Project Management: *Defined*

- **Project** is a series of related jobs usually directed toward some major output and requiring a significant period of time to perform.
- **Project Management** are the management activities of planning, directing, and controlling resources (people, equipment, material) to meet the technical, cost, and time constraints of a project.

**OBJECTIVES**

- Definition of Project Management
- Work Breakdown Structure
- Project Control Charts
- Structuring Projects
- Critical Path Scheduling

**Gantt Chart**

- Vertical Axis: Always Activities or Jobs
- Horizontal bars used to denote length of time for each activity or job.

- Activity 1
- Activity 2
- Activity 3
- Activity 4
- Activity 5
- Activity 6

- Time: Horizontal Axis: Always Time
Organizational Structures

- Three basic organization structures
  - **Functional**: functional managers report to the CEO
  - **Project**: program managers report to the CEO
  - **Matrix**: middle ground between functional and project structures; personnel often report to two or more bosses; structure can be weak, balanced, or strong matrix

Pure Project

A pure project is where a self-contained team works full-time on the project

Structuring Projects: Pure Project

- The project manager has full authority over the project
- Team members report to one boss
- Shortened communication lines
- Team pride, motivation, and commitment are high
Structuring Projects: Pure Project Disadvantages

- Duplication of resources
- Organizational goals and policies are ignored
- Lack of technology transfer
- Team members have no functional area "home"

Functional Project

A functional project is housed within a functional division

Example, Project “B” is in the functional area of Research and Development.

Structuring Projects Functional Project: Advantages

- A team member can work on several projects
- Technical expertise is maintained within the functional area
- The functional area is a “home” after the project is completed
- Critical mass of specialized knowledge

Structuring Projects Functional Project: Disadvantages

- Aspects of the project that are not directly related to the functional area get short-changed
- Motivation of team members is often weak
- Needs of the client are secondary and are responded to slowly
Matrix Project Organization Structure

President

Research and Development

Engineering

Manufacturing

Marketing

Manager

Project A

Manager

Project B

Manager

Project C

Structuring Projects Matrix: Advantages

- Enhanced communications between functional areas
- Pinpointed responsibility
- Duplication of resources is minimized
- Functional “home” for team members
- Policies of the parent organization are followed

Structuring Projects Matrix: Disadvantages

- Too many bosses
- Depends on project manager’s negotiating skills
- Potential for sub-optimization

Work Breakdown Structure

A work breakdown structure defines the hierarchy of project tasks, subtasks, and work packages cf. WBS/Alton bridge (PM2.avi)

<table>
<thead>
<tr>
<th>Level</th>
<th>Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Project 1</td>
</tr>
<tr>
<td>2</td>
<td>Task 1.1</td>
</tr>
<tr>
<td>3</td>
<td>Subtask 1.1</td>
</tr>
<tr>
<td>4</td>
<td>Work Package 1.1.1</td>
</tr>
</tbody>
</table>
Network-Planning Models

- A project is made up of a sequence of activities that form a network representing a project.
- The path taking longest time through this network of activities is called the “critical path”.
- The critical path provides a wide range of scheduling information useful in managing a project.
- Critical Path Method (CPM) helps to identify the critical path(s) in the project networks.

Prerequisites for Critical Path Methodology

- A project must have:
  - Well-defined jobs or tasks whose completion marks the end of the project;
  - Independent jobs or tasks;
  - Tasks that follow a given sequence.

Types of Critical Path Methods (CPM)

- CPM with a Single Time Estimate
  - Used when activity times are known with certainty
  - Used to determine timing estimates for the project, each activity in the project, and slack time for activities
- CPM with Three Activity Time Estimates
  - Used when activity times are uncertain
  - Used to obtain the same information as the Single Time Estimate model and probability information
- Time-Cost Models
  - Used when cost trade-off information is a major consideration in planning
  - Used to determine the least cost in reducing total project time
- Cf: CPM/Alton bridge (PM5.avi)

Steps in the CPM with Single Time Estimate

1. Activity Identification
2. Activity Sequencing and Network Construction
3. Determine the critical path
   - From the critical path, all of the project and activity timing information can be obtained
**CPM with Single Time Estimate**

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.

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**First draw the network**

![Network Diagram]

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

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**Determine early starts (ES) and early finish (EF) times**

![Earliest Times Diagram]

**Determine late starts (LS) and late finish (LF) times**

![Latest Times Diagram]
Critical Path & Slack

ES = 0, EF = 2
LS = 0, LS = 2, LF = 2
ES = 2, EF = 3
LS = 2, LS = 3, LF = 3
ES = 3, EF = 4
LS = 3, LS = 4, LF = 4
ES = 4, EF = 7
LS = 4, LS = 7, LF = 7
ES = 7, EF = 9
LS = 7, LS = 9, LF = 9
ES = 9, EF = 14
LS = 9, LS = 14, LF = 14
ES = 14, EF = 15
LS = 14, LS = 15, LF = 15

Slack = (9 - 4) = 3 Wks

Duration = 15 weeks

Example 2. CPM with Three Activity Time Estimates

<table>
<thead>
<tr>
<th>Task</th>
<th>Immediate Predecessors</th>
<th>Optimistic</th>
<th>Most Likely</th>
<th>Pessimistic</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>None</td>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>B</td>
<td>None</td>
<td>2</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td>6</td>
<td>12</td>
<td>30</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>2</td>
<td>5</td>
<td>8</td>
</tr>
<tr>
<td>E</td>
<td>C</td>
<td>5</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>F</td>
<td>D</td>
<td>3</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td>G</td>
<td>B</td>
<td>3</td>
<td>9</td>
<td>27</td>
</tr>
<tr>
<td>H</td>
<td>E, F</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>I</td>
<td>G, H</td>
<td>4</td>
<td>19</td>
<td>28</td>
</tr>
</tbody>
</table>

Expected Time Calculations

ET (A) = \frac{3 + 4(6) + 15}{6} = 7

ET (B) = \frac{2 + 4(4) + 14}{6} = 5.333


Ex. 2. Expected Time Calculations

ET (A) = 3 + 4(6) + 15

ET (B) = 2 + 4(4) + 14

Ex 2. Expected Time Calculations

<table>
<thead>
<tr>
<th>Task</th>
<th>Immediate Predecessors</th>
<th>Expected Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>None</td>
<td>7</td>
</tr>
<tr>
<td>B</td>
<td>None</td>
<td>5.333</td>
</tr>
<tr>
<td>C</td>
<td>A</td>
<td>14</td>
</tr>
<tr>
<td>D</td>
<td>A</td>
<td>5</td>
</tr>
<tr>
<td>E</td>
<td>C</td>
<td>11</td>
</tr>
<tr>
<td>F</td>
<td>D</td>
<td>7</td>
</tr>
<tr>
<td>G</td>
<td>B</td>
<td>11</td>
</tr>
<tr>
<td>H</td>
<td>E,F</td>
<td>4</td>
</tr>
<tr>
<td>I</td>
<td>G,H</td>
<td>18</td>
</tr>
</tbody>
</table>

\[ ET(C) = 6 + 4(12) + 30 \]

\[ ET(C) = 84/6 = 14 \]


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Example 2. Network

Duration = 54 Days

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Example 2. Probability Exercise

What is the probability of finishing this project in less than 53 days?

\[ p(t < D) \]

\[ D = 53 \]

\[ T_E = 54 \]

\[ Z = \frac{D - T_E}{\sqrt{\sum \sigma^2}} \]

Activity variance, \( \sigma^2 = \left(\frac{\text{Pessimistic} - \text{Optimistic}}{6}\right)^2 \)

\[ \sum \sigma^2 = 41 \]
There is a 43.8% probability that this project will be completed in less than 53 weeks.

What is the probability that the project duration will exceed 56 weeks?

Time-Cost Models

- Basic Assumption: Relationship between activity completion time and project cost
- Time Cost Models: Determine the optimum point in time-cost tradeoffs
  - Activity direct costs
  - Project indirect costs
  - Activity completion times
  - cf. p. 89
CPM Assumptions/Limitations

- Project activities can be identified as entities (There is a clear beginning and ending point for each activity.)
- Project activity sequence relationships can be specified and networked
- Project control should focus on the critical path
- The activity times follow the beta distribution, with the variance of the project assumed to equal the sum of the variances along the critical path
- Project control should focus on the critical path

Question Bowl

Which of the following are examples of Graphic Project Charts?

a. Gantt
b. Bar
c. Milestone
d. All of the above
e. None of the above

Answer: d. All of the above

Question Bowl

Which of the following are one of the three organizational structures of projects?

a. Pure
b. Functional
c. Matrix
d. All of the above
e. None of the above

Answer: d. All of the above

Question Bowl

A project starts with a written description of the objectives to be achieved, with a brief statement of the work to be done and a proposed schedule all contained in which of the following?

a. SOW
b. WBS
c. Early Start Schedule
d. Late Start Schedule
e. None of the above

Answer: a. SOW (or Statement of Work)
Question Bowl

For some activities in a project there may be some leeway from when an activity can start and when it must finish. What is this period of time called when using the Critical Path Method?

a. Early start time
b. Late start time
c. Slack time
d. All of the above
e. None of the above

Answer: c. Slack time

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Question Bowl

How much “slack time” is permitted in the “critical path” activity times?

a. Only one unit of time per activity
b. No slack time is permitted
c. As much as the maximum activity time in the network
d. As much as is necessary to add up to the total time of the project
e. None of the above

Answer: b. No slack time is permitted (All critical path activities must have zero slack time, otherwise they would not be critical to the project completion time.)

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Question Bowl

When looking at the Time-Cost Trade Offs in the Minimum-Cost Scheduling time-cost model, we seek to reduce the total time of a project by doing what to the least-cost activity choices?

a. Crashing them
b. Adding slack time
c. Subtracting slack time
d. Adding project time
e. None of the above

Answer: a. Crashing them (We “crash” the least-cost activity times to seek a reduced total time for the entire project and we do it step-wise as inexpensively as possible.)