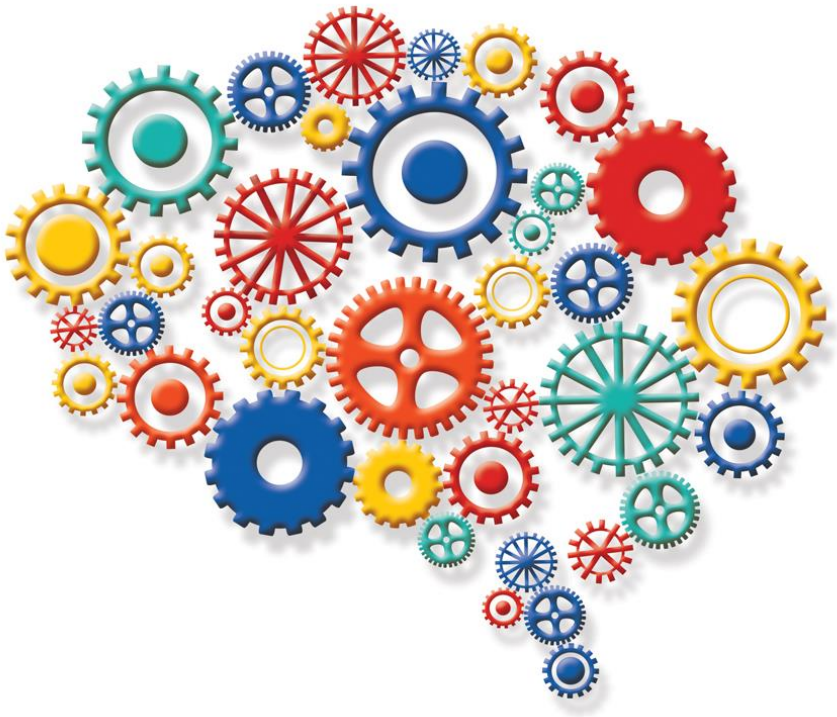
Lecture 4

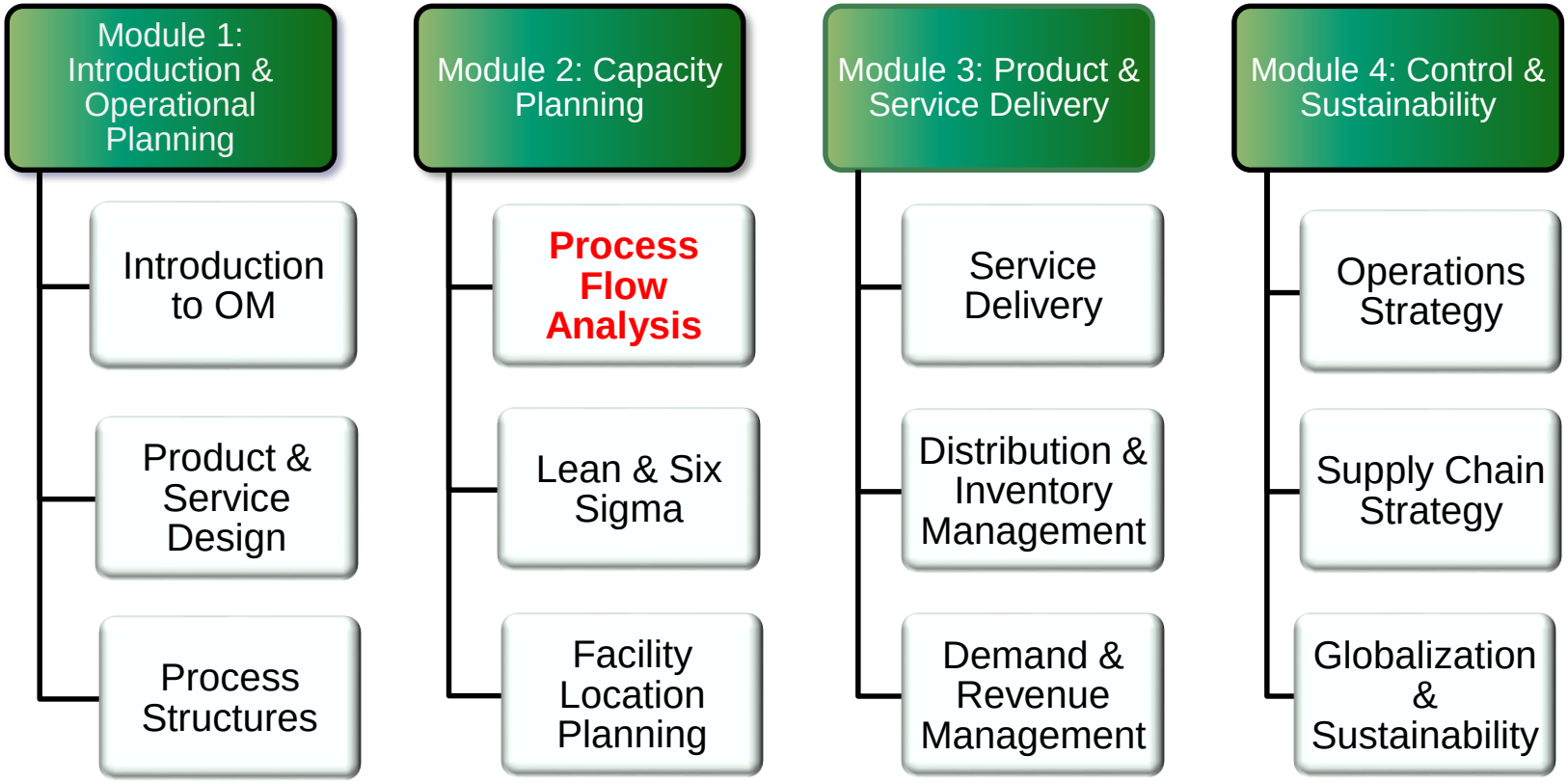


Process Flow Analysis

Learning Objectives

- Describe the critical facility design features.
- Draw a process flow diagram.
- Identify the bottleneck operation in a product layout and rebalance for increased capacity.
- Use operations sequence analysis to minimize flow (flow of people, materials, information)-(travel) distance in a process layout.

Course Structure



Facility Design & Layout

The layout problem involves finding the best arrangement of the physical components of the service system possible within the time, cost and technology constraints of the situation. *(Layout is the arrangement of the service delivery system.)*

Facility Layout & Design (Cont.)

The objectives of designing a good layout are:

1. Minimize movement of people, materials and paperwork to increase efficiency
2. High utilization of space but balanced with possibility for expansion
3. Flexibility for rearrangement, services and growth
4. Satisfactory physical environment for workers

   e.g., good lighting, temperature, noise level, etc.
5. Convenience for customers during the service
6. Attractive appearance of room office arrangements for management and customers

Process Flowchart

A process flowchart is a visual aid used by industrial engineers when analyzing production systems to identify opportunities for ***improvement in process efficiency***.

Process Flow Analysis

I. Diagram a process

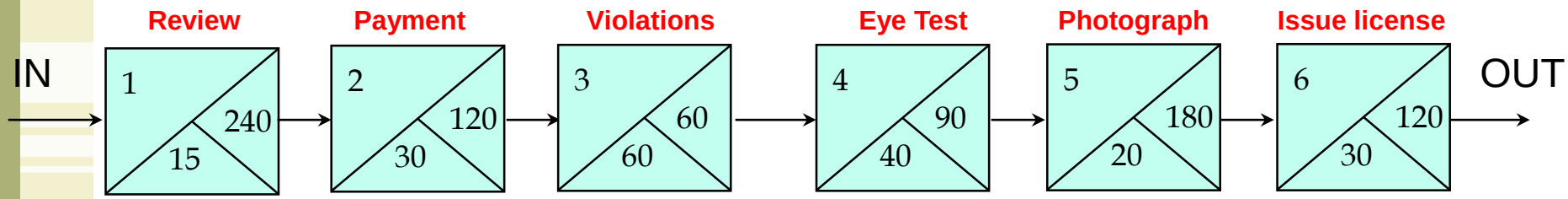
II. Identify bottleneck operation

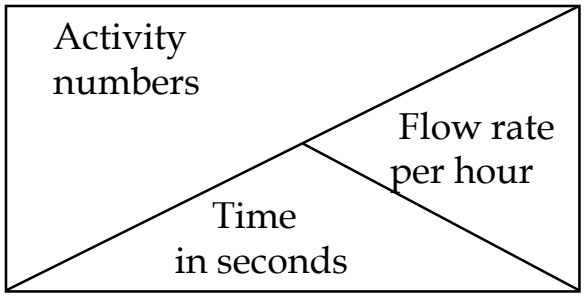
III. Determine system capacity

IV. Make improvements

License Renewal Process – Process Flow Diagram

Automobile Driver's License Office – Scenario #1





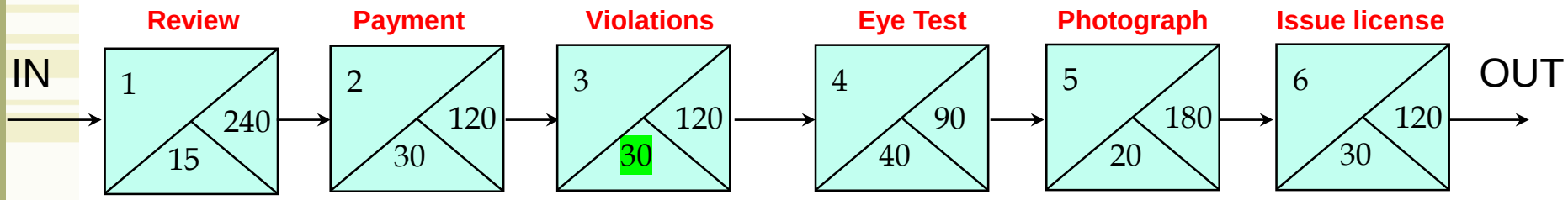
Activity	Description	Cycle Time (Sec.)
1	Review application for correctness	15
2	Process and record payment	30
3	Check for violations and restrictions	60
4	Conduct eye test	40
5	Photograph applicant	20
6	Issue temporary license	30

What is the current flow rate: _____ applicants per hour?

Where is the bottleneck? _____

Automobile Driver's License Office (Scenario #2)

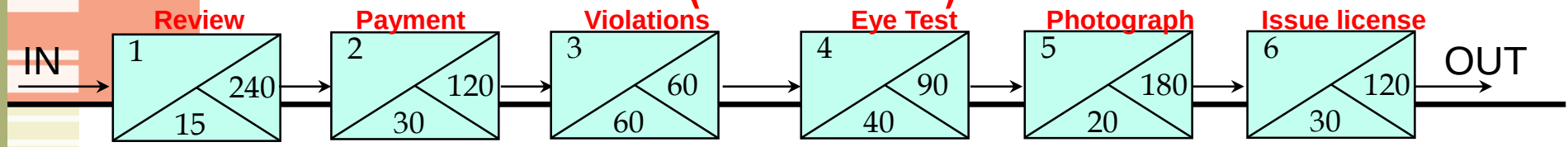
- Assume that "violations checking" can now be done on computer terminal, with that activity now taking 30 seconds instead of 60 seconds.

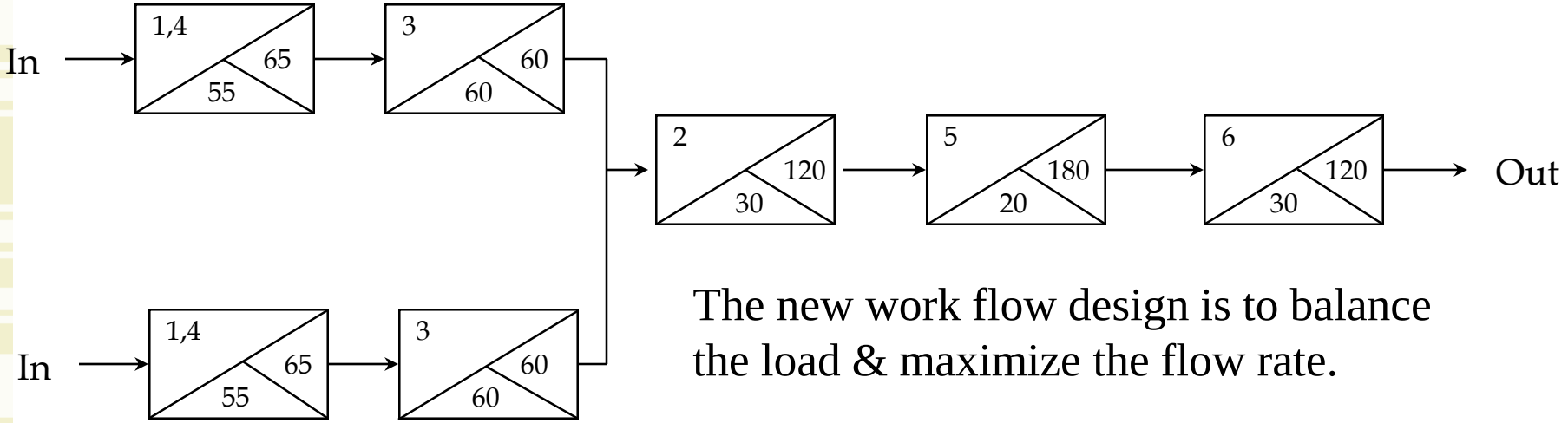


The maximum capacity is now ____ applicants per hour.

The new bottleneck is the process of _____

Automobile Driver's License Office (Scenario #3)





The new work flow design is to balance the load & maximize the flow rate.

- From Scenario #1, by adding one server on activity 3 & combining operations 1 & 4, the system can now achieve a flow rate of _____ applicants per hours.
- Identify the bottleneck(s): _____

How to make process flow improvement?

How to make process flow improvement?

- Identify the bottleneck process
- Division of labor & job rotation
  - Combine the bottleneck process with other process(es);
  - Then reallocate resources for sharing the workload.
- Use of technology
- Introduce self-service

In-class Exercise #1
Process Flow Analysis

Process Flow

- The activities can occur in any order, but the doctor's consultation must be last.
- Three nurses are assigned to perform activities 1,2 and 4; two doctors for activities 3 & 5 (i.e. one head count per activity).

Activity	Average Time, Min.
1. Blood pressure, wt., temp.	6
2. Medical history	20
3. Doctor's checkup	18
4. Lab work	10
5. Doctor's consultation	12

a. What are the bottleneck activity and the maximum number of patients who can be seen per hour?

b. Suggest a reallocation of nursing and/or doctor activities that would result in increased service capacity, and draw a product flow diagram. What is the capacity of your improved system?

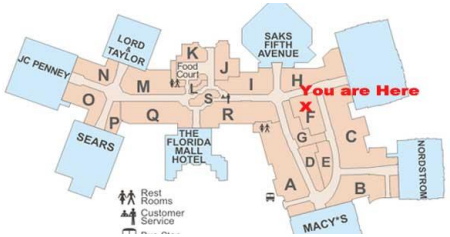
(c) New Scenario:-

- Due to the resource constraints, the physician's office needs to cut one headcount from nurses.
- Suggest a reallocation of activities that would have a service capacity better than the initial process.
- Identify the capacity of your improved system.
- In addition to savings on personnel costs, what other operational benefit can this arrangement achieve?

Process Layout & the Relative Location Problem

Environmental Orientation Considerations

- Need for spatial cues to orient visitors;
- Formula facilities draw on previous experience, removed the anxiety of disorientation so that customers know exactly what to do;
- Entrance atrium allows visitors to gain a quick orientation and observe others for behavioral cues;
- Orientation aids and signs such as “You Are Here” maps, color-coded subway routes help promote smooth flow of traffic.

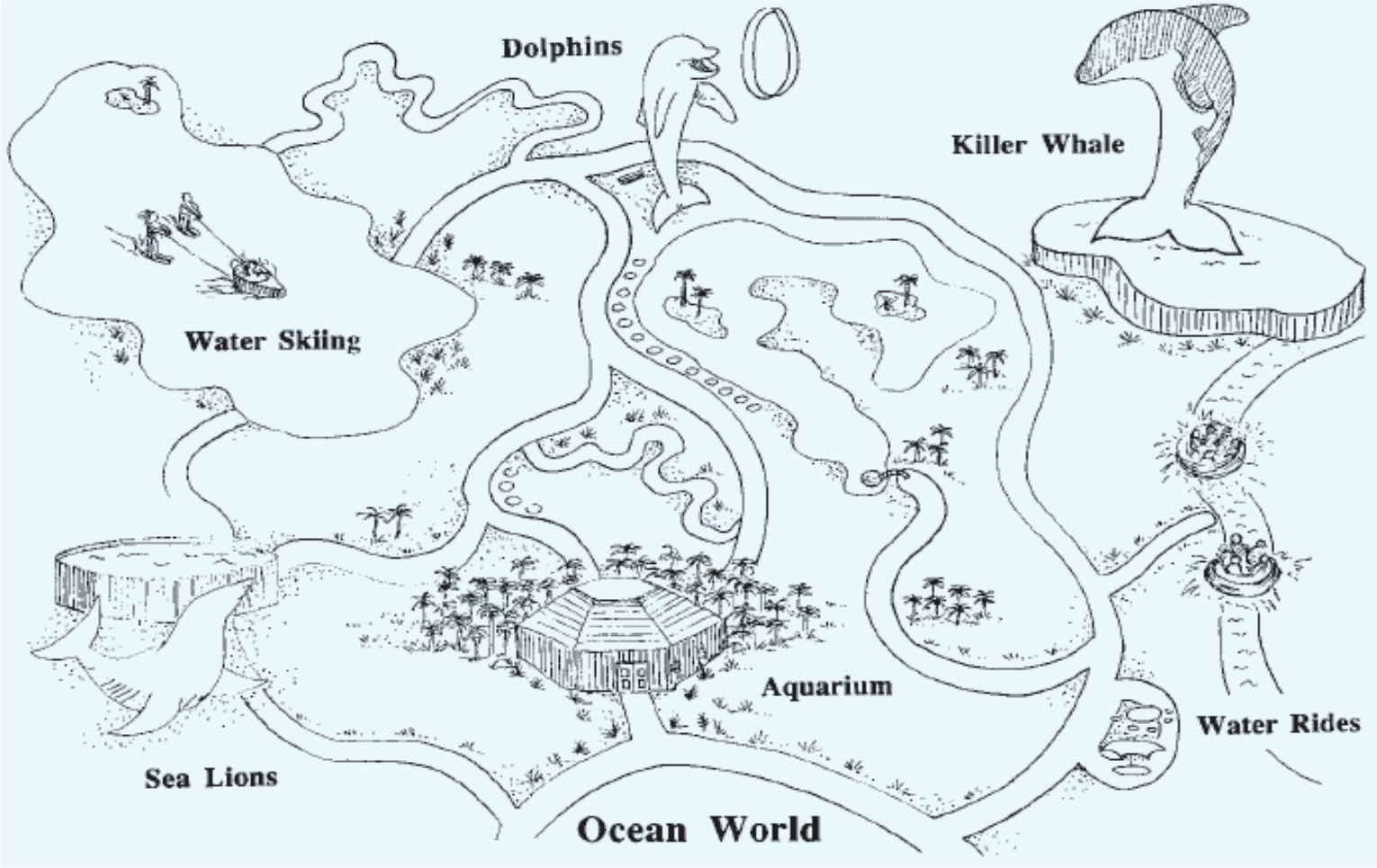


Process Layout & the Relative Location Problem

- Process layout allows the customers to define their own sequence of service activities to meet their needs (some degree of customization)
- Possible number of layouts = n!
- Operations sequence analysis can be used to identify a good layout to ***minimize the total traveling distance and flow amount***
- CRAFT: Computerised Relative Allocation of Facilities Technique

  Example: Ocean World Theme Park case

Process Layout: Ocean World Theme Park



Operations Sequence Analysis

Ocean World Theme Park Daily Flows of Visitors between Attractions (in hundreds)

Flow Matrix (Given)

	A	B	C	D	E	F
A		7	20	0	5	6
B	8		6	10	0	2
C	10	6		15	7	8
D	0	30	5		10	3
E	10	10	1	20		6
F	0	6	0	3	4	

Step 1: Create a triangularized matrix – sum the flows in either direction

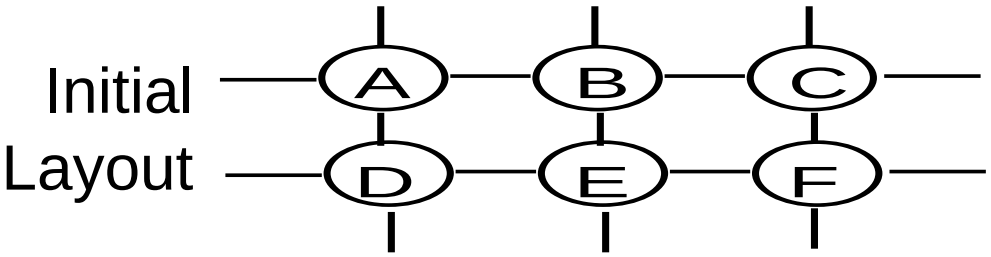
Net flow →

	A	B	C	D	E	F
A		15	30	0	15	6
B			12	40	10	8
C				20	8	8
D					30	6
E						10
F						

Description of Attractions

A=killer whale, B=sea lions, C=dolphins,
D=water skiing, E=aquarium, F=water rides.

Initial Layout

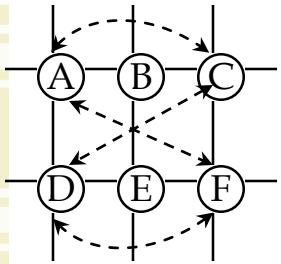


Ocean World Theme Park - Proposed Layout

Step 2: Calculate total flow distance of initial flow (nonadjacent attractions are multiplied by the number of grids that separate the attractions)

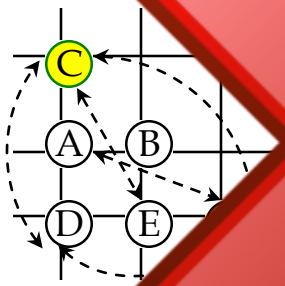
Step 3: Attractions with high daily flow between them should be placed adjacent to each other

(a) Initial layout (Given)



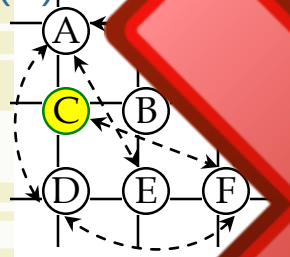
Attraction pairs	Flow distances
AC	30 * 2 = 60
AF	6 * 2 = 12
DC	20 * 2 = 40
DF	6 * 2 = 12
Total	= 124

(b) **e to A**



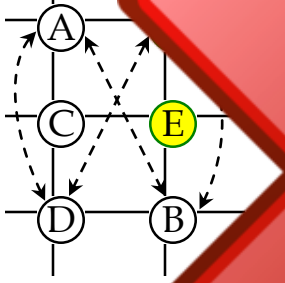
Attraction pairs	Flow distances
	0 * 2 =40
	* 2 =16
DF	= 12
AF	= 12
CE	* 2 = 16
Total	= 96

(c) **Excl A and C**



AE	= 30
	2 = 16
	6 * 2 = 12
	0 * 2 = 0
	* 2 = 12
	= 70

(d) Excha E and m



AB	=30
	2 = 0
	8 * 2 = 16
	* 2 = 12
	= 58

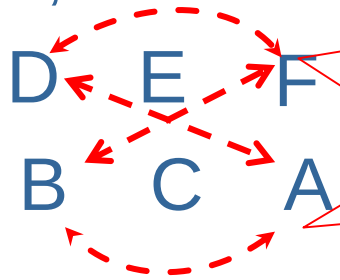
A smarter way:

- Review the triangularized matrix

	A	B	C	D	E	F
A		15	30	0	15	6
B			12	40	10	8
C				20	8	8
D					30	6
E						10
F						

AD = 0x2 = 0
DF = 6x2 = 12
BF = 8x2 = 16
AB = 15x2=30
58

- Select the attraction pairs with least flow distance: AD=0, DF=6, BF=8
- Put them at the corner:



Improvement of flow = 124-58 = 66

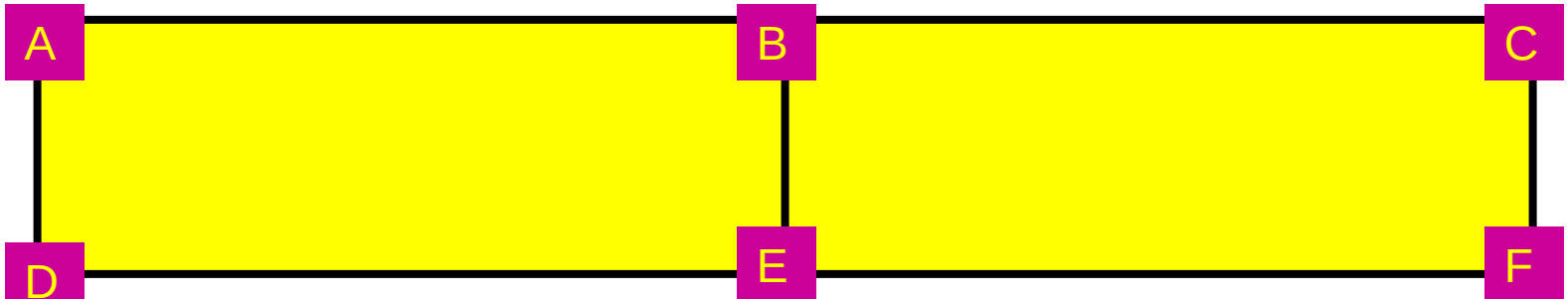
In-class Exercise #2
Operations Sequence Analysis

In-class Exercise #2

- The Second Best Discount Store is considering rearranging its stockroom to improve customer service. Currently, stock pickers are given customer orders to fill from six warehouse areas.
- Movement between these areas is noted in the following flow matrix.

Movements between areas

	A	B	C	D	E	F
A	-	1	4	2	0	3
B	0	-	2	0	2	1
C	2	2	-	4	5	2
D	3	0	2	-	0	2
E	1	4	3	1	-	4
F	4	3	1	2	0	-



Instructions:

1. Create a triangularized flow matrix.
2. Calculate the initial flow amount.
3. Perform an operations sequence analysis to determine a layout that minimizes total flow between non-adjacent departments. ***(Hints: Place the pairs with the least flow into four corners)***
4. Calculate the total improvement of flow.

Key Take Away

Facility Design & Layout

Process Flow Analysis

Operations Sequence Analysis