CHAPTER 1
INTRODUCTION TO PROJECT MANAGEMENT
(Chapter 1)

CHAPTER 2
PROJECT SELECTION
(Chapter 2)

CHAPTER 3
PROJECT ORGANIZATION
(Chapter 3)

CHAPTER 4
PROJECT PLANNING
• Budgeting and Cost Estimation
  (Chapter 5)
• Scheduling
  (Chapter 6)
• Resource Allocation
  (Chapter 7)

CHAPTER 8
MONITORING AND INFORMATION SYSTEMS
(Chapter 8)

CHAPTER 9
PROJECT CONTROL
(Chapter 9)

CHAPTER 10
PROJECT TERMINATION
(Chapter 10)
Chapter 7. Resource Allocation

7.1 Critical Path Method – Crashing a Project
7.2 The Resource Allocation Problem
7.3 Resource Loading
7.4 Resource Leveling
Course Unit Instructional Outcomes

At the end of the chapter, the students should be able to:

1. Discuss the importance of resource allocation in a project.
2. Discuss the process of resource allocation in a project.
3. Calculate the cost slope of a project.
4. Discuss the relationship between resource loading and resource leveling and some of the approaches employed to solve allocation problems, including the Critical Path Method (CPM).

Resources in Project Management

- Budget
- People
- Technology
- Time
- Space
- Tools
- Equipment
- Etc.
Resource Allocation

- Resource allocation permits efficient use of physical assets
  - Within a project, or across multiple projects
  - Drives both the identification of resources, and timing of their application

Project Crashing Question

Can we **cut short** its project completion time?
If so, how!
Project Crashing Solution!

Yes, the project duration can be reduced by assigning more resources to project activities. But, doing this would somehow increase our project cost!

How do we strike a balance?

- **Project crashing** is a method for shortening project duration by reducing one or more critical activities to a time less than normal activity time.

Critical Path Method - Crashing a Project

- The first time/cost combination is called *normal*, and the second set is referred to as *crash*.

- Normal times are “normal” in the same sense as the ‘m’ time estimate used in PERT.

- **Normal**: Most likely task duration, like “m”

- **Crash**: Expedite an activity, by applying additional resources
  - Specialized or additional equipment
  - More people (e.g., borrowed staff, temps)
  - More hours (e.g., overtime, weekends)
Activity Slopes-Cost per Period for Crashing

<table>
<thead>
<tr>
<th>Activity</th>
<th>Slope ($/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>40/1 = -40</td>
</tr>
<tr>
<td>b</td>
<td>60/1 = -60</td>
</tr>
<tr>
<td>c</td>
<td>-</td>
</tr>
<tr>
<td>d</td>
<td>90/3 = -30</td>
</tr>
<tr>
<td>e</td>
<td>-70 (2 days)</td>
</tr>
</tbody>
</table>

Compute a cost/time slope for each activity that can be expedited (crashed). Slope is defined as:

\[
\text{slope} = \frac{\text{crash cost} - \text{normal cost}}{\text{crash time} - \text{normal time}}
\]

The cost per day of crashing a project. The slope is negative, indicating that as the time required for a project or task is decreased, the cost is increased. Note that activity c cannot be expedited.

Crashing a Project – CPM

- First task is to develop a table or graph of the cost of a project as a function of the project’s various possible completion dates.

- Starting with the normal schedule for all project activities, crash selected activities, one at a time, to decrease project duration at the minimum additional cost.
To crash a project, follow two simple principles:

- First, focus on the critical path(s) when trying to shorten the duration of a project, with the exception we noted above when a resource used by an activity not on the critical path is needed for another project.
  
  Crashing a noncritical activity will not influence project duration.

- Second, when shortening a project’s duration, select the least expensive way to do it.

### Project Crashing Example

<table>
<thead>
<tr>
<th>Activity</th>
<th>Normal Time</th>
<th>Crash Time</th>
<th>Normal Cost</th>
<th>Crash Cost</th>
<th>Slope</th>
<th>Maximum Crash Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>4</td>
<td>RO 500</td>
<td>RO 600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>6</td>
<td>RO 1,200</td>
<td>RO 2,000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>11</td>
<td>RO 300</td>
<td>RO 600</td>
<td></td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>4</td>
<td>RO 1,000</td>
<td>RO 1,400</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Project Crashing Example

<table>
<thead>
<tr>
<th>Activity</th>
<th>Normal Time</th>
<th>Crash Time</th>
<th>Normal Cost</th>
<th>Crash Cost</th>
<th>Slope</th>
<th>Maximum Crash Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>5</td>
<td>4</td>
<td>RO 500</td>
<td>RO 600</td>
<td>RO 100</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>10</td>
<td>6</td>
<td>RO 1,200</td>
<td>RO 2,000</td>
<td>RO 200</td>
<td>4</td>
</tr>
<tr>
<td>D</td>
<td>13</td>
<td>11</td>
<td>RO 300</td>
<td>RO 600</td>
<td>RO 150</td>
<td>2</td>
</tr>
<tr>
<td>E</td>
<td>5</td>
<td>4</td>
<td>RO 1,000</td>
<td>RO 1,400</td>
<td>RO 400</td>
<td>1</td>
</tr>
</tbody>
</table>

Class Activity 1
Crash by 2 days – How much will it cost?

<table>
<thead>
<tr>
<th>ACTIVITY</th>
<th>NORMAL</th>
<th>CRASH</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Time (Days)</td>
<td>Cost RO</td>
</tr>
<tr>
<td>1-2</td>
<td>8</td>
<td>100</td>
</tr>
<tr>
<td>1-3</td>
<td>4</td>
<td>150</td>
</tr>
<tr>
<td>2-4</td>
<td>2</td>
<td>50</td>
</tr>
<tr>
<td>2-5</td>
<td>10</td>
<td>100</td>
</tr>
<tr>
<td>3-4</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>4-5</td>
<td>3</td>
<td>80</td>
</tr>
</tbody>
</table>

Use the formula: \[ \text{Close Slope} = \frac{\text{Crash Cost} - \text{Normal Cost}}{\text{Normal Time} - \text{Crash Time}} \]

Reference: https://www.youtube.com/watch?v=JxnPBnccqY
Importance of Resource Allocation

- A project manager frequently comes across resource constraints.
- There may be delay in the arrival of building materials.
- The available personnel may fall short of the requirement on some days and there may be excess personnel available on some other days.
- The job of the project manager is to plan and allocate the resources for the different activities so that the resource utilization is optimized.
Resource Loading

- Describes the amounts of individual resources an existing schedule requires during specific-time period.
- Because the project action plan is the source of information on activity precedence, durations, and resources requirements, it is the primary input for both the project schedule and its budget.
- The action plan links the schedule directly to specific demands for resources.
- It is the project manager’s responsibility to ensure that the required resources, in the required amounts, are available when and where they are needed.
Resource Leveling

- A project management technique used to examine unbalanced use of resources (usually people or equipment) over time, and for resolving over-allocations or conflicts.

- Leveling resources involves redistributing an imbalance of allocated work. It assists project team members by keeping them from becoming overwhelmed, working overtime, or running into project burnout.

Resource Leveling

- Resource leveling aims to minimize the period-by-period variations in resource loading by shifting tasks within their slack allowances.

- Resource leveling, referred to as resource smoothing.

- The purpose is to create a smoother distribution of resource usage.

- Several advantages include:
  - Less hands-on management is required
  - May be able to use a “just-in-time” inventory policy
Class Activity 2
Resource Loading Problem

If a Project Manager is working on two projects, how will he maximize his time given the above Project Schedule?
Class Activity 2
Resource Loading Problem

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Member 1</td>
<td>Project 1</td>
<td>Project 1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Team Member 2</td>
<td></td>
<td>Project 1</td>
<td>Project 1</td>
<td></td>
</tr>
<tr>
<td>Team Member 3</td>
<td></td>
<td></td>
<td>Project 1</td>
<td>Project 1</td>
</tr>
</tbody>
</table>

Describes the amounts of individual resources an existing schedule requires during specific-time period.

Class Activity 2
Resource Loading Problem

<table>
<thead>
<tr>
<th></th>
<th>January</th>
<th>February</th>
<th>March</th>
<th>April</th>
</tr>
</thead>
<tbody>
<tr>
<td>Team Member 1</td>
<td>Project 1</td>
<td></td>
<td>Project 2</td>
<td>Project 2</td>
</tr>
<tr>
<td>Team Member 2</td>
<td>Project 2</td>
<td>Project 2</td>
<td>Project 1</td>
<td>Project 1</td>
</tr>
<tr>
<td>Team Member 3</td>
<td>Project 2</td>
<td>Project 1</td>
<td>Project 2</td>
<td>Project 2</td>
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Leveling resources involves redistributing an imbalance of allocated work. It assists project team members by keeping them from becoming overwhelmed, working overtime, or running into project burnout.
Chapter 7.
Resource Allocation