Unit -2
Line Balancing Algorithm

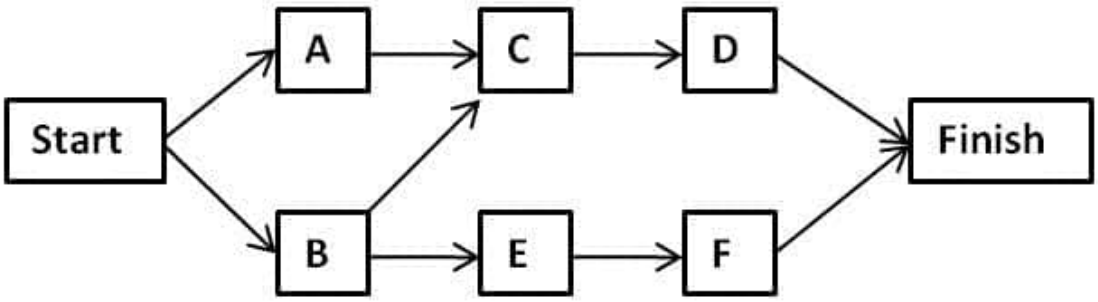
1. Introduction

- **Definition:** Line balancing is the process of assigning tasks to workstations along an assembly line to optimize efficiency and minimize idle time.
- **Goal:** Distribute workload evenly across workstations for smooth and continuous production flow.

2. Key Concepts

- **Task:** A unit of work performed on a product.
- **Workstation:** A location on the assembly line where one or more tasks are performed.
- **Cycle Time:** The maximum time allowed for each workstation to complete its assigned tasks.
    - **Formula:** Cycle Time = Available Production Time per Period / Required Production Quantity per Period
- **Precedence Diagram:** A graphical representation of the order in which tasks must be performed.
    - **Nodes:** Represent individual tasks.
    - **Arrows:** Indicate the order of task execution (precedence relationships).

3. Precedence Diagram Example



Precedence Diagram Method (PDM)

simple precedence diagram with 5 nodes and arrows showing dependencies

- **Task A:** 30 seconds
- **Task B:** 20 seconds (depends on A)
- **Task C:** 15 seconds (depends on A)
- **Task D:** 10 seconds (depends on B)
- **Task E:** 25 seconds (depends on C)

4. Theoretical Minimum Number of Workstations

- **Formula:**
  - Minimum Number of Workstations = Sum of Task Times / Cycle Time

5. Line Balancing Algorithms

- **a) Ranked Positional Weight (RPW) Method**
  1. **Calculate Positional Weight:**
     - For each task, calculate its positional weight considering its task time and the number of following tasks.
     - Higher weight indicates greater importance in minimizing idle time.
  2. **Assign Tasks:**
     - Assign tasks to workstations in descending order of their positional weight, while respecting precedence constraints.
- **b) Largest Candidate Rule (LCR) Method**
  1. **Select Longest Task:**
     - Assign the task with the longest processing time to the current workstation, considering precedence constraints.
     - Repeat until all tasks are assigned.

6. Line Balancing Example

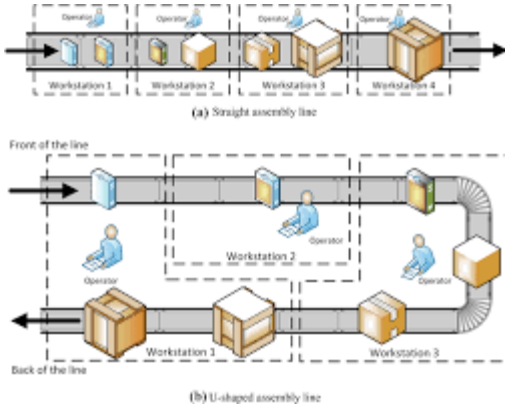
Scenario:

- Product: Simple toy car
- Tasks: A, B, C, D, E (as shown in the precedence diagram)
- Task Times: A: 30s, B: 20s, C: 15s, D: 10s, E: 25s
- Precedence: A -> B, A -> C, B -> D, C -> E
- Cycle Time: 60s (determined based on production demand)

Steps:

1. **Calculate Minimum Workstations:**
   - Sum of task times / Cycle Time = (30 + 20 + 15 + 10 + 25) / 60 = 1.67
   - Minimum workstations = 2 (rounded up)
2. **Apply Line Balancing Method (e.g., RPW):**
   - Calculate positional weights for each task.
   - Assign tasks to workstations based on their weights and precedence.
3. **Assign Tasks to Workstations:**
   - **Workstation 1:** A, C, E (Total time: 70s)
   - **Workstation 2:** B, D (Total time: 30s)

7. Line Balancing Diagram



simple assembly line diagram with two workstations and the assigned tasks

8. Conclusion

- Line balancing is crucial for optimizing production processes.
- By carefully considering task times, precedence relationships, and cycle time, manufacturers can achieve:
    - Increased productivity
    - Reduced costs
    - Improved efficiency
    - Better quality control