

# Problem 04

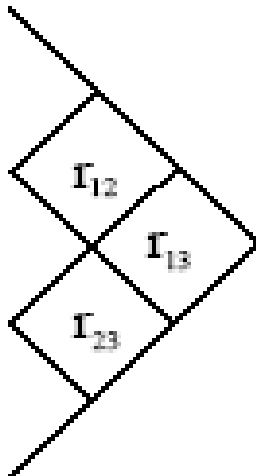
## Side by Side

SCHOOL OF  
ENGINEERING

# 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.



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

# Assignment of Importance

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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.

A = absolutely necessary  $\leq 5\%$

E = especially important  $\leq 10\%$

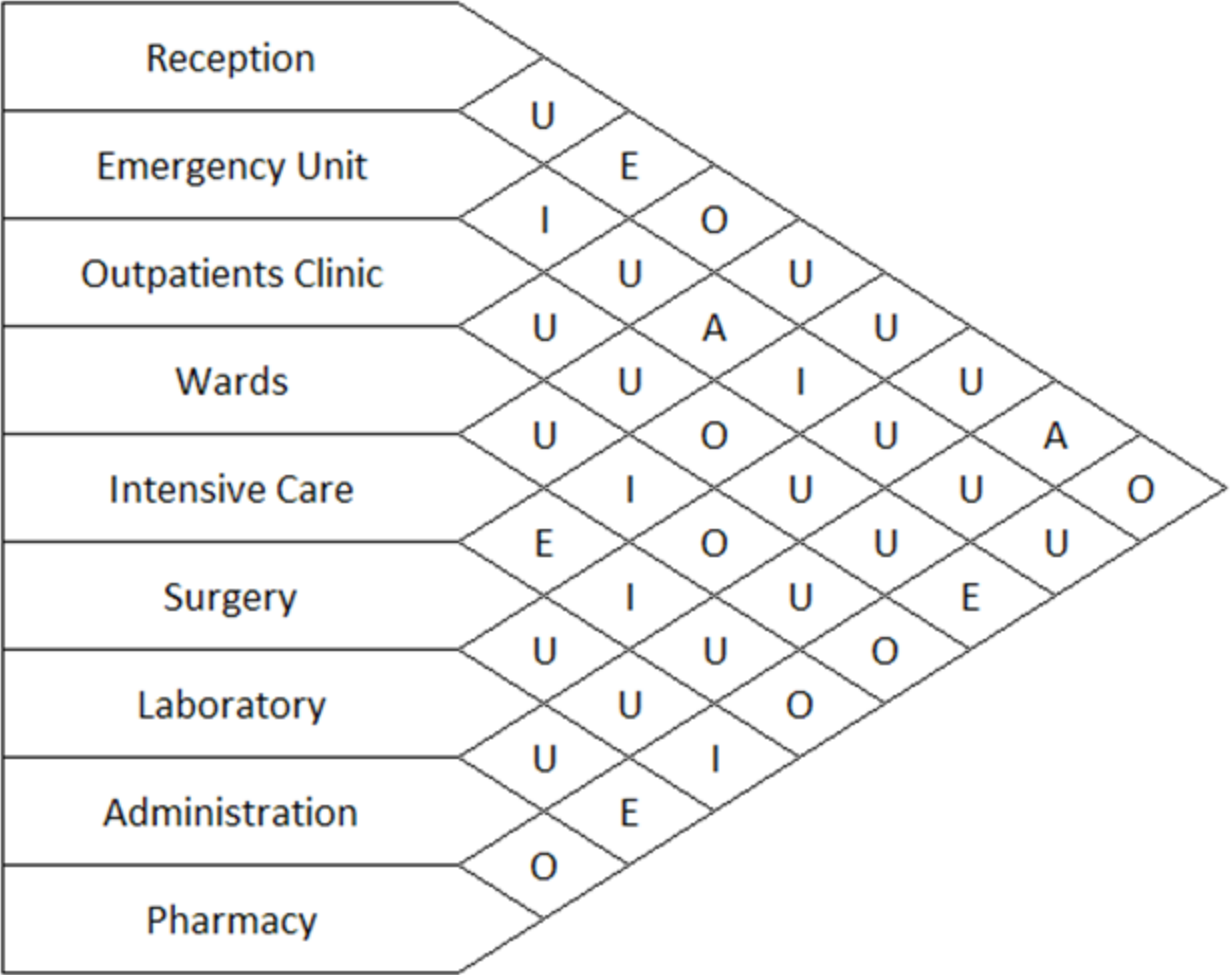
I = important  $\leq 15\%$

O = ordinary closeness  $\leq 20\%$

U = unimportant  $\geq 50\%$

X = undesirable  $\leq 5\%$

# Example of REL Chart for a Hospital



# Closeness Value

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

$$V(A) = 125$$

$$V(E) = 25$$

$$V(I) = 5$$

$$V(O) = 1$$

$$V(U) = 0$$

$$V(X) = -125$$

# Total Closeness Rating



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

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

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- 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

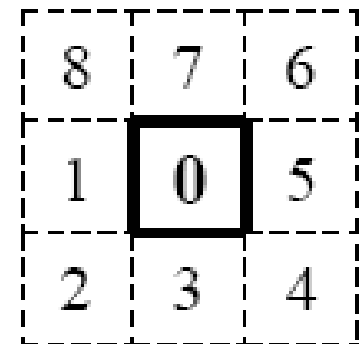


- First department to be placed is the one with the greatest TCR value.
  - If a tie exists, choose the department with more A's
- If a department has an X relationship with the first one, it is placed last in the layout
  - If a tie exists, choose the one with the smallest TCR value
- Second department is the one with an A relationship with the first one
  - If a tie exists, choose the one with the greatest TCR value
- 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
- 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
- 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).
  - Position 1, 3, 5 or 7 is “**fully adjacent**” with that department
  - Position 2, 4, 6 or 8 is “**partially adjacent**” with that department



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

# Important Notes

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- 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, the largest TCR value
  - If ties persist, 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. If ties exist, consider
  - largest boundary length
  - arbitrary assignment

# P04 Sample Solution

# Problem Objectives

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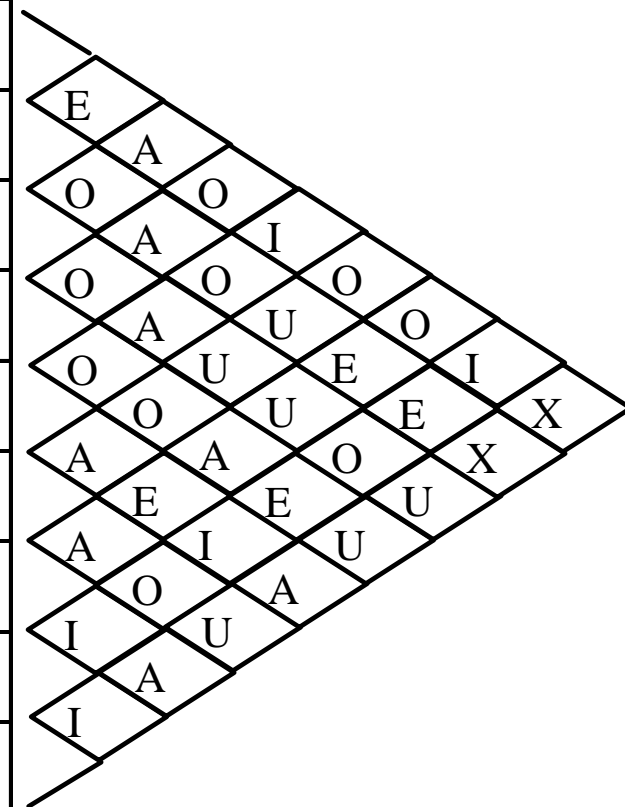


- Establish relationships between departments
- Layout different departments within a facility based on importance of relationships between departments
  - REL chart
  - manual CORELAP algorithm

# Relationship Chart for the Plant



1. Receiving
2. Shipping
3. Raw Materials Storage
4. Finished Goods Storage
5. Manufacturing
6. Work-In-Process Storage
7. Assembly
8. Purchasing & Sales
9. Product Engineering (Testing)



# Example: TCR Value Computation



Closeness Values	
V (A)	500
V (E)	200
V (I)	50
V (O)	2
V (U)	0
V (X)	-100

Choose the department with highest TCR (Department 7) to start the layout

Partial Adjacency ( $\alpha$ ): 0.5

Departments	Departments									Summary						TCR	Rank
	1	2	3	4	5	6	7	8	9	A	E	I	O	U	X		
1 Receiving		E	A	O	I	O	O	I	X	1	1	2	3	0	1	706	8
2 Shipping	E		O	A	O	U	E	E	X	1	3	0	2	1	1	1004	6
3 Raw Material Storage	A	O		O	A	U	U	O	U	2	0	0	3	3	0	1006	4
4 Finished Goods Storage	O	A	O		O	O	A	E	U	2	1	0	4	1	0	1208	3
5 Manufacturing	I	O	A	O		A	E	I	A	3	1	2	2	0	0	1804	2
6 WIP Warehouse	O	U	U	O	A		A	O	U	2	0	0	3	3	0	1006	4
7 Assembly	O	E	U	A	E	A		I	A	3	2	1	1	1	0	1952	1
8 Purchase & Sales	I	E	O	E	I	O	I		I	0	2	4	2	0	0	604	9
9 Testing	X	X	U	U	A	U	A	I		2	0	1	0	3	2	850	7

# Example: First and Second dept. placement



1. Department 7 with the highest TCR value is placed first.
2. Department 4, 6 and 9 have **A** relationship with department 7. Since department 4 has the highest TCR value among the 3, the next department to be placed is **Department 4**.

250	500	250
500	<b>7</b>	500
250	500	250

Since department 7 has an **A** relationship with 4, the box which is directly adjacent to 7 has WP of 500.

Assuming a partial adjacency factor  $\alpha = 0.5$

The WP of the boxes partially adjacent to 7 is  $0.5 \times 500 = 250$

- Department 4 would be placed at the any of the locations with highest WP

# Example: 3<sup>rd</sup> dept. placement



3. Department 2 have **A & E** relationship with Department 4 and 7. Department 6 have **O & A** relationship with Department 4 and 7. Department 9 have **U & A** relationship with Department 4 and 7. Thus, the next department to be placed is **Department 2 (with the highest relationship rating with Departments 7 and 4).**

100	450	600	250
200	<b>7</b>	<b>4</b>	500
100	450	600	250

e.g. Directly adjacent to 4 and partially adjacent to 7

Department 2 has A relationship with 4, add 500 to WP

Department 2 has E relationship with 7, add  $0.5 \times 200$  to WP

$$WP = 500 + 100 = 600$$

- Department 2 would be placed at any of the location with highest WP

# Example: subsequent dept.



4) Placing Department 6

250	501	252	1
500	<b>7</b>	<b>4</b>	2
250	501	<b>2</b>	1
	0	0	0

5) Placing Department 5

250	500	250	
600	<b>6</b>	602	1
450	<b>7</b>	<b>4</b>	3
100	203	<b>2</b>	3
	1	2	1

6) Placing Department 9

0	250	500	250
250	<b>6</b>	<b>5</b>	500
500	<b>7</b>	<b>4</b>	200
250	400	<b>2</b>	-100
	-50	-100	-50

7) Placing Department 3

	0	250	500	250
0	0	<b>6</b>	<b>5</b>	501
0	<b>9</b>	<b>7</b>	<b>4</b>	253
0	0	3	<b>2</b>	3
		1	2	1

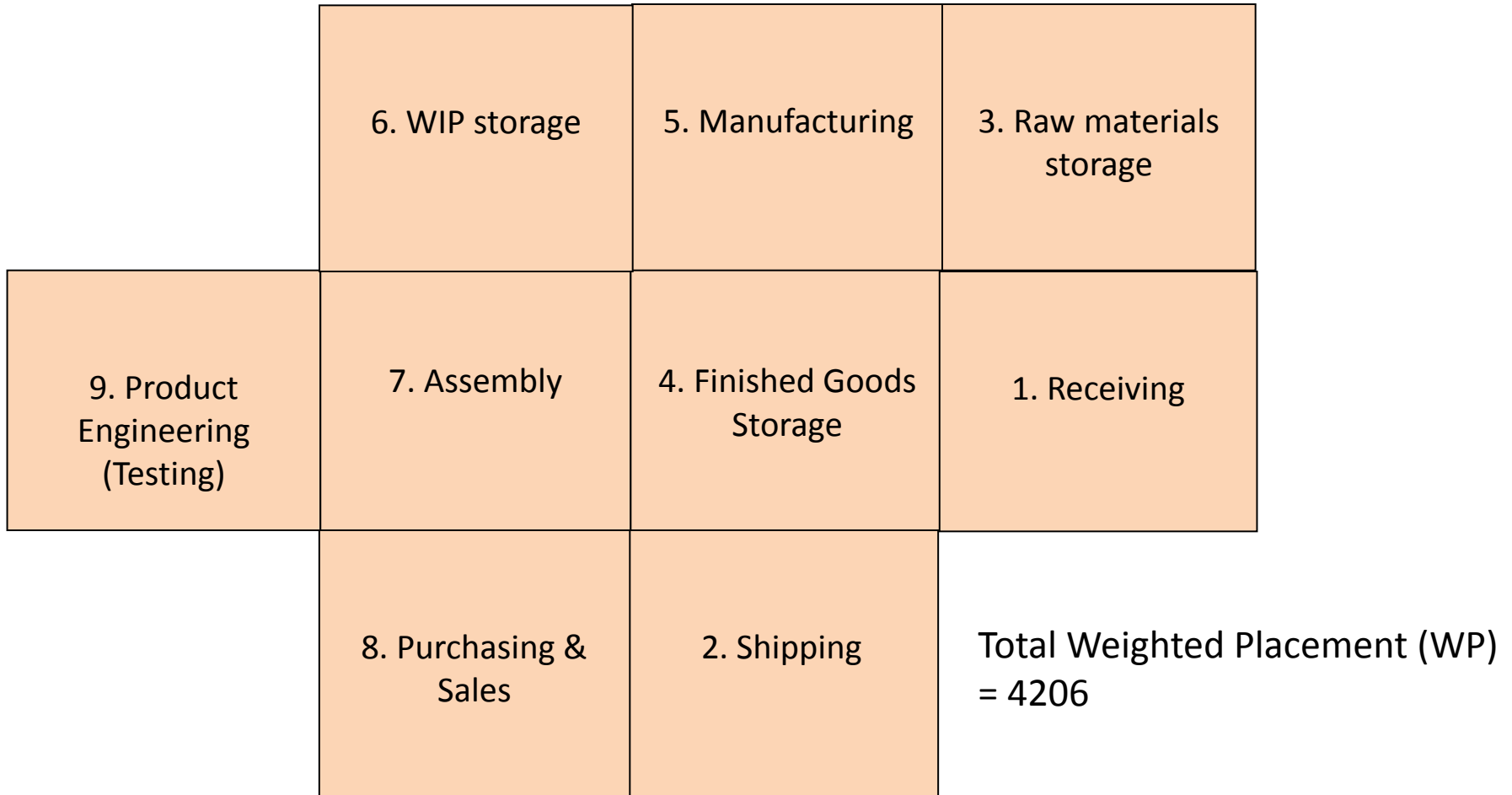
8) Placing Department 1

	1	27	301	525	250
-50	-97	<b>6</b>	<b>5</b>	<b>3</b>	500
-100	<b>9</b>	<b>7</b>	<b>4</b>	627	250
-50	-99	153	<b>2</b>	201	
		100	200	100	

9) Placing Department 8

	1	27	52	27	1
25	77	<b>6</b>	<b>5</b>	<b>3</b>	27
50	<b>9</b>	<b>7</b>	<b>4</b>	<b>1</b>	51
25	75	375	<b>2</b>	350	25
		100	200	100	

# Initial Layout



# Practical Considerations

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- 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)

# Learning Objectives

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- Construct REL chart based on relationships between departments
- Develop initial square block layout by manual CORELAP algorithm

# Preparation for P05

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- Bring along some writing materials for next week's learning.
- There will be MORE drawings involved!!!