Facility Layout and Line Balancing

IPE 4111

Presented By-
Mahjabin Moon
Lecturer
Department of Mechanical and Production Engineering
Ahsanullah University of Science and Technology

Facility Layout

- Facility layout is an arrangement of different aspects of manufacturing in an appropriate manner as to achieve desired production results. Facility layout considers available space, final product, safety of users & facility and convenience of operations.
- Layout refers to the specific configuration of physical facilities in an organization.
- Objective of layout strategy is to develop an effective and efficient layout that will meet the firm’s competitive requirements.

Objective of Layout Design

1. Use workers and space efficiently
2. Facilitate attainment of product or service quality
3. Avoid bottlenecks
4. Minimize unnecessary material handling costs
5. Eliminate unnecessary movement of workers or materials
6. Minimize production time or customer service time
7. Design for safety

Factors affecting Facility Layout

Facility layout designing and implementation is influenced by various factors. These factors are as follows:

- The design of the facility layout should consider overall objectives set by the organization.
- Optimum space needs to be allocated for process and technology.
- A proper safety measure as to avoid mishaps.
- Overall management policies and future direction of the organization

Basic Layout Types

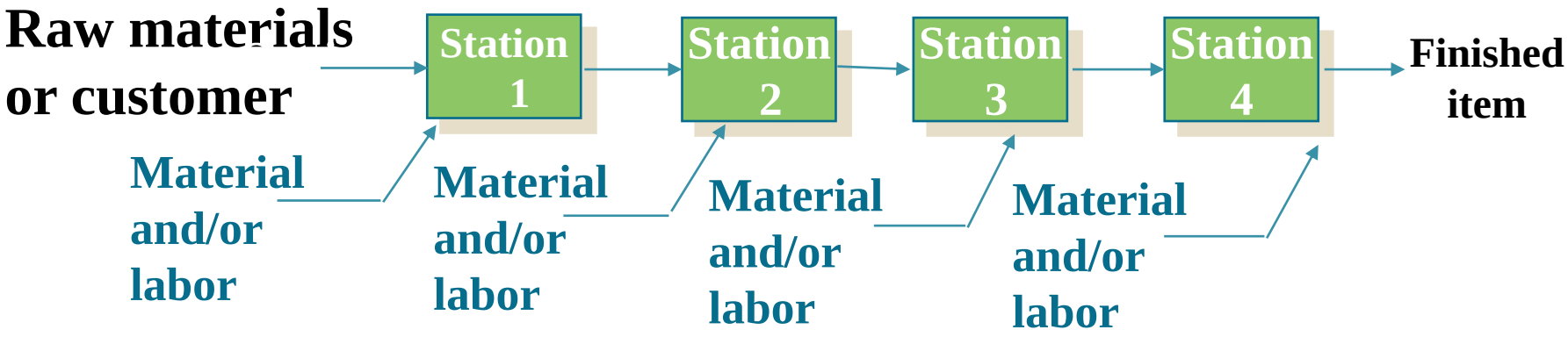
- Product layouts
- Process layouts
- Cellular layouts
- Fixed-Position layout

Product Layout

- A product layout is where the equipment, tools, and machines are located according to how a product is made.
- The work is divided into a series of standardized tasks, permitting specialization of both labour and equipment.
- Layout that uses standardized processing operations to achieve smooth, rapid, high volume flow.

Product Layout

- Products are passed down the line from station to station as they are being made.
- Used for Repetitive or Continuous Processing



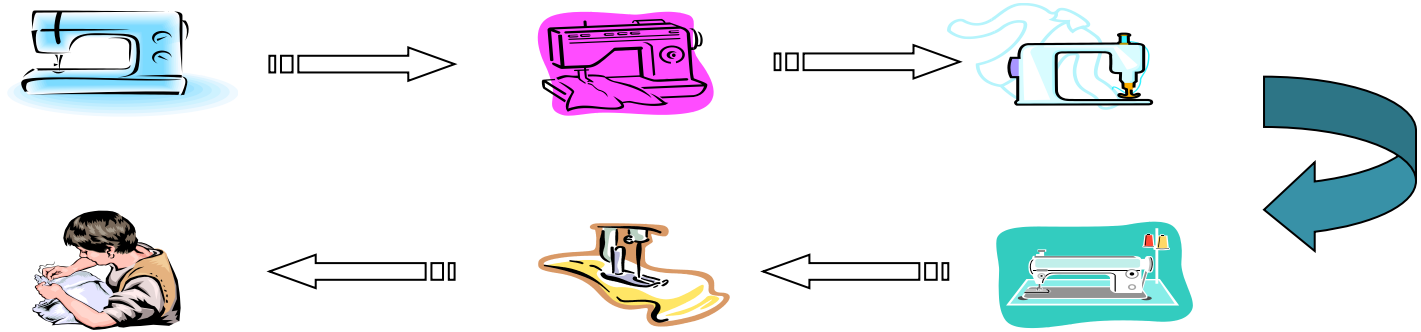
Advantages of Product Layout

- High rate of output
- Low unit cost
- Labor specialization
- Low material handling cost
- High utilization of labor and equipment
- Established routing and scheduling

Disadvantages of Product Layout

- Creates dull, repetitive jobs
- Poorly skilled workers may not maintain equipment or quality of output
- Fairly inflexible
- Highly susceptible to shutdowns
- Needs preventive maintenance
- Individual incentive plans are impractical

U-shaped Layout



Features:

- Compact
- Increased communication
- Flexibility in work

[Advantages and Disadvantages are similar to those of Product Layout]

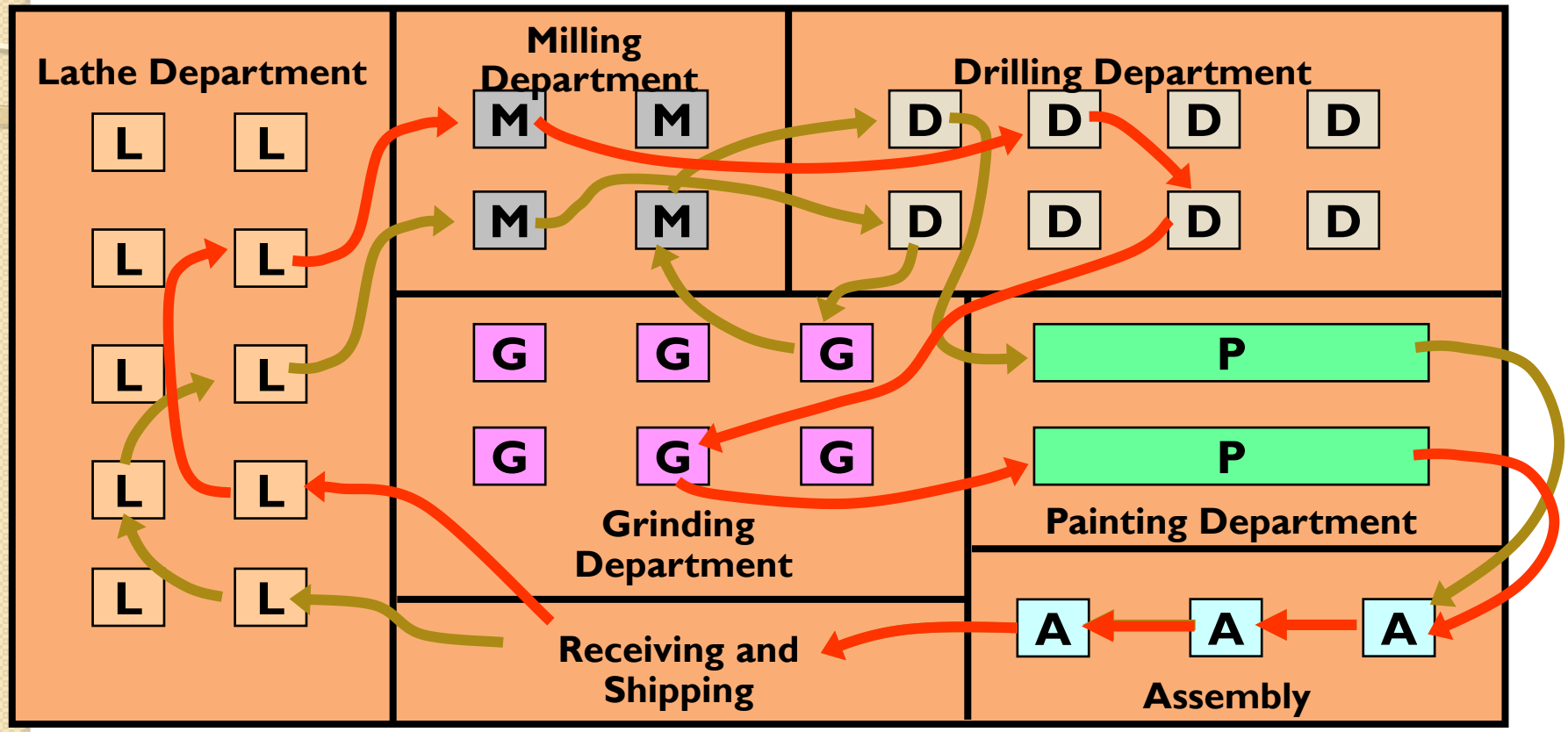
Additional Disadvantages:

- Possibility of gossiping among workers
- Risk of mixing inputs and outputs

Process Layout

- Process layouts are facility configurations in which operations of a similar nature or function are grouped together.
- Similar machines and equipment are grouped together
- Used to deal with low-volume, high-variety production
- Each product / service undergoes a different sequence of operations

Process Layout



Advantages of Process Layouts

- Can handle a variety of processing requirements
- Not particularly vulnerable to equipment failures
- Flexibility is high
- Workers become multiskilled
- Monotony does not arise for workers
- Possible to use individual incentive plans

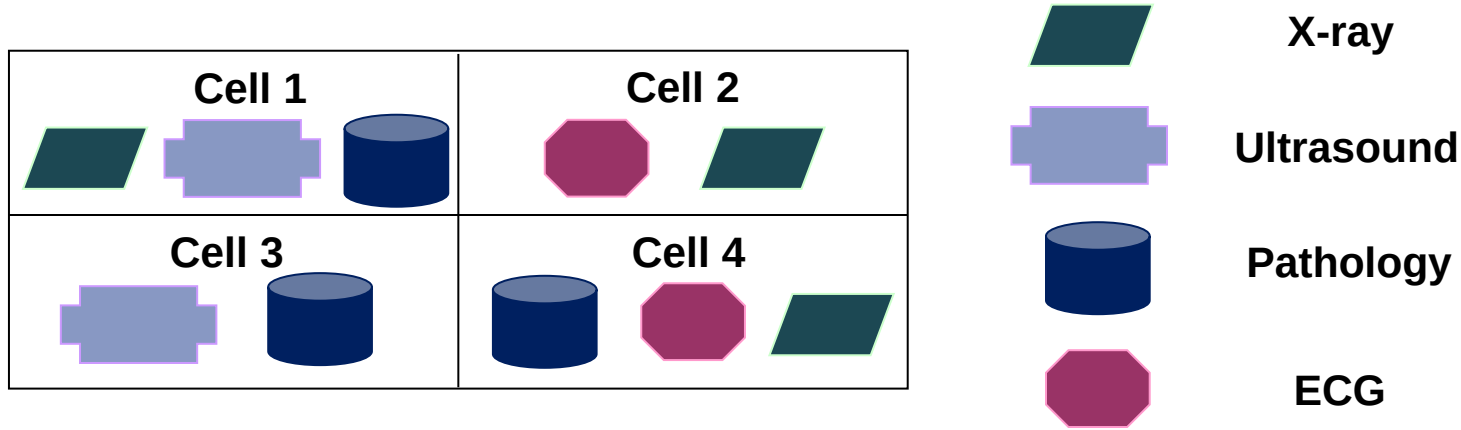
Disadvantages of Process Layouts

- In-process inventory costs can be high
- Challenging routing and scheduling
- Equipment utilization rates are low
- Material handling slow and inefficient
- Complexities often reduce span of supervision
- Special attention for each product or customer

Cellular Layout

Machines are grouped into cells

Groupings are determined by operations needed to perform work for a set of similar items



Cells are miniature versions of Product/Process layout

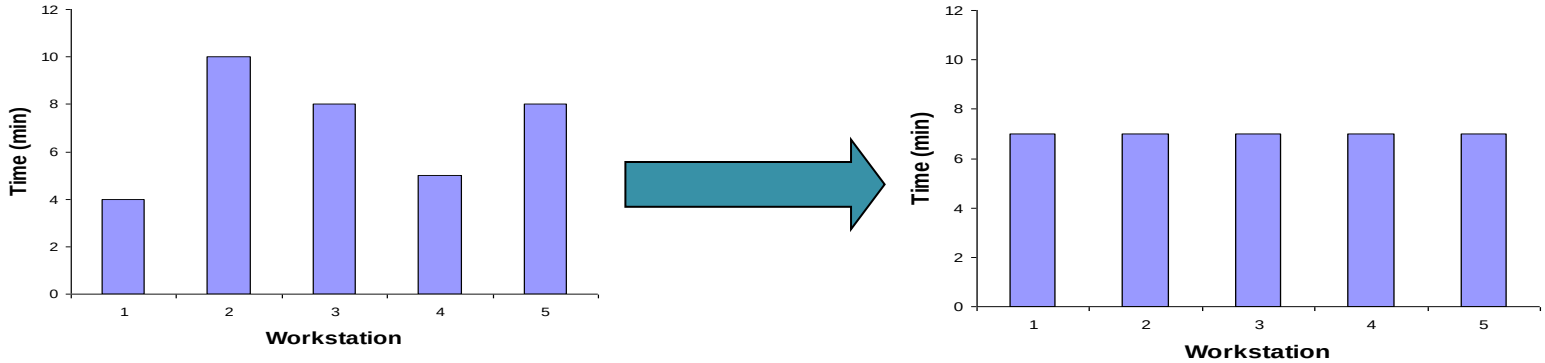
Fixed Position Layout

Weight, size, bulk or some other factor makes it undesirable or extremely difficult to move the product

The items being worked on remains stationary, and workers, material and equipment are moved about

Line Balancing

- Line Balancing is the assignment of work to stations in a line to achieve the desired output rate with the smallest no. of workstations so that unassigned time (idle time) across the stations is minimized.
- The goal is to obtain workstations with well balanced workload.
- Need to match the output rate with desired plan.



General Procedure for Line Balancing

1. Determine precedence relationships – the order in which tasks must be performed in the assembly
2. Calculate Cycle time* , $C = \dfrac{\text{Total work time available}}{\text{Units required}}$
3. Determine minimum number of work stations, $N = \dfrac{\text{Total of all task time}}{\text{cycle time}}$
4. Determine the candidate list which includes the following tasks
   a) The task whose immediate predecessors have been assigned to a workstation
   b) The task for which adequate time is available at the work station
5. Decision rule: Primary rule: Assign task with the longest processing time

   Secondary rule: Assign task with greatest no of followers

   For tie, choose arbitrarily.
6. After task assignment, determine Idle time = Cycle time-sum of time already assigned tasks
7. Continue until all tasks have been assigned to workstations.
8. Determine efficiency = $\dfrac{\text{Sum of all task time}}{\text{No of Actual Work stations} \times \text{Cycle time}} \times 100\%$

***Cycle time* is the maximum time allowed at each workstation to complete its set of tasks on a unit**

Line Balancing (Example 1)

There are 240 productive minutes available per day. The production schedule requires to complete 600 units each day. The tasks and the order in which they must be performed according to their assembly requirements are given below:

Task	Immediate Predecessor	Time (Min)
A	—	0.1
B	A	0.2
C	A	0.4
D	B, C	0.3

Line Balancing (Example 1)

i. Draw the precedence diagram.

ii. Find Cycle time.

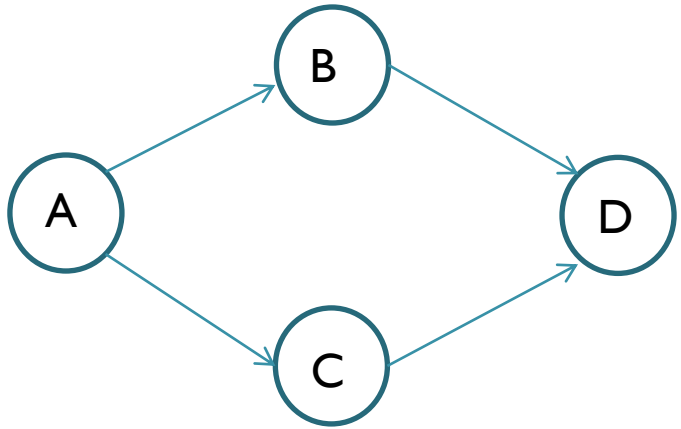
iii. Calculate theoretical number of workstations.

iv. Balance the line stating which tasks would be done in each workstation.

v. Determine total idle time and efficiency of the balanced line.

Line Balancing (Example 1)

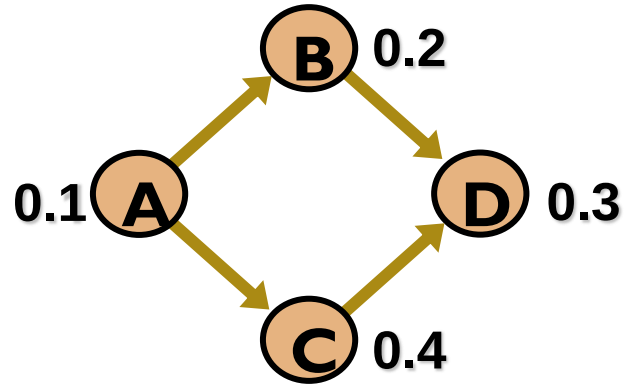
Task	Immediate Predecessor	Time (Min)
A	—	0.1
B	A	0.2
C	A	0.4
D	B, C	0.3



Line Balancing (Example 1)

There are 240 productive minutes available per day. The production schedule requires to complete 600 units each day.

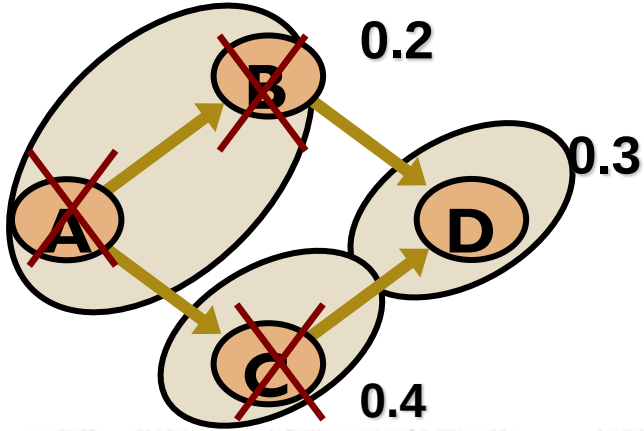
Task	Immediate Predecessor	Time (Min)
A	—	0.1
B	A	0.2
C	A	0.4
D	B, C	0.3



$$\textit{Cycle time} = \frac{\text{Production time available per day}}{\text{Output needed per day}} =$$

$$N_{min} = \frac{\text{Total task time}}{\text{Cycle time}} =$$

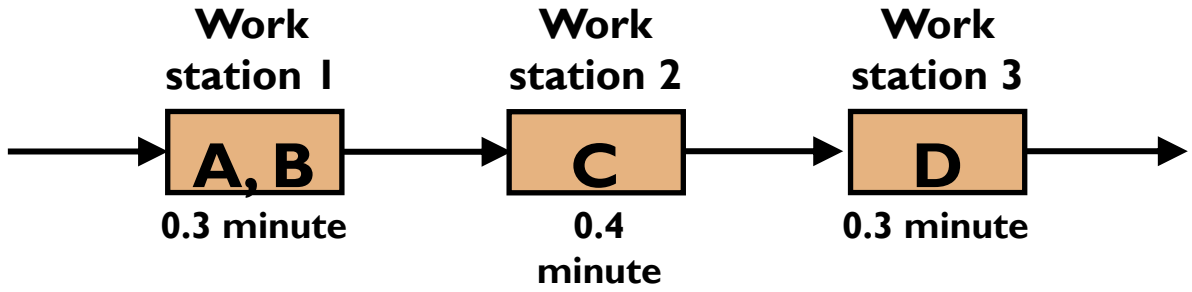
Line Balancing (Example 1)



Cycle time = 0.4 min/unit

Station Number	Candidate list	Task assigned	Task time	Total time	Idle time
1	A	A	0.1	0.1	0.3
	B	B	0.2	0.3	0.1
2	C	C	0.4	0.4	0
3	D	D	0.3	0.3	0.1

Line Balancing (Example 1)



$$\textit{Efficiency} = \frac{\text{Total task times}}{\text{(no of actual workstations) x Cycle time}}$$

=

=

Total Idle Time = (no of actual workstations x Cycle time) — Total task times

=

=

Line Balancing (Example 2)

(1) Draw a precedence diagram for the assembly line

Task	*Performance Time (minutes)*	*Immediate predecessor*
A	5	—
B	3	*A*
C	4	*B*
D	3	*B*
E	4	*C*
F	1	*C*
G	4	*D, E, F*
H	7	*G*

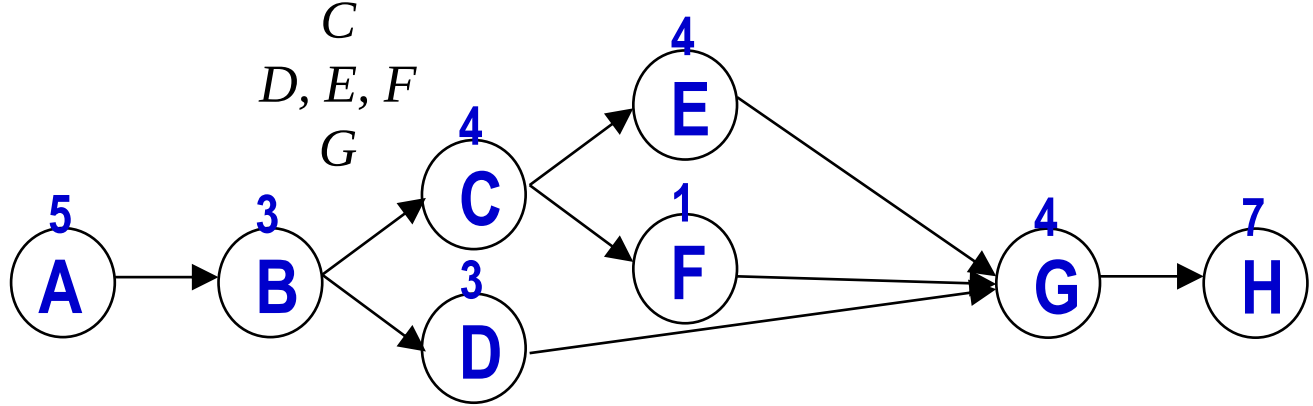
Total time 31

Line Balancing (Example 2)

(1) Draw a precedence diagram for the assembly line

Task	*Performance Time (minutes)*	*Immediate predecessor*
A	5	—
B	3	*A*
C	4	*B*
D	3	*B*
E	4	*C*
F	1	*C*
G	4	*D, E, F*
H	7	*G*

Total time 31



Line Balancing (Example 2)

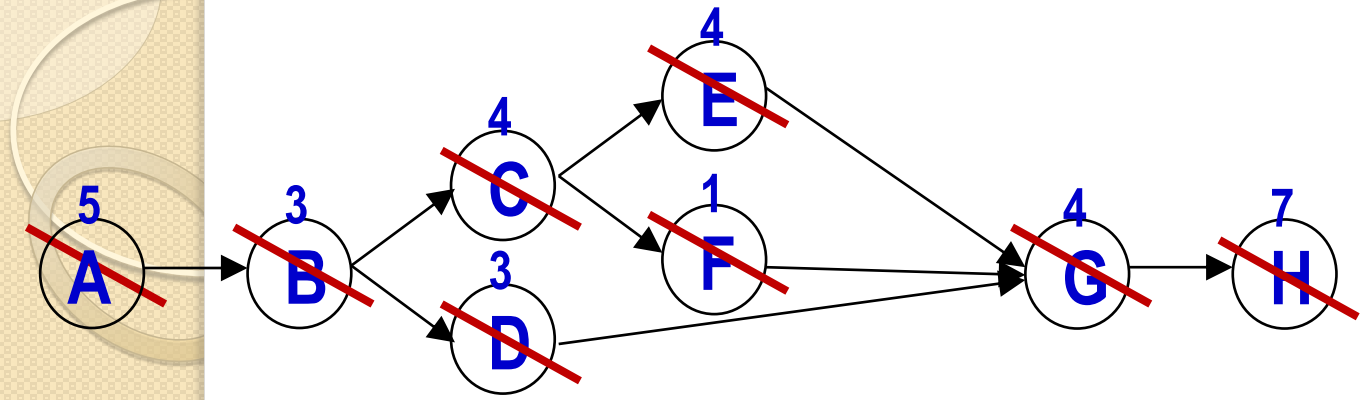
(2) Assuming 500 productive minutes available per day, compute the task time needed to obtain an output of 65 units per day.

$$\textit{Cycle time} = \frac{\text{Production time available per day}}{\text{output required per day}}$$

$$= 500 / 65$$

$$= 7.7 \textit{ minutes per unit}$$

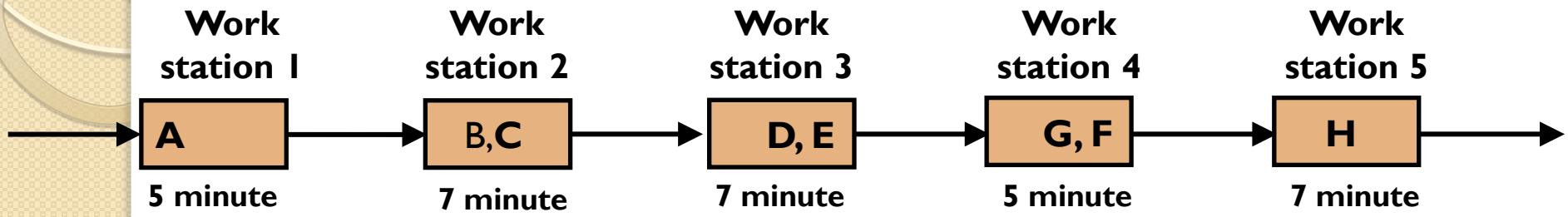
$$N_{min} = \frac{\text{total task time}}{\text{cycle time}} = \frac{31}{7.7} = 4.03 \approx 5$$



Cycle time = 7.7 min/unit

Station Number	Candidate list	Task assigned	Task time	Total time	Idle time
1	A	A	5	5	2.7
2	B	B	3	3	4.7
	C, D	C	4	7	0.7
3	D, E, F	E	4	4	3.7
	D, F	D	3	7	0.7
4	F	F	1	1	6.7
	G	G	4	5	2.7
5	H	H	7	7	0.7

Line Balancing (Example 2)



$$Efficiency = \frac{Total\ task\ times}{(no\ of\ actual\ workstations)\ x\ Cycle\ time}$$

$$= \frac{31\ minutes}{(5\ stations)\ x\ (7.7\ minutes)}$$

$$= 80.52\%$$

Total Idle Time = (no of actual workstations x Cycle time) — Total task times

= 5 x 7.7 — 31 = 7.5 minutes

Thank You