Learning Objectives

• Define Project and Project Management
• Compare and Contrast Pure, Functional, and Matrix Project Organizational Structures
• Understand Gantt Chart and Network Diagram
• Be Able to Use CPM Method for Project Scheduling
• Understand the Concept of PERT and Crashing
• Understand Assumptions/Limitations of PERT/CPM Method

What Is A Project?
Project

- A set of activities (tasks) that are interrelated with a common aim to produce a valuable output
- Characteristics
  - Large-scale, one of a kind, one-time job
  - Precedence relationship among activities
  - Time and budget limits

Project Management

- Planning, directing, and controlling resources (people, equipment, material) to meet specific objectives within the technical, cost, and time constraints of the project

Effective Project Management

- Better control of financial, physical, and human resources
- Improved customer relations
- Shorter development times
- Lower costs
- Higher quality and reliability
- Better internal coordination
Project Organizational Structures

- Pure Project
  - performed by a self-contained team works full time on the project
- Functional Project
  - each component is performed by people within a functional area
- Matrix Project
  - A combination of pure and functional projects

Pure Project: Advantages

- Full authority of project manager
- One boss to report
- Shortened communication lines
- High team pride, motivation, and commitment

Pure Project: Disadvantages

- Duplication of resources
- Lack of organizational goals and policies
- Lack of technology transfer
- No functional area "home" for team members
Functional Project:

**Advantages**
- Shared manpower and resources
- Maintained technical expertise within the functional area
- Natural “home” in the functional area for team members
- Critical mass of specialized knowledge

**Disadvantages**
- Compromised non-functional-related activities
- Weak motivation of team members
- Slow response to clients’ needs
Matrix Project:

Advantages

- Enhanced interfunctional communications
- Pinpointed responsibility
- Minimized duplication of resources
- Functional home for team members

Matrix Project:

Disadvantages

- Too many bosses
- Depends on Project Manager’s negotiating skills
- Potential for suboptimization
Work Breakdown Structure (WBS)

Program

- Project 1
- Project 2

Task 1.1

Subtask 1.1.1

Work Package 1.1.1.1

Task 1.2

Subtask 1.1.2

Work Package 1.1.1.2

Work Breakdown Structure Example

Program: New Plant Construction and Start-up
Project 1: Analytical Study
  Task 1: Marketing/Production Study
  Task 2: Cost Effectiveness Analysis
Project 2: Design and Layout
  Task 1: Product Processing Sketches
  Task 2: Product Processing Blueprints
Project 3: Installation
  Task 1: Fabrication
  Task 2: Setup
  Task 3: Testing and Run

Project Scheduling: CPM and PERT

- CPM (Critical Path Method)
  - J. E. Kelly of Remington-Rand and M. R. Walker of Du Pont (1957)
  - Scheduling maintenance shutdowns of chemical processing plants
- PERT (Program Evaluation and Review Technique)
  - U.S. Navy Special Projects Office (1958)
  - Polaris missile project
Typical Questions Addressed by CPM/PERT

- When will the project be completed?
- How likely can the project be completed by due date?
- Which tasks are most critical to ensure timely completion of the project?
- Which tasks can be delayed if necessary without delaying the whole project?

Scheduling and Representing Projects:

**Gantt Chart**

<table>
<thead>
<tr>
<th>Activities</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td></td>
</tr>
</tbody>
</table>

Scheduling and Representing Projects:

**Network Diagram**

- Marketing Survey
  - Determine survey objectives
  - Design Questionnaire
  - Select Participants
  - Select and Hire personnel
  - Train Personnel
  - Personnel Assignments
Critical Path Scheduling

**INPUTS**
- List of project activities
- Precedence relationship among activities
- Time estimate for each activity

**OUTPUTS**
- Estimated duration of project
- Identification of critical activities
- Amount of slack for each activity

CPM/PERT Terminology

- Path
  - A connected sequence of activities leading from the starting event to the ending event
  - **Critical Path**
    - The longest path which determines the project duration (shortest time to complete the project)
- Critical Activities
  - All of the activities that make up the critical path
  - Any delay in critical activities will delay the project duration

CPM/PERT Terminology

- Early Start (ES)
  - The earliest time that an activity can begin after all preceding activities have been completed
- Early Finish (EF)
  - EF = ES + activity time
- Late Finish (LF)
  - The latest time that an activity can finish without changing the project completion time
- Late Start (LS)
  - LS = LF - activity time
CPM/PERT Terminology

- Slack: the amount of time that an activity can be delayed without delaying the project completion date.
- Compute an activity’s slack time
  \[ \text{slack} = \text{LS} - \text{ES} = \text{LF} - \text{EF} \]
- What is the slack time for a critical activity?

Critical Path Scheduling Procedure

- **Forward Pass**: for each activity, compute early times (ES and EF).
- **Backward Pass**: compute late times (LF and LS) backward.
- **Slack Times**: for each activity, compute slack time = LS - ES or LF - EF.
- **Critical Path**: = path with zero-slack-time activities

Example 1

Consider the following consulting project:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Designation</th>
<th>Immed. Pred.</th>
<th>Time (Weeks)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Assess customer’s needs</td>
<td>A</td>
<td>None</td>
<td>2</td>
</tr>
<tr>
<td>Write and submit proposal</td>
<td>B</td>
<td>A</td>
<td>1</td>
</tr>
<tr>
<td>Obtain approval</td>
<td>C</td>
<td>B</td>
<td>1</td>
</tr>
<tr>
<td>Develop service vision and goals</td>
<td>D</td>
<td>C</td>
<td>2</td>
</tr>
<tr>
<td>Train employees</td>
<td>E</td>
<td>C</td>
<td>5</td>
</tr>
<tr>
<td>Quality improvement pilot groups</td>
<td>F</td>
<td>D, E</td>
<td>5</td>
</tr>
<tr>
<td>Write assessment report</td>
<td>G</td>
<td>F</td>
<td>1</td>
</tr>
</tbody>
</table>

Develop a critical path diagram and determine the duration of the critical path and slack times for all activities.
Network Diagram

<table>
<thead>
<tr>
<th>Act.</th>
<th>Imed.</th>
<th>Pred.</th>
<th>Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>None</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>A</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td>B</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>C</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>C</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>F</td>
<td>D,E</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>G</td>
<td>F</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

**Forward Pass:**
Calculate ES and EF

- \( A, 2 \)  
- \( B, 1 \)  
- \( C, 1 \)  
- \( D, 2 \)  
- \( E, 5 \)  
- \( F, 5 \)  
- \( G, 1 \)  

<table>
<thead>
<tr>
<th>Activity</th>
<th>ES</th>
<th>EF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>C</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>9</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>9</td>
</tr>
<tr>
<td>G</td>
<td>1</td>
<td>14</td>
</tr>
</tbody>
</table>

**Backward Pass:**
Calculate LF and LS

- \( A, 2 \)  
- \( B, 1 \)  
- \( C, 1 \)  
- \( D, 2 \)  
- \( E, 5 \)  
- \( F, 5 \)  
- \( G, 1 \)  

<table>
<thead>
<tr>
<th>Activity</th>
<th>LS</th>
<th>LF</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>14</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>9</td>
<td>9</td>
</tr>
<tr>
<td>C</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>E</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>F</td>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>G</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
**Example 1**

### Critical Path & Slack Times

<table>
<thead>
<tr>
<th>Activity</th>
<th>ES</th>
<th>EF</th>
<th>Slack</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>B</td>
<td>2</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>C</td>
<td>3</td>
<td>4</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>4</td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td>9</td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>5</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>G</td>
<td>1</td>
<td>2</td>
<td>1</td>
</tr>
</tbody>
</table>

Critical path: A, B, C, E, F, G

Duration = 15 weeks

### Questions & Answers

Q: What is the minimum time to finish the project?
A: 15 weeks

Q: Which activities are critical for the whole project?
A: Activities A, B, C, E, F, G

Q: Which activities can be delayed, by how much?
A: D, 3 weeks

Q: If D were delayed by 5 weeks, how long will the project be completed?
A: D, 17 weeks

### Scheduling and Monitoring project

#### Gantt Chart

<table>
<thead>
<tr>
<th>Activity</th>
<th>Week</th>
</tr>
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<tbody>
<tr>
<td>Assess customer's needs</td>
<td>A</td>
</tr>
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<td>B</td>
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<td>F</td>
</tr>
<tr>
<td>Write assessment report</td>
<td>G</td>
</tr>
</tbody>
</table>

Example 1
• Describe how the airlines, suppliers, and outsourced vendors affect Boeing's development of the 787, citing how changes in one affect the other.
• Critique Boeing's project management strategy for the 787 Dreamliner.
  o What are the major characteristics?
  o What works well? What doesn't?
  o What changes need to be made for future projects?