Project Management

Introduction to CPM and PERT

Project Management involves planning, scheduling, and controlling resources to achieve specific project goals within time, cost, and scope constraints.

Two of the most widely used techniques in project scheduling and analysis are:

- **CPM (Critical Path Method)**
- **PERT (Program Evaluation and Review Technique)**

1. CPM – Critical Path Method

- Developed for **deterministic** activity times (fixed and known).
- Used for projects where **activity duration is predictable**.
- Focuses on **time-cost trade-offs** (crashing).

2. PERT – Program Evaluation and Review Technique

- Developed for **probabilistic** activity durations.
- Suitable for **R&D and uncertain environments**.
- Uses **three time estimates**:
    - Optimistic time (O)
    - Most likely time (M)
    - Pessimistic time (P)
- Expected time (TE) is calculated as:
  TE=O+4M+P6TE = \frac{O + 4M + P}{6}

Basic Differences Between CPM and PERT

Aspect	CPM	PERT
Type of Activity Time	Deterministic (fixed)	Probabilistic (uncertain)
Application	Construction, maintenance, production	Research, development, planning
Focus	Time-cost optimization	Time uncertainty and risk analysis
Estimates Used	One (fixed)	Three (O, M, P)
Critical Path Emphasis	High – used for crashing	High – used for estimating project time
Slack Computation	Available	Available

CPM/PERT Network Components and Precedence Relationship

Components of a Network Diagram:

1. **Activity (Arrow or Node):**
    - Represents a task to be completed.
    - In **AOA (Activity on Arrow)**, activities are arrows.
    - In **AON (Activity on Node)**, activities are nodes (preferred in modern tools).
2. **Event (Node):**
    - Represents the start or completion of an activity (AOA only).
3. **Dummy Activity:**
    - A logical connector showing dependency, without time or cost.

Precedence Relationships:

- **Finish-to-Start (FS):** Task B starts after Task A finishes (most common).
- **Start-to-Start (SS):** Task B starts after Task A starts.
- **Finish-to-Finish (FF):** Task B finishes after Task A finishes.
- **Start-to-Finish (SF):** Task B finishes after Task A starts (rare).

Critical Path Analysis

The **Critical Path** is the **longest path** through the project network and determines the **minimum project duration**. Activities on the critical path have **zero slack**, meaning any delay will delay the project.

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1. Forward Pass Method (Earliest Times)

Calculates the **Earliest Start (ES)** and **Earliest Finish (EF)** times:

- ES for first activity = 0
- EF = ES + Activity Duration
- ES of next activity = Maximum EF of all predecessor activities

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2. Backward Pass Method (Latest Times)

Calculates the **Latest Start (LS)** and **Latest Finish (LF)** times:

- LF of last activity = Project duration
- LS = LF - Activity Duration
- LF of preceding activity = Minimum LS of all successors

Slack or Float:

Slack=LS−ES=LF−EF\text{Slack} = LS - ES = LF - EF

- If Slack = 0 → Activity is **critical**
