Project Management

Session 8

Time Management

Project Network

Burke Chapter 10
Kerzner Ch. 12
PMBOK Ch. 5
Project Management Objectives

Primary

- Best time
- Least cost
- Best quality
- Least risk

Secondary

- Studying alternatives
- Optimum schedules
- Effective use of resources
- Communications
- Refinement of the estimating process
- Ease of project control
- Ease of time or cost revisions

Limitations

- Calendar completion
- Quality Requirements
- Limited resources
- Management approvals

- Scope Requirements
- Cash or cash flow restrictions
- Legal Requirements
- Management Requirements
Planning and Control Cycle
Practice Effective Time Management
Time Robbers

- Incomplete work
- A job poorly done that must be done over
- Poor communications channels
- Uncontrolled telephone calls
- Lack of adequate responsibility and commensurate authority
- Poor functional performance
- Changes without direct notification/explanation
- Casual visitors
- Waiting for people
- Failure to delegate, or unwise delegation
- Poor retrieval systems
Time Robbers (Continued)

- Lack of information in a ready-to-use format
- Day-to-day administration
- Spending more time than anticipated answering questions
- Lack of sufficient clerical support
- Late appointments
- Impromptu tasks
- Union grievances
- Having to explain “thinking” to superiors
- Too many levels of review
- Too many people in a small area
- Office casual conversations
- Lack of employee discipline
- Lack of qualified manpower
Time Robbers (Continued)

- Misplaced information
- Sorting mail
- Record-keeping
- Shifting priorities
- Indecision or delaying decisions
- Procrastination
- Proofreading correspondence
- Setting up appointments
- Too many meetings
- Monitoring delegated work
- Unclear roles/job descriptions
- Unnecessary crisis intervention
Time Robbers (Continued)

- Overcommitted outside activities
- Executive meddling
- Budget adherence requirements
- Poorly educated customers
- Need to get involved in details to get job done
- Not enough proven or trustworthy managers
- Vague goals and objectives
- Lack of job description
- Too many people involved in minor decision making
- Lack of technical knowledge
- Disorganization of superiors
- Lack of authorization to make judgment decisions
- Poor functional status reporting
Time Robbers (Continued)

- Inability to use one’s full potential
- Overeducated for daily tasks
- Work overload
- Unreasonable time constraints
- Lack of commitment from higher authorities
- Not being responsible for the full scope
- Indecision on the part of higher management
- Too much travel
- Lack of adequate project management tools
- Poor functional communications/writing skills
- Departmental “buck passing”
- Inability to relate to peers in a personal way
Time Robbers (Continued)

- Rush into decisions/beat the deadlines
- Lack of reward ("a pat on the back can do wonders")
- Expecting too much from one’s people and oneself
- Multiple time constraints
- Non-supportive family
- Company political power struggles
- Going from crisis to crisis
- Conflicting directives
- Line management acting as a "father" figure
- Fire drills
- Lack of privacy
- Project manager not involved in decisions
- Bureaucratic roadblocks ("ego")
Time Robbers (Continued)

- Empire-building line managers
- No communication between sales and engineering
- Too much work for one person to handle effectively
- Excessive paperwork
- Lack of clerical/administrative support
- Workload growing faster than capacity
- Reeducating project managers
- Personnel not willing to take risks
- Demand for short-term results
- Lack of long-range planning
- Being over-directed
- Changing company systems, which requires relearning
- Overreacting management
Time Robbers (Continued)

- Poor lead time on projects
- Disregard for company or personal things
- Documentation (reports/red tape)
- Large number of projects
- Inadequate or inappropriate requirements
- Desire for perfection
- Lack of dedication by technical experts
- Poor salary compared to contemporaries
- Lack of project organization
- Constant pressure
- Constant interruptions
- Problems coming in waves
- Severe home constraints
- Project monetary problems
- Shifting of functional personnel
**Time Management Actions**

- Delegate.
- Follow the schedule.
- Decide fast.
- Decide who should attend.
- Learn to say no.
- Start now.
- Do the tough part first.
- Travel light.
- Work at travel stops
- Avoid useless memos.
- Refuse to do the unimportant.
- Look ahead

- Ask: Is this trip necessary?
- Know your energy cycle.
- Control telephone time.
- Send out the meeting agenda.
- Shut off in-house visits.
- Overcome procrastination.
- Manage by exception.
Rules for time management

- Conduct a time analysis (time log).
- Plan solid blocks for important things.
- Classify your activities.
- Establish priorities.
- Establish opportunity cost on activities.
- Train your system (boss, subordinate, peers).
- Practice delegation.
- Practice calculated neglect.
- Practice management by exception.
- Focus on opportunities - not on problems.
Preparing the To-Do Checklist

Questions

- What am I doing that I don’t have to be doing at all?
- What am I doing that can be done better by someone else?
- What am I doing that could be done as well by someone else?
- Am I establishing the right priorities for my activities?
Where do Schedules Come from? Defining Activities

- **Project charter** (planned project start and end date)
- **Detailed scope statement**
- **WBS**
- **Budget information**

- **Triple constraint** (balancing scope, time, and cost goals), reflecting the basic order of first three processes in time management: activity definition, activity sequencing, and activity duration estimating.
Creating a WBS

1. Determine a tree structure or outline format in creating WBS.
2. Determine how many levels of decomposition are appropriate.
3. Determine how the levels of the WBS will be organized.
4. Label level one the project name.
5. At level two, decompose the project into a set of deliverables.
6. For each subsequent level, decompose into smaller components.
7. Create the lowest level of decomposition. This level, called the work package, should be small enough to easily assign to one person to complete. You also will be able to easily create time and cost estimates for this level.
8. Create a unique numerical identifier for each component. The numbering scheme starts at the left of the WBS and works the same as a numeric outline (1.0, 1.1, 1.1.2, etc.).
Activity Sequencing

- Involves reviewing the activities in the detailed WBS, detailed product descriptions, assumptions, and constraints to determine the relationships between activities. It also involves evaluating the reasons for dependencies and the different types of dependencies.

A dependency or relationship shows the sequencing of project activities or tasks. For example,

- Should an activity be finished before another one starts?
- Can several activities be done in parallel?
- Can some overlap?

Basic reasons for creating dependencies among activities.

- Mandatory dependencies
- Discretionary dependencies
- External dependencies
Note: Assume all durations are in days; A=1 means Activity A has a duration of 1 day.

Figure 5-2. Sample Activity-on-Arrow (AOA) Network Diagram for Project X
Network Scheduling Techniques

- Gantt or bar charts
- Milestone charts
- Line of balance

Networks
- Program Evaluation and Review Technique (PERT)
- Arrow Diagram Method (ADM) [Sometimes called the Critical Path Method (CPM)]
- Graphical Evaluation and Review Technique (GERT)
- Precedence Diagram Method (PDM)
A **Gantt chart** is a common tool for displaying project schedule information.

**PERT** analysis is one means for evaluating schedule risk on projects.

**Critical path analysis / method** is a very important tool for developing and controlling project schedules.

**Critical chain scheduling** is a techniques that accounts for resources constraints.
Activity-on-arrow (AOA) or the Arrow Diagramming Method (ADM) is a network diagramming technique in which activities are represented by arrows and connected at points called nodes to illustrate the sequence of activities. A node is simply the starting or ending point of an activity. Bursts occur when a single node is followed by two or more activities. A merge occurs when two or more nodes precede a single node.

The precedence diagramming method (PDM) is a network diagramming technique in which boxes represent activities. It is particularly useful for visualizing certain types of time relationship.
**Activity Duration Estimating**

- **Duration** includes the actual amount of time worked on an activity plus elapsed time. For example, even though it might take one work-week, or five workdays, to perform a certain activity, the duration estimate might be two weeks to allow for someone working only halftime on the activity or someone needing to wait a week to obtain outside information.

- Inputs to duration estimating: detailed activity list and sequencing. Review constraints and assumptions related to the estimates. Historical information is also useful. One important consideration is the availability of resources, especially human resources.
  - What specific skills do people need to do the work?
  - What are the skill levels of the people assigned to the project?
  - How many people are expected to be available to work on the project at any one time?
**Steps to Creating Activity Duration Estimates**

1. Determine if the WBS needs to be decomposed into smaller activities, called an activity list. These activities should be small enough to be assigned to one person.

2. Understand the resource requirements for each activity.

3. Determine whether it would be best to use expert judgment, analogous estimating, or quantitatively based durations for each activity.

4. Determine the proper duration estimate for each activity.

5. Analyze each activity for schedule risk.

6. Determine what type of reserve time you might apply: a work unit or percentage.

7. Add reserve time to each activity where appropriate.
## Task dependencies

The nature of the relationship between two linked tasks. You link tasks by defining a dependency between their finish and start dates. For example, the "Contact caterers" task must finish before the start of the "Determine menus" task. There are four kinds of task dependencies in Microsoft Project:

<table>
<thead>
<tr>
<th>Task dependency</th>
<th>Example</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Finish-to-start (FS)</td>
<td><img src="diagram1.png" alt="Diagram" /></td>
<td>Task (B) cannot start until task (A) finishes.</td>
</tr>
<tr>
<td>Start-to-start (SS)</td>
<td><img src="diagram2.png" alt="Diagram" /></td>
<td>Task (B) cannot start until task (A) starts.</td>
</tr>
<tr>
<td>Finish-to-finish (FF)</td>
<td><img src="diagram3.png" alt="Diagram" /></td>
<td>Task (B) cannot finish until task (A) finishes.</td>
</tr>
<tr>
<td>Start-to-finish (SF)</td>
<td><img src="diagram4.png" alt="Diagram" /></td>
<td>Task (B) cannot finish until task (A) starts.</td>
</tr>
</tbody>
</table>

*Figure 5-3. Task Dependency Types*
Figure 5-5. Gantt Chart for Project X
The black diamond symbol represents a **milestone** – a significant event on a project with zero duration. Milestones are a particularly important part of schedules, and some people use the **SMART criteria** to help define them.

The **SMART criteria** are guidelines suggesting that milestones should be **specific**, **measurable**, **assignable**, **realistic**, and **time-framed**.

You can use Gantt chart to evaluate progress on a project by showing actual schedule information. **Tracking Gantt chart** compares planned and actual project schedule information. The planned schedule dates for activities are called the **baseline dates**.

A white diamond on the tracking Gantt chart represents a **slipped milestone**. A slipped milestone means the milestone was actually reached later than originally planned.
Figure 5-6. Gantt Chart for Software Launch Project
### Task Name

<table>
<thead>
<tr>
<th>Task</th>
<th>March</th>
<th>April</th>
<th>May</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contract Awarded</td>
<td>28</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td><strong>Main Task 1</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Subtask 1.1</td>
<td>9</td>
<td>12</td>
<td>15</td>
</tr>
<tr>
<td>Subtask 1.2</td>
<td>18</td>
<td>21</td>
<td>24</td>
</tr>
<tr>
<td>Subtask 1.3</td>
<td>27</td>
<td>30</td>
<td>2</td>
</tr>
<tr>
<td>Deliverable 1</td>
<td></td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td><strong>Main Task 2</strong></td>
<td>11</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Subtask 2.1</td>
<td></td>
<td>8</td>
<td>11</td>
</tr>
<tr>
<td>Subtask 2.2</td>
<td></td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Deliverable 2</td>
<td></td>
<td>20</td>
<td>23</td>
</tr>
<tr>
<td>Main Task 3</td>
<td></td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>Project Review 1</td>
<td>2</td>
<td>5</td>
<td>6</td>
</tr>
<tr>
<td>Project Review 2</td>
<td>11</td>
<td>14</td>
<td>17</td>
</tr>
<tr>
<td>Final Report and Presentation</td>
<td>14</td>
<td>14</td>
<td>17</td>
</tr>
</tbody>
</table>

**Figure 5-7. Sample Tracking Gantt Chart**
Milestone Chart

ACTIVITY
TESTING
ANALYSIS
REPORT
PRESENTATION

TIME
Standard CPM/PERT Nomenclature

LEGEND

EVENT

ACTIVITY

COMPLETE TESTING

COMPLETE FINAL REPORT

6

3 WEEKS

3
Dependencies

BURST POINT

SINK
Conversion From Bar To PERT

**BAR CHART**

1 2
3 4 5
6 7

**PERT CHART**

1 3 2
1 2 2
1 2 2
2 2 2
1 4

TIME
Simplified PERT Network

LEGEND: (TIME = WEEKS)

- EVENT
- ACTIVITY
- CRITICAL PATH ACTIVITY
Critical path method (CPM) – also called critical path analysis – is a project network analysis technique used to predict total project duration. It is an important tool that helps you combat project schedule overruns. A critical path for a project is the series of activities that determine the earliest time by which the project can be completed. It is the longest path through the network diagram and has the least amount of slack or float.

Slack or float is the amount of time an activity may be delayed without delaying a succeeding activity or the project finish date. Free slack or free float is the amount of time an activity can be delayed without delaying the early start of any immediately following activities.
Schedule Development - Critical Path Method

Note: Assume all durations are in days.

Path 1: A-D-H-J Length = 1+4+6+3 = 14 days
Path 2: B-E-H-J Length = 2+5+6+3 = 16 days
Path 3: B-F-J Length = 2+4+3 = 9 days
Path 4: C-G-I-J Length = 3+6+2+3 = 14 days

Since the critical path is the longest path through the network diagram, Path 2, B-E-H-J, is the critical path for Project X.

Figure 5-8. Determining the Critical Path for Project X
 Dummy Activities

Dummy Activities

ACTIVITY | PRECEDING ACTIVITY
---|---
A | -
B | -
C | B
D | A,B
NETWORK FOR HOUSE CONSTRUCTION

HOW CAN YOU TELL THAT THIS IS A PERT/CPM OR PRECEDENCE NETWORK?
Using Critical Path Analysis to Make Schedule Trade-Offs

- The **early start date** for an activity is the earliest possible time an activity can start based on the project network logic. **Total slack** or **total float** is the amount of time an activity may be delayed from its early start without delaying the planned project finish date. You calculate free slack and total slack by doing a forward and backward pass through a network diagram.

- A **forward pass** determines the early start and early finish dates for each activity. The **early finish date** for an activity is the earliest possible time an activity can finish based on the project network logic.

- A **backward pass** through the network diagram determines the late start and late finish dates for each activity in a similar fashion. The **late start date** for an activity is the latest possible time an activity might begin without delaying the project finish date. The **late finish date** for an activity is the latest possible time an activity can be completed without delaying the project finish date.
Slack Identification

ACTIVITY

C (8,10)

2 (15,17)

EARLIEST START TIME

EARLIEST FINISH TIME

LATEST FINISH TIME

LATEST START TIME

TIME
Types Of Slack

[ 20, 26 ]
[ 24, 30 ]

POSITIVE SLACK

[ 30, 36 ]
[ 24, 30 ]

NEGATIVE SLACK
Negative Slack

FORWARD PASS

CUSTOMER’S CUSTOMER’S
START DATE FINISH DATE

BACKWARD PASS

1 2 3 4
PROJECT NETWORK TECHNIQUES (PNT)

PERT
- Probabilistic approach
- Based on three time estimates:
  - An optimistic time
  - A most likely time
  - A pessimistic time
- Develops an expected time (TE) for each activity

CPM
- Deterministic approach
- Activity-on-arrow (A-O-A)
- Event-Oriented

TYPICAL USES
- Construction projects
- Engineering projects

1956

1960

1970
Program Evaluation and Review Technique (PERT)

- Another project time management technique is the Program Evaluation and Review Technique (PERT) – a network analysis technique used to estimate project duration where there is a high degree of uncertainty about the individual activity duration estimates. PERT applies the critical path method to a weighted average duration estimate.

- PERT uses probabilistic time estimates – duration estimates based on using optimistic, most likely, and pessimistic estimates of activity duration – instead of one specific or discrete duration estimate.

\[
\text{optimistic time} + 4 \times \text{most likely time} + \text{pessimistic time} \\
\text{PERT weighted average} = \frac{\text{optimistic time} + 4 \times \text{most likely time} + \text{pessimistic time}}{6}
\]
Resource Allocation

- Resource allocation (or resource limited planning) is an attempt to find the shortest possible critical path based upon the available or fixed resources.

- The problem with this approach is that the employees may not be qualified technically to perform work on more than one activity in a network.
Resource Leveling

- Resource leveling is an attempt to eliminate the manpower peaks and valleys by smoothing out the period-to-period resource requirements. The ideal situation is to do this without changing the end date. However, in reality, the end date moves out and additional costs are incurred.
Techniques for Shortening a Project Schedule

- **Crashing** is a technique for making cost and schedule trade-offs to obtain the greatest amount of schedule compression for the least incremental cost.

- **Fast tracking** involves doing activities in parallel that you would normally do in sequence.
Schedule Compression

- Elimination of some parts of the project
- Addition of more resources
- Substitution of less time-consuming components/activities
- Parallelization of activities
- Shortening critical path activities
- Shortening early activities
- Shortening longest activities
- Shortening easiest activities
- Shortening activities that are least costly to speed up
- Shortening activities for which you have more resources
- Increasing the number of work hours per day
Program Crashing Costs

- All Activities Crashed
- Minimum Cost
- Total Crash

- Crash A
- Crash B
- Crash E
- Crash F

Normal Operations

Program Cost, $

Program Completion Time, Weeks
Precedence Network

MONTHS AFTER GO-AHEAD

<table>
<thead>
<tr>
<th>TASKS</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Types Of Precedence Charts

**ACTIVITY 1**

- **FINISH-TO-START**
  - **FINISH**
  - **ACTIVITY 1**
  - **START**

- **START-TO-START**
  - **START**
  - **ACTIVITY 1**
  - **START**

**ACTIVITY 2**

- **START**
  - **ACTIVITY 2**
  - **FINISH**
Types Of Precedence Charts

FINISH-TO-FINISH

ACTIVITY 1

ACTIVITY 2

PERCENT COMPLETE

ACTIVITY 1

50%

ACTIVITY 2

20%

FINISH
Figure 5-4. Sample Precedence Diagramming Method (PDM) Network Diagram for Project X
<table>
<thead>
<tr>
<th>EARLY START</th>
<th>TIME DURATION</th>
<th>EARLY FINISH</th>
</tr>
</thead>
<tbody>
<tr>
<td>01/06/97</td>
<td>2 WORK-WEEKS</td>
<td>14/06/97</td>
</tr>
<tr>
<td>ACTIVITY 4</td>
<td>TOTAL SLACK(TS)</td>
<td>$250,000</td>
</tr>
<tr>
<td></td>
<td>FREE SLACK (FS)</td>
<td></td>
</tr>
<tr>
<td>LATE START</td>
<td>COST/PROFIT</td>
<td>LATE FINISH</td>
</tr>
<tr>
<td>15/06/97</td>
<td>CENTER 2810</td>
<td>28/06/97</td>
</tr>
</tbody>
</table>
Controlling Changes to the Project Schedule

Reality checks on scheduling

- The project manager should review the draft schedule usually included in the project charter.
- The project manager and his or her team should prepare a more detailed schedule and get stakeholders’ approval.
- Another type of reality check comes from progress meetings with stakeholders. The project manager is responsible for keeping the project on track, and key stakeholders like to stay informed, often through high-level periodic reviews.

Working with people issues

Several leadership skills that help project managers control schedule changes include:
- Empowerment
- Incentives
- Discipline
- Negotiation
Planning and Control Cycle

Scope of work
WBS - BOM

CPM Network Diagram

Procurement Schedule

Resource Histogram

Cash-flow Statement

Purpose of Project

Activity Number | Mon 1 | Tue 2 | Wed 3 | Thu 4 | Fri 5 | Sat 6 | Sun 7 | Mon 8 | Tue 9 | Wed 10 | Responsibility
--- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | ---
100 | | | | | | | | | | | Tony
300 | | | | | | | | | | | Emelie
200 | | | | | | | | | | | Miriam
500 | | | | | | | | | | | Norma
400 | | | | | | | | | | | Dennis
600 | | | | | | | | | | | Raymond

Data Capture

Revised Plan

Project Control

Earned Value Report
### Table 1: Logic Table and Activity Data

<table>
<thead>
<tr>
<th>Preceding Activity</th>
<th>Succeeding Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>400</td>
</tr>
<tr>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>400</td>
<td>700</td>
</tr>
<tr>
<td>500</td>
<td>800</td>
</tr>
<tr>
<td>600</td>
<td>800</td>
</tr>
<tr>
<td>700</td>
<td>800</td>
</tr>
<tr>
<td>800</td>
<td>Finish</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Activity</th>
<th>Duration</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>2</td>
</tr>
<tr>
<td>200</td>
<td>3</td>
</tr>
<tr>
<td>300</td>
<td>6</td>
</tr>
<tr>
<td>400</td>
<td>2</td>
</tr>
<tr>
<td>500</td>
<td>5</td>
</tr>
<tr>
<td>600</td>
<td>7</td>
</tr>
<tr>
<td>700</td>
<td>3</td>
</tr>
<tr>
<td>800</td>
<td>1</td>
</tr>
</tbody>
</table>
**Activity Box**

ES = Early Start
000 = Activity Number
F = Float
LS = Late Start

EF = Early Finish
DUR = Duration
LF = Late Finish

**Logic Diagram**

Start

100
F DUR
LS LF

Finish

200
F DUR
LS LF

**Table 2: Logic Table**
(extract from table 1)

<table>
<thead>
<tr>
<th>Preceding Activity</th>
<th>Succeeding Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Start</td>
<td>100</td>
</tr>
<tr>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td>100</td>
<td>300</td>
</tr>
<tr>
<td>100</td>
<td>400</td>
</tr>
</tbody>
</table>
Activity 100 is drawn first, because this is the start activity, the other three activities (200, 300, 400) follow, finish-to-start (see figure 3).

Figure 3: Network Diagram
Step 2: The next three lines from the logic table 1 are (table 3):

<table>
<thead>
<tr>
<th>Preceding Activity</th>
<th>Succeeding Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>200</td>
<td>500</td>
</tr>
<tr>
<td>300</td>
<td>600</td>
</tr>
<tr>
<td>400</td>
<td>700</td>
</tr>
</tbody>
</table>

Table 3: Logic Table  
(extract from table 1)

This means that activity 500 follows 200, activity 600 follows 300 and activity 700 follows 400 (figure 4).

Figure 4: Network Diagram
Step 3: The last four lines of the logic table 1 are (table 4):

Table 4: Logic Table  
(extract from table 1)
Figure 6: Network Diagram
Figure 8: Network Diagram
Figure 9: Network Diagram
Figure 11: Network Diagram