Layout

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2018-12-18

Agenda

- The need for layout planning.
- Reasons for redesign a layout.
- Types of layouts.
- Types of pocesses.

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What is layout?

What is layout?

Layout is about facilities planning.

What is layout?

Layout is about facilities planning, for example:

- Departments.
- Equipment.
- Movement of materials, through the production system.
- Movement of matrials, through the assembly system.
- Movement of materials, through the logistic system.

The need for layout planning

The need for layout planning

The need for layout planning arises when:

- Designing new facilities.
- Redesigning existing facilities.

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Reasons for redesign a layout

Reasons for redesign a layout

Reasons for redesign a layout arise when:

1. Inefficient operations, for example bottlenecks.
2. Safety problems.
3. Design changes, of products or services.
4. Introduction of new products or services.

Reasons for redesign a layout

Reasons for redesign a layout arise when:

5. Changes in volume.
6. Change in methods or equipment.
7. Change in legal requirements.
8. Morale problem, for example lack of face to face contact.

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Types of layouts

Types of layouts

- Fixed position layout.
- Process oriented layout.
- Product oriented layout.
- Continuous flow layout.
- Hybrid layout.
- Warehouse layout.
- Service layout.

Types of layouts

- **Fixed position layout**
  - Extremely low volumes.
  - One of a kind.
  - For example build a bridge or an airplane.
  - We need this layout when we have a project.

Fixed position layout when we have a **Project.**

Types of layouts

- **Fixed position layout**

Types of layouts

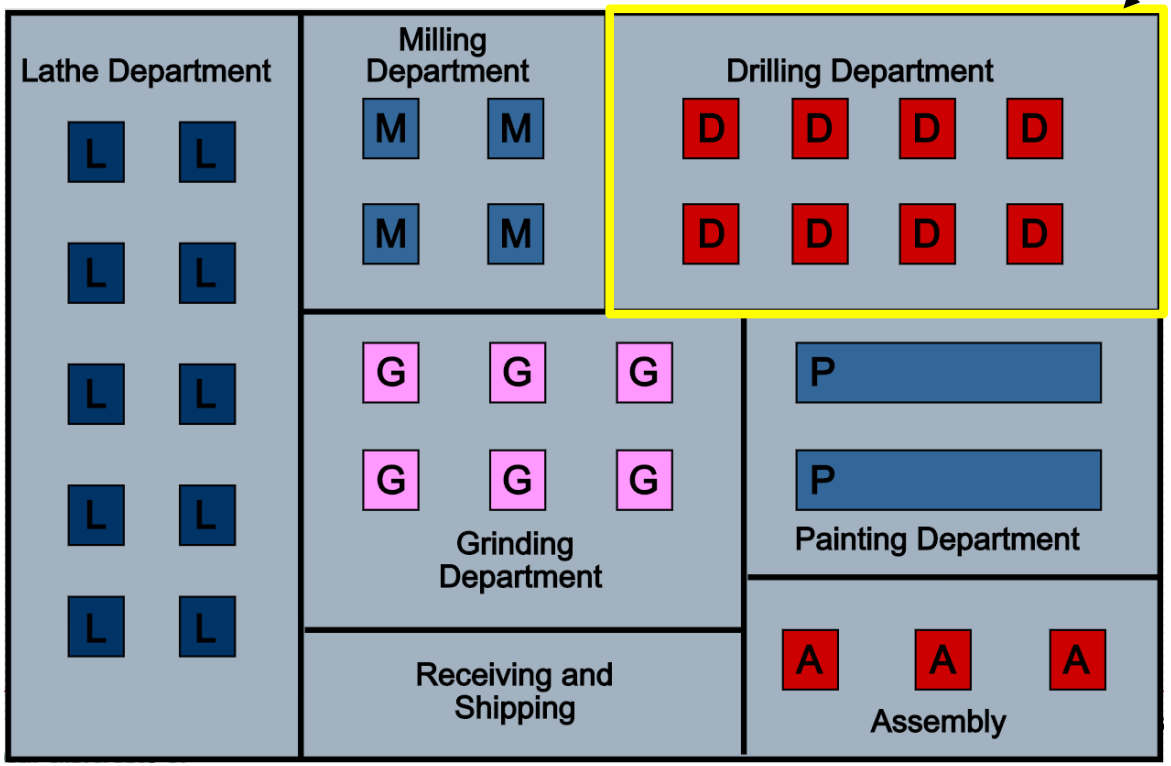
- **Process oriented layout**
  - Low volumes.
  - ”Made to customer” products.
  - We use this layout when we have a job process.
  - Job process is a process with flexibility to produce variety products.

Process oriented layout when we have a **Job process.**

Types of layouts

A plock is a department.

- **Process oriented layout**



It is a plock plan. It is not like a line process, therefore we use this layout to produce variety products. We can start in which department we want, depending on the type of product.

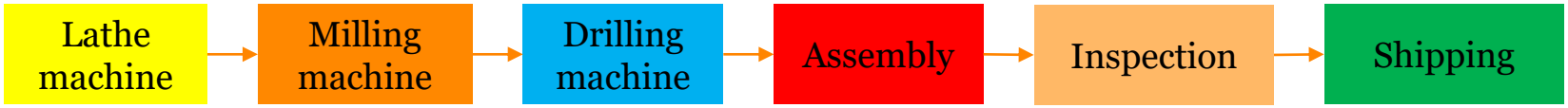
Types of layouts

- **Product oriented layout**
  - Low to higher volumes.
  - For example books.
  - We use this layout when we have a batch process and line process.
  - Line process is a process with connected line with highly repetitive work. Batch process has disconnected line with highly repetitive work.

Product oriented layout when we have a **Batch process** or **Line process**.

Types of layouts

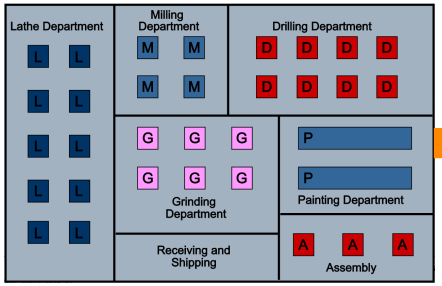
- **Product oriented layout**



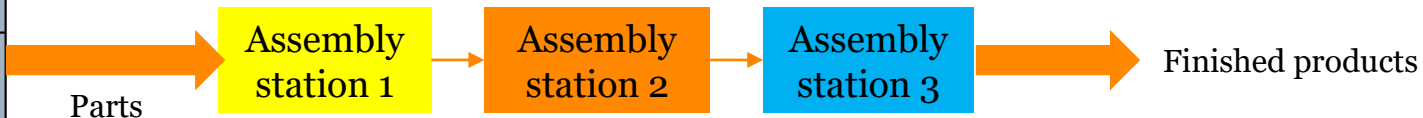
It is a line.

Types of layouts

- **Hybrid layout**
  - Combination of product oriented layout and process oriented layout.
  - **Example:** Manufacturing of a new product
    - We use Process oriented layout for manufacturing of all parts that the product consist of, and we use Product oriented layout for the assembly line.



Process oriented layout for manufacturing of all parts.



Product oriented layout for the assembly line.

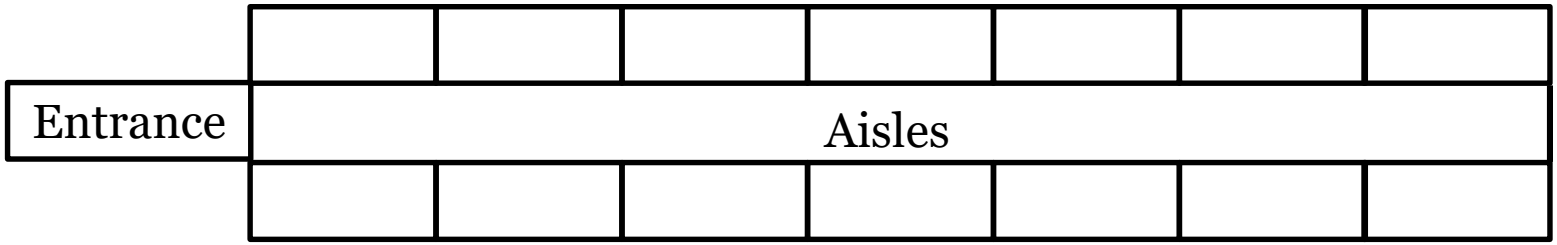
Types of layouts

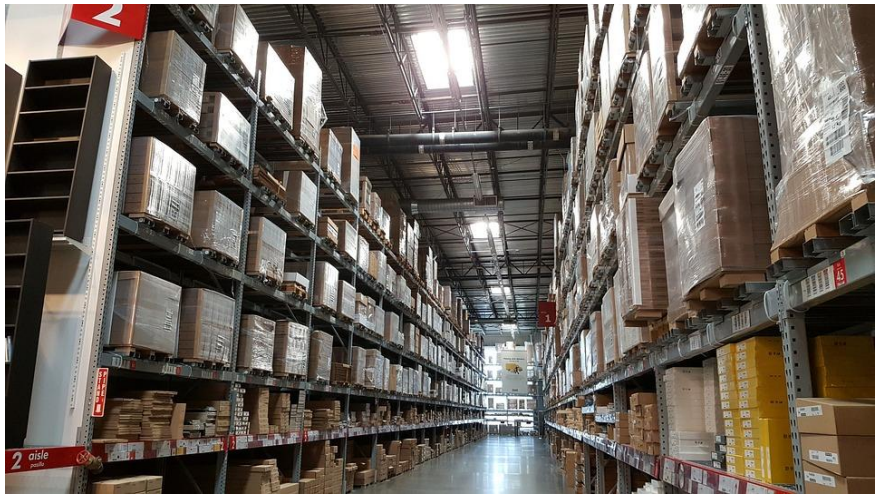
- **Continuous flow layout**
  - High volumes.
  - Standard products.
  - For example paper.
  - We use this layout when we have a continuous process.
  - Continuous process is a process with continuous flow.

Continuous flow layout when we have a **Continuous process**.

Types of layouts

- **Warehouse layout**





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What type of layout shall we use?

What type of layout shall we use?

Layout requirements are depending on the type of process.

What type of layout shall we use?

Types of process:

- Job process.
- Batch process.
- Line process.
- Continuous process.

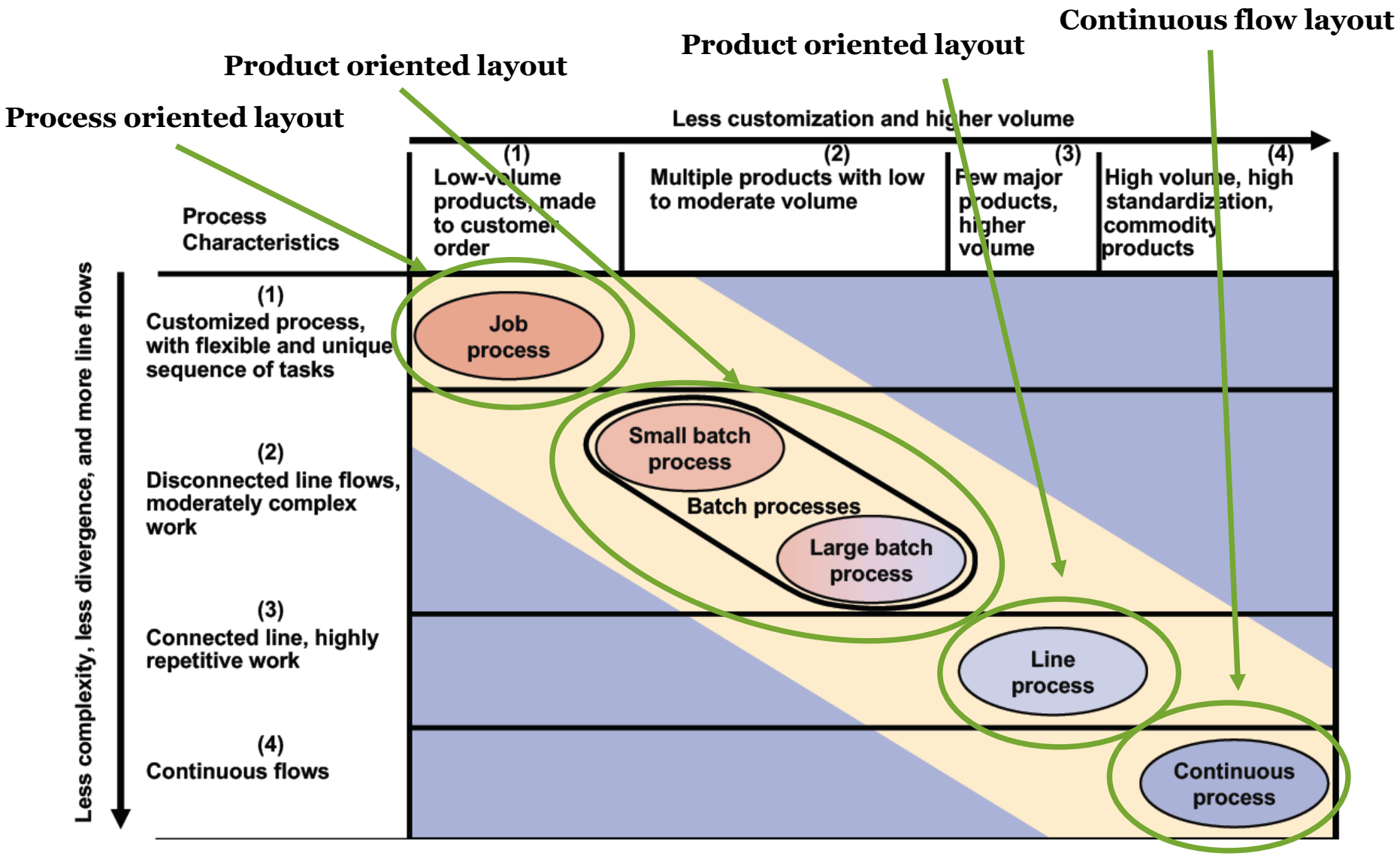
What type of layout shall we use?

What type of process shall we use?

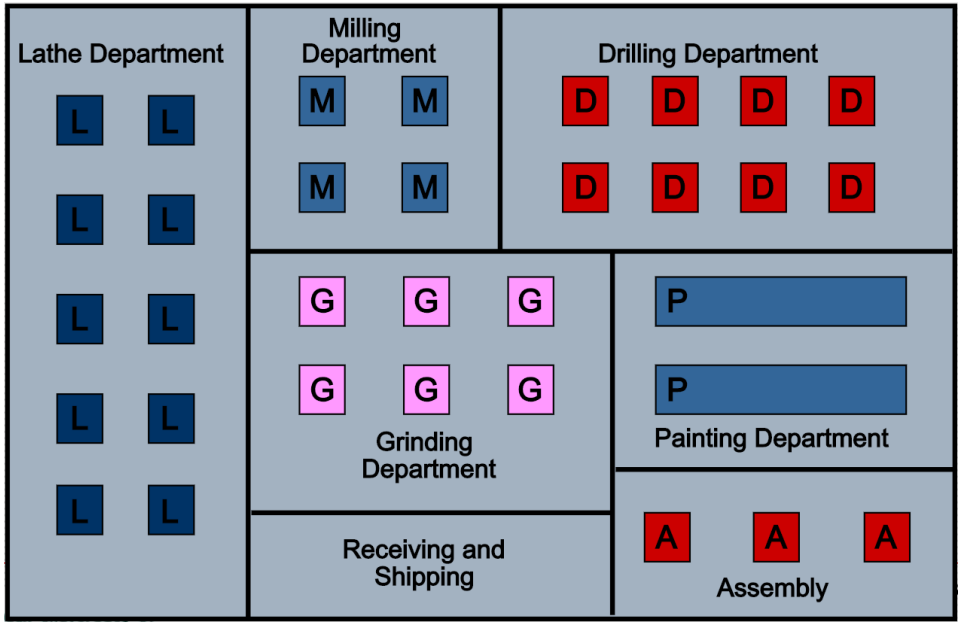
What type of layout shall we use?

We can use a tool called **Product-Process Matrix**, to choose a right process.

What type of layout shall we use?



Designing process oriented layout



Designing process oriented layout

Steps to follow for designing a process oriented layout

1. **Gather information about:**
   a) Space requirements of each derpartment.
   b) Available space in the facility.
   c) Closeness factor (which departments need to be located next to each other).

2. **Develop proposed block plan** (allocate space and indicate placement of each department).

3. **Compare the old plock plan with the proposed block plan using load-distance method and make choice.**

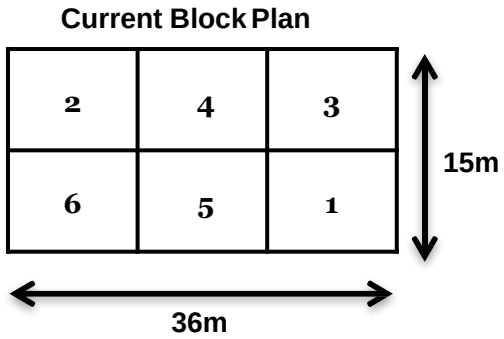
Designing process oriented layout

Example 1: Designing process oriented layout

Designing process oriented layout

Example 1: Designing process oriented layout

San machining is a machine shop that produces a variety of small metal products. Design a block plan for San machining. Current block plan is below, 6 different departments. Departments 3 and 4 can not be moved because of constraints in the building design. The goal is to minimize materials handling cost.



Designing process oriented layout

Example 1: Designing process oriented layout

1. **We start by gathering information about:**

   a) Space requirements of each department.

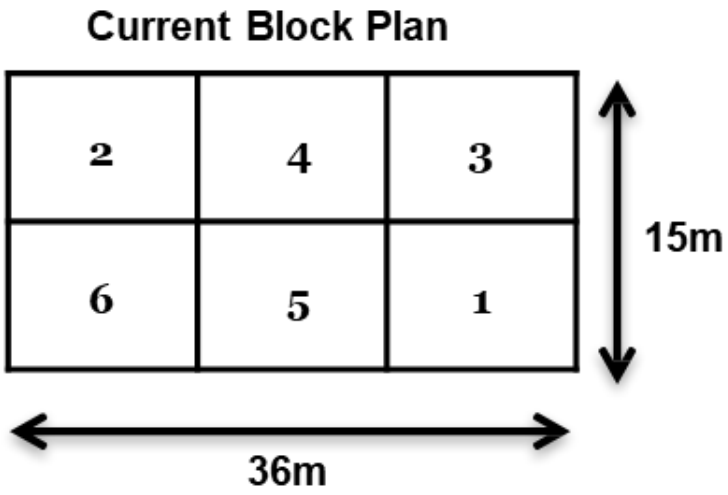
Department	Area needed m²
1. Burr and grind	100
2. NC equipment	95
3. Shipping and receiving	75
4. Lathes and drills	120
5. Tool crib	80
6. Inspection	70
TOTAL:	540

Designing process oriented layout

Example 1: Designing process oriented layout

1. **We start by gathering information about:**

   b) Available space in the facility.



Designing process oriented layout

Example 1: Designing process oriented layout

1. **We start by gathering information about:**

   c) Closeness factor (which departments need to be located next to each other). Below is the trip matrix which gives number of trips between departments.

	Trips between departments					
Department	1	2	3	4	5	6
1. Burr and grind	-	20		20		80
2. NC equipment		-	10		75	
3 Shipping and receiving			-	15		90
4 Lathes and drills				-	70	
5 Tool crib					-	
6 Inspection						-

Designing process oriented layout

Example 1: Designing process oriented layout

2. **Develop proposed block plan** (allocate space and indicate placement of each department).

Use trail and error. A good place to start is with the largest closeness in the trip matrix and working down the list, because the goal is to minimize materials handling cost. We start with 3 and 6.

- Departments 3 and 6 close together
- Departments 1 and 6 close together
- Departments 2 and 5 close together
- Departments 4 and 5 close together

	Trips between departments					
Department	1	2	3	4	5	6
1. Burr and grind	-	20		20		80
2. NC equipment		-	10		75	
3 Shipping and receiving			-	15		90
4 Lathes and drills				-	70	
5 Tool crib					-	
6 Inspection						-

Departments 3 and 4 can not be moved because of constraints in the building design.

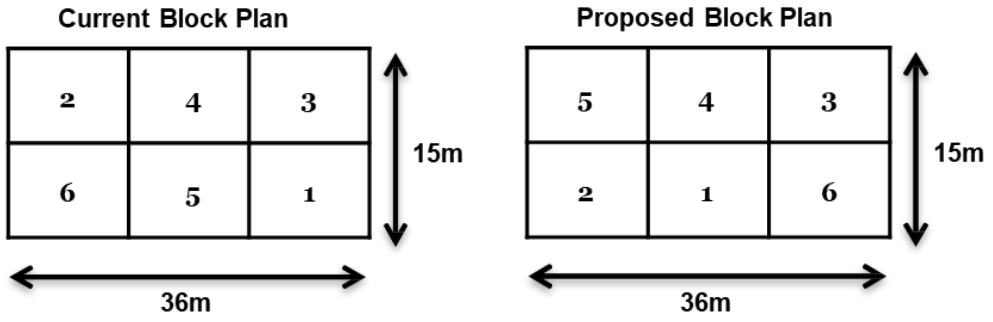
Designing process oriented layout

Example 1: Designing process oriented layout

2. **Develop proposed block plan** (allocate space and indicate placement of each department).

- Departments 3 and 6 close together.
- Departments 1 and 6 close together.
- Departments 2 and 5 close together.
- Departments 4 and 5 close together.

Departments 3 and 4 can not be moved because of constraints in the building design.



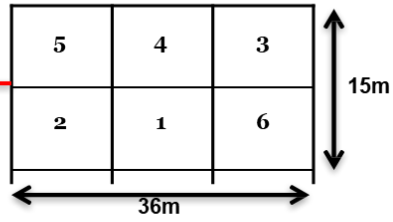
Designing process oriented layout

Example 1: Designing process oriented layout

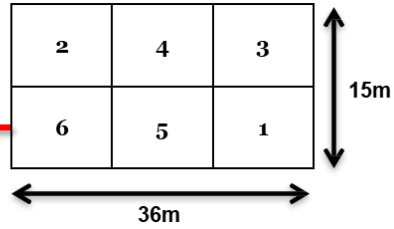
3. **Compare the old plock plan with the proposed block plan using load-distance method and make choice.**

Department pair	Load	Current plan: Distance	Current plan: Load-Distance	Proposed plan: Distance	Proposed plan: Load-Distance
1-2	20	3	60	1	20
1-4	20	2	40	1	20
1-6	80	2	160	1	80
2-3	10	2	20	3	30
2-5	75	2	150	1	75
3-4	15	1	15	1	15
3-6	90	3	270	1	90
4-5	70	1	70	1	70
		Tot:	785		400

Proposed Block Plan



Current Block Plan



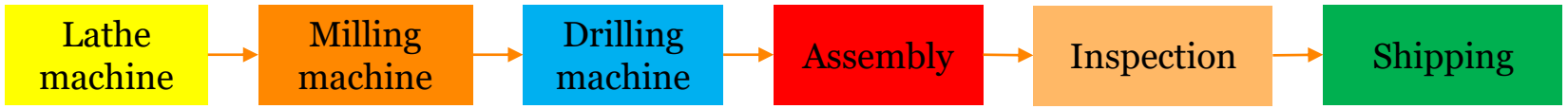
Trips between departments

Department	1	2	3	4	5	6
1. Burr and grind	-	20		20		80
2. NC equipment		-	10		75	
3 Shipping and receiving			-	15		90
4 Lathes and drills				-	70	
5 Tool crib					-	
6 Inspection						-

Distance is based on the number of boxes, from the block plan.

20 x 3 = 60
Load x distance

Designing product oriented layout



Designing product oriented layout

- **Steps to follow for designen product oriented layout**

1. Construct a precedence diagram (A precedence diagram shows which work elements we need to perform first, before we can start with the next work element).
2. Calculate the cycle time for the line.
3. Calculate the theoretical minimum number of workstations that the line consist of.
4. Calculate the efficiency of the line.

Designing process oriented layout

Example 2: Designing product oriented layout

Designing product oriented layout

Example 2: Designing product oriented layout

Green Grass is a manufacturer of lawn and garden equipment. The company is designing an assembly line to produce a new fertilizer spreader, the Big Broadcaster.

a) **Using the following information and construct a precedence diagram for the Big Broadcaster.**

Work Element	Description	Time (sec)	Immediate Predecessor(s)
A	Bolt leg frame to hopper	40	None
B	Insert impeller shaft	30	A
C	Attach axle	50	A
D	Attach agitator	40	B
E	Attach drive wheel	6	B
F	Attach free wheel	25	C
G	Mount lower post	15	C
H	Attach controls	20	D, E
I	Mount nameplate	18	F, G
		Total 244	

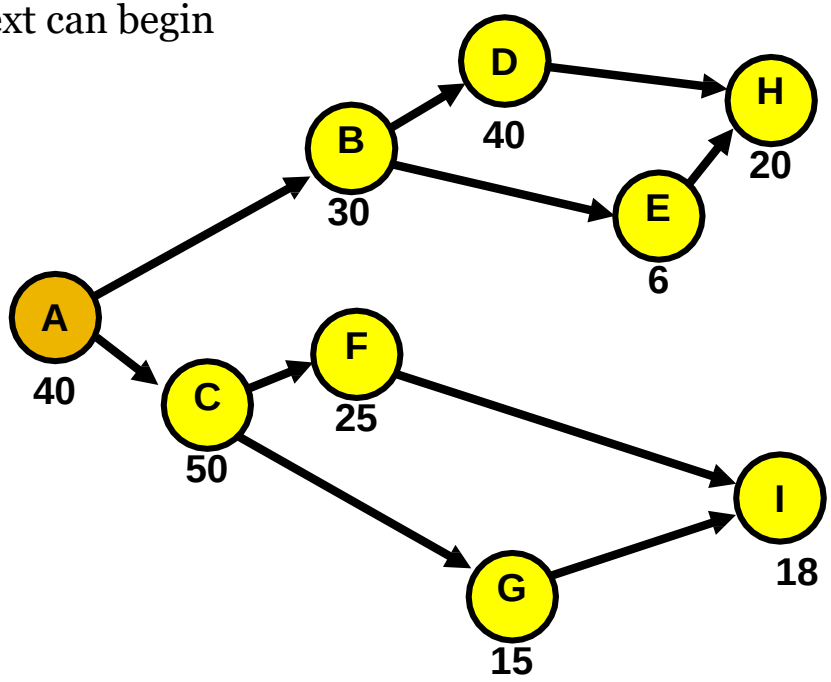
Designing product oriented layout

Example 2: Designing product oriented layout

a) Using the following information on the production process, construct a precedence diagram for the Big Broadcaster.

A precedence diagram shows which work elements that must be performed before the next can begin

Work Element	Description	Time (sec)	Immediate Predecessor(s)
A	Bolt leg frame to hopper	40	None
B	Insert impeller shaft	30	A
C	Attach axle	50	A
D	Attach agitator	40	B
E	Attach drive wheel	6	B
F	Attach free wheel	25	C
G	Mount lower post	15	C
H	Attach controls	20	D, E
I	Mount nameplate	18	F, G
		Total 244	



Designing product oriented layout

Example 2: Designing product oriented layout

The plant manager just received the marketing's latest forecasts of Big Broadcaster sales for the next year. She wants its production line to be designed to make 2,400 spreaders per week for at least the next 3 months. The plant will operate 40 hours per week.

b) **What should be the line's cycle time?**

c) **Calculate the theoretical minimum number of stations that the line consist of.**

d) **What would be the line's efficiency?**

Designing product oriented layout

Example 2: Designing product oriented layout

b) Calculate the cycle time for the line.

$$c = \frac{1}{r}$$

r = desired output rate in units per hour
c = cycle time in hour per unit

Convert the output 2,400 units per week to output per hour, by dividing the weekly output by 40 hours.

$$r = \frac{2400}{40} = 60 \text{ unit per hour}$$

$$c = \frac{1}{r} = \frac{1}{60} \text{ hour per unit} = 1 \text{ minute/unit} = 60 \text{ seconds/unit}$$

Designing product oriented layout

Example 2: Designing product oriented layout

c) Calculate the theoretical minimum number of workstations that the line consist of.

Work Element	Description	Time (sec)	Immediate Predecessor(s)
A	Bolt leg frame to hopper	40	None
B	Insert impeller shaft	30	A
C	Attach axle	50	A
D	Attach agitator	40	B
E	Attach drive wheel	6	B
F	Attach free wheel	25	C
G	Mount lower post	15	C
H	Attach controls	20	D, E
I	Mount nameplate	18	F, G
		Total 244	

$$TM = \frac{\Sigma t}{c}$$

Σt = the sum of the time for all work elements.

c = cycle time

TM = Theoretical minimum number of workstations

$$TM = \frac{\Sigma t}{c} = \frac{244 \text{ seconds}}{60 \text{ seconds}}$$

= 4.067 or 5 stations

Designing product oriented layout

Example 2: Designing product oriented layout

d) What would be the line's efficiency?

$$\text{Efficiency} = \frac{\Sigma t}{nc}(100)$$

n = number of stations
c = cycle time
Σ*t* = the sum of the time for all work elements

$$\text{Efficiency} = \frac{\Sigma t}{nc}(100) = \frac{244}{5(60)} = 81.3\%$$

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Designing warehouse layout

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Example 3: Designing warehouse layout

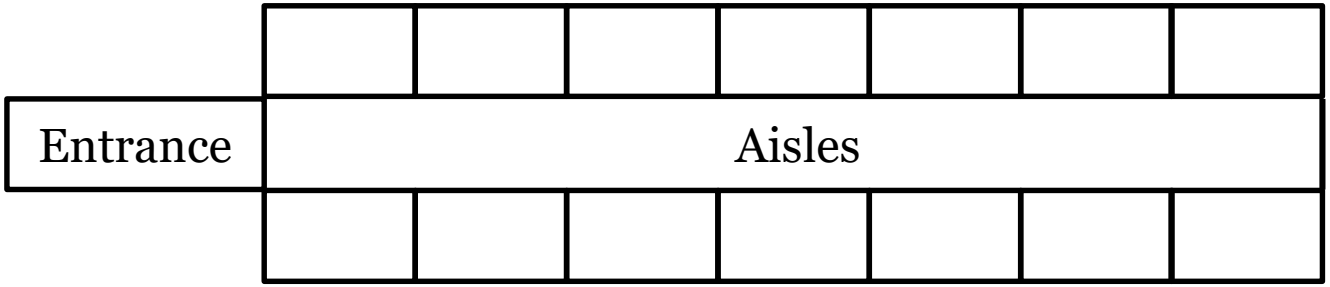
Designing warehouse layout

- **Example 3:** Designing warehouse layout

Design a new layout for the following company. All information needed is below.

Department	Trips to and from entrance	Blocks needed for each department
1. Toasters	280	1
2. Air conditioners	160	2
3. Microwaves	360	1
4. Stereos	375	3
5. TVs	800	4
6. Radios	150	1
7. Computers	100	2

Information about all departments



Building design

Designing warehouse layout

- **Example 3:** Designing warehouse layout

We start by calculating ratio for each department.

Department	Trips to and from entrance	Blocks needed for each department	Ratio = trips to and from entrance/blocks needed for each department
1. Toasters	280	1	280
2. Air conditioners	160	2	80
3. Microwaves	360	1	360
4. Stereos	375	3	125
5. TVs	800	4	200
6. Radios	150	1	150
7. Computers	100	2	50

Designing warehouse layout

- **Example 3:** Designing warehouse layout

The next step is to rank all department, from the highest ratio and down.

Department	Trips to and from entrance	Blocks needed for each department	Ratio = trips to and from entrance/blocks needed for each department	Rank
1. Toasters	280	1	280	2
2. Air conditioners	160	2	80	6
3. Microwaves	360	1	360	1
4. Stereos	375	3	125	5
5. TVs	800	4	200	3
6. Radios	150	1	150	4
7. Computers	100	2	50	7

The microwaves has the highest ratio and therefore ranks first.

Designing warehouse layout

- **Example 3:** Designing warehouse layout

The next step is to place departments into building, based on the ratio. Highest ratio will be close to the entrance.

Department	Trips to and from entrance	Blocks needed for each department	Ratio = trips to and from entrance/blocks needed for each department	Rank
1. Toasters	280	1	280	2
2. Air conditioners	160	2	80	6
3. Microwaves	360	1	360	1
4. Stereos	375	3	125	5
5. TVs	800	4	200	3
6. Radios	150	1	150	4
7. Computers	100	2	50	7

	3	5	5	6	4	2	7
Entrance	Aisles						
	1	5	5	4	4	2	7

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Layout constraints

Layout constraints

Even if we have a perfect layout, there are some constraints to have in mind.

Layout constraints

- Human factors.
- Equipment limitations.
- Space limitations.

Chapters in coursebook

- **CHAPTER 2:** PROCESS STRATEGY AND ANALYSIS