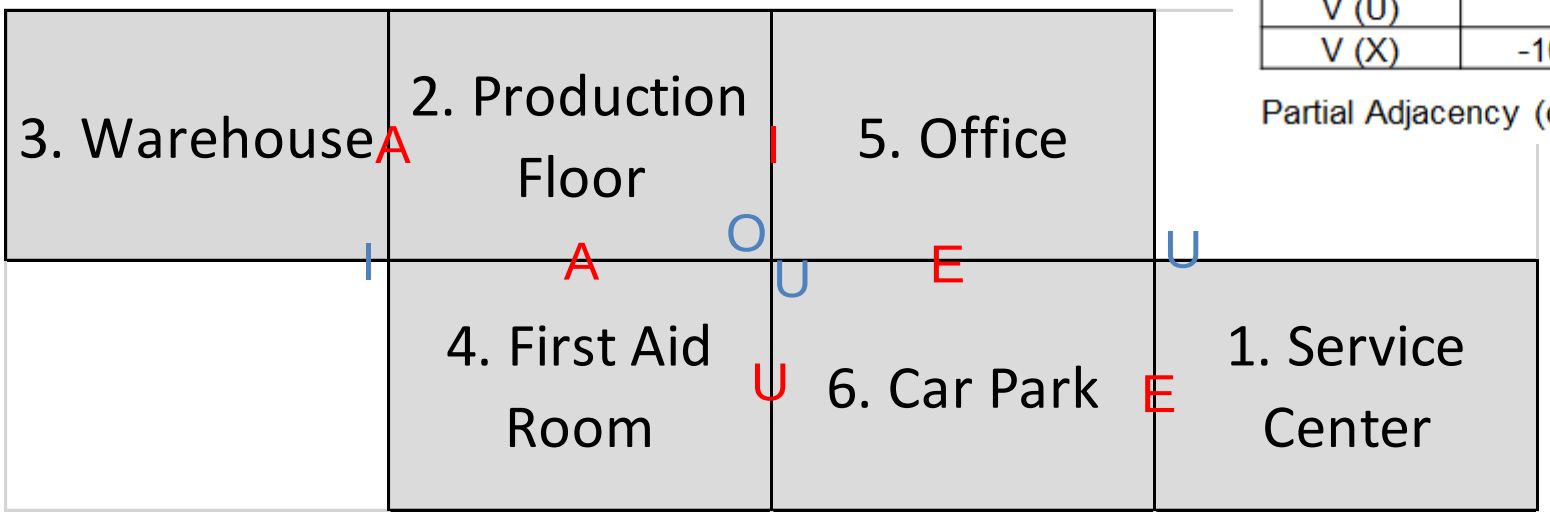
3	2	5	
	4	6	1

3. Warehouse	2. Production Floor	5. Office	
	4. First Aid Room	6. Car Park	1. Service Center

Initial Layout-Calculate the Total Weighted Placement

Closeness Values	
V (A)	1000
V (E)	100
V (I)	10
V (O)	1
V (U)	0
V (X)	-1000

Partial Adjacency (α): 0.5



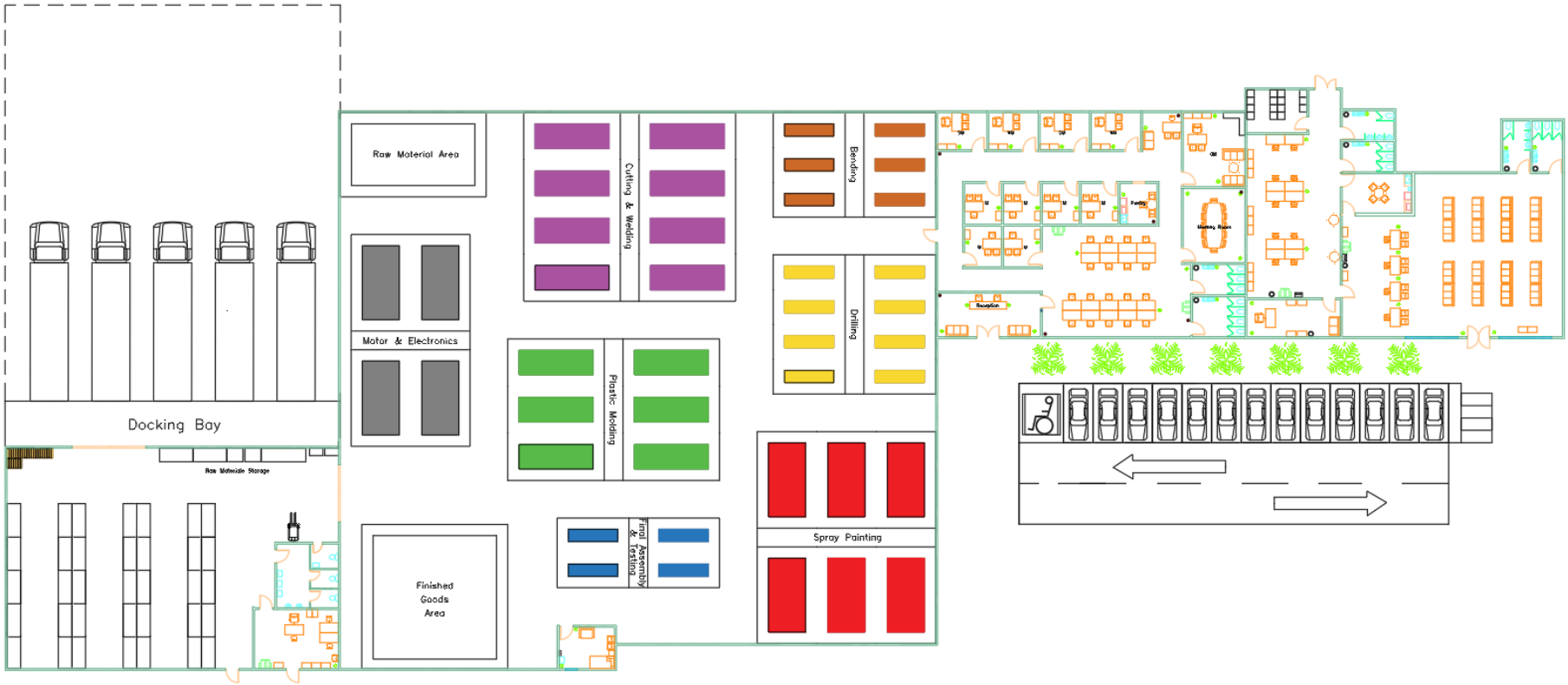
Total Weighted Placement (WP)

= (2x(A)) + (2x(E)) + (1x(I)) + (1x(U)) + 0.5((1x(I)) + (1x(O)) + (2x(U)))

= (2x1000) + (2x100) + (1x10) + (1x0) + 0.5((1x(10)) + (1x(1)) + (2x(0)))

= **2215.5**

Final Layout Draft (AutoCAD)



Additional Practical Considerations

- Location of building core (Structural columns, Staircase, etc.)
- Size of department
- Shape of building
- Location of loading/unloading bay (same place, location of road leading to the plant)

AutoCAD Architecture 2018

List of AutoCAD commands and functions we have used:

- Copy
- Move
- Mirror
- Offset
- Trim
- Hatch
- Line
- Mtext
- Dimension (DIM)
- Area
- Scale
- Array
- GRIDMODE (F7)
- Object Snap / OSNAP (F3)
- ORTHOMODE (F8)
- Green and Blue Selector

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Overview of E212 Facilities Planning and Design