The Resource Problem

• Resources and Priorities
  – Project network times are not a schedule until resources have been assigned.
    • The implicit assumption is that resources will be available in the required amounts when needed.
    • Adding new projects requires making realistic judgments of resource availability and project durations.
  – Cost estimates are not a budget until they have been time-phased.

• Resource Smoothing (or Leveling)
  – Involves attempting to even out varying demands on resources by using slack (delaying noncritical activities) to manage resource utilization when resources are adequate over the life of the project.

• Resource-Constrained Scheduling
  – The duration of a project may be increased by delaying the late start of some of its activities if resources are not adequate to meet peak demands.

Types of Project Constraints

• Technical or Logic Constraints
  – Constraints related to the networked sequence in which project activities must occur.

• Physical Constraints
  – Activities that cannot occur in parallel or are affected by contractual or environmental conditions.

• Resource Constraints
  – The absence, shortage, or unique interrelationship and interaction characteristics of resources that require a particular sequencing of project activities.
Classification of A Scheduling Problem

- Classification of Problem
  - Using a priority matrix will help determine if the project is time or resource constrained.

- Time Constrained Project
  - A project that must be completed by an imposed date.
    - Time is fixed, resources are flexible: additional resources are required to ensure project meets schedule.

- Resource Constrained Project
  - A project in which the level of resources available cannot be exceeded.
    - Resources are fixed, time is flexible: inadequate resources will delay the project.

Resource Allocation Methods

- Limiting Assumptions
  - Splitting activities is not allowed—once an activity is start, it is carried to completion.
  - Level of resources used for an activity cannot be changed.

- Risk Assumptions
  - Activities with the most slack pose the least risk.
  - Reduction of flexibility does not increase risk.
  - The nature of an activity (easy, complex) doesn’t increase risk.

Resource Allocation Methods (cont’d)

- Time-Constrained Projects
  - Projects that must be completed by an imposed date.
    - Require the use of leveling techniques that focus on balancing or smoothing resource demands by using positive slack (delaying noncritical activities) to manage resource utilization over the duration of the project.
      - Peak resource demands are reduced.
      - Resources over the life of the project are reduced.
      - Fluctuation in resource demand is minimized.
Resource Allocation Methods (cont’d)

• Resource Demand Leveling Techniques for Time-Constrained Projects
  – Advantages
    • Peak resource demands are reduced.
    • Resources over the life of the project are reduced.
    • Fluctuation in resource demand is minimized.
  – Disadvantages
    • Loss of flexibility that occurs from reducing slack.
    • Increases in the criticality of all activities.

Resource-Constrained Projects
  – Projects that involve resources that are limited in quantity or by their availability.
  – Scheduling of activities requires the use of heuristics (rules-of-thumb) that focus on:
    1. Minimum slack
    2. Smallest (least) duration
    3. Lowest activity identification number
  – The parallel method is used to apply heuristics
    • An iterative process that starts at the first time period of the project and schedules period-by-period any activities scheduled to start using the three priority rules.

Resource-Constrained Schedule through Period 2–3

Resource-Constrained Schedule through Period 5–6
Computer Demonstration of Resource-Constrained Scheduling

- **EMR Project**
  - The development of a handheld electronic medical reference guide to be used by emergency medical technicians and paramedics.

- **Problem**
  - There are only eight design engineers who can be assigned to the project due to a shortage of design engineers and commitments to other projects.

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**EMR Project—Time Constrained Resource Usage View, January 15–23, 2005**

<table>
<thead>
<tr>
<th>Resource Name</th>
<th>Work: Jan 15–30</th>
<th>Jan 21–30</th>
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</thead>
<tbody>
<tr>
<td><strong>Design engineers</strong></td>
<td>3,684 hrs</td>
<td>2,978 hrs</td>
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<tr>
<td>Mental series</td>
<td>1,960 hrs</td>
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<tr>
<td>External series</td>
<td>1,320 hrs</td>
<td>1,010 hrs</td>
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<tr>
<td>Coordinate</td>
<td>1,000 hrs</td>
<td>810 hrs</td>
</tr>
<tr>
<td>Total</td>
<td>1,060 hrs</td>
<td>810 hrs</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>7,844 hrs</td>
<td>6,698 hrs</td>
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</tbody>
</table>

---

**Legend**
- ES: EMR Project
- ID: EMR Project
- EF: EMR Project
- LS: EMR Project
- LF: EMR Project

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Haeryip Sihombing
The Impacts of Resource-Constrained Scheduling

- Reduces delay but reduces flexibility.
- Increases criticality of events.
- Increases scheduling complexity.
- May make traditional critical path no longer meaningful.
- Can break sequence of events.
- May cause parallel activities to become sequential and critical activities with slack to become noncritical.

Splitting/Multitasking

- Splitting/Multitasking
  - A scheduling technique used to get a better project schedule and/or increase resource utilization.
  - Involves interrupting work on an activity to employ the resource on another activity, then returning the resource to finish the interrupted work.
  - Is feasible when startup and shutdown costs are low.
  - Is considered the major reason why projects fail to meet schedule.

Activity duration without splitting

Activity duration split into three segments—A, B, C

Activity duration split with shutdown and startup
Assigning Project Work

- Factors to Consider in Assigning Work:
  - Don’t always pick the same people for the toughest assignments.
  - Choose people with an eye to fostering their development through participation on the project.
  - Pick people with compatible work habits and personalities but who complement each other.
  - Team-up veterans with new hires to share experience and socialize newcomers into the organization.
  - Select people who may need to learn work together on later stages of the project or other projects.

Benefits of Scheduling Resources

- Leaves time for consideration of reasonable alternatives:
  - Cost-time tradeoffs
  - Changes in priorities
- Provides information for time-phased work package budgets to assess:
  - Impact of unforeseen events
  - Amount of flexibility in available resources

Multiproject Resource Schedules

- Multiproject Scheduling Problems
  - Overall project slippage
    - Delay on one project create delays for other projects
  - Inefficient resource application
    - The peaks and valleys of resource demands create scheduling problems and delays for projects.
  - Resource bottlenecks
    - Shortages of critical resources required for multiple projects cause delays and schedule extensions.

Managing Multiproject Scheduling

- Create project offices or departments to oversee the scheduling of resources across projects.
- Use a project priority queuing system: first come, first served for resources.
- Centralize project management: treat all projects as a part of a “megaproject.”
- Outsource projects to reduce the number of projects handled internally.
Two Time-Phased Work Packages (Labor Cost Only)

<table>
<thead>
<tr>
<th>Work Package Time-Phased Budget (Labor cost only)</th>
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<tbody>
<tr>
<td>Work Package Description: Software</td>
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<tr>
<td>Work Package ID: 1.1.3.2.4.1 and 1.1.3.2.4.2</td>
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<tr>
<td>Deliverable: Circuit Board</td>
</tr>
<tr>
<td>Responsible organization: Software</td>
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<td>Labor cost only</td>
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<p>| Time-Phased Labor Budget (000$)                  |</p>
<table>
<thead>
<tr>
<th>Work Package</th>
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</tbody>
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FIGURE 13

Patient Entry Project Network

FIGURE 14

Patient Entry Time-Phased Work Packages Assigned

FIGURE 15

CEBOO Project Monthly Cash Flow Statement

FIGURE 16

CEBOO Project Weekly Resource Usage Schedule

FIGURE 17

Key Terms

- Heuristic
- Leveling/smoothing
- Multitasking
- Resource-constrained projects
- Resource profile
- Splitting
- Time-constrained projects
THE END