Chapter 6:
Project Schedule Management

Learning Objectives

- Illustrate the importance that project schedules and good project schedule management can have in helping to make projects successful
- Discuss the process of planning schedule management
- Define activities as the basis for developing project schedules
- Describe how project managers use network diagrams and dependencies to assist in activity sequencing
- Explain how various tools and techniques help project managers perform activity duration estimates
- Use a Gantt chart for planning and tracking schedule information, find the critical path for a project, and describe how critical chain scheduling and the Program Evaluation and Review Technique (PERT) affect schedule development
- Compare how schedule management is addressed using Agile vs. more predictive project approaches
- Discuss how reality checks and discipline are involved in controlling and managing changes to the project schedule
- Describe how project management software can assist in project schedule management and review words of caution before using this software
- Discuss considerations for agile/adaptive environments

The Importance of Project Schedules

- Managers often cite delivering projects on time as one of their biggest challenges
  - Time has the least amount of flexibility; it passes no matter what happens on a project
- Individual work styles and cultural differences may also cause schedule conflicts
  - Different cultures and even entire countries have different attitudes about schedules
- Project time management processes
  - Planning schedule management
  - Defining activities
  - Sequencing activities
  - Estimating activity resources
  - Estimating activity durations
  - Developing the schedule
  - Controlling the schedule

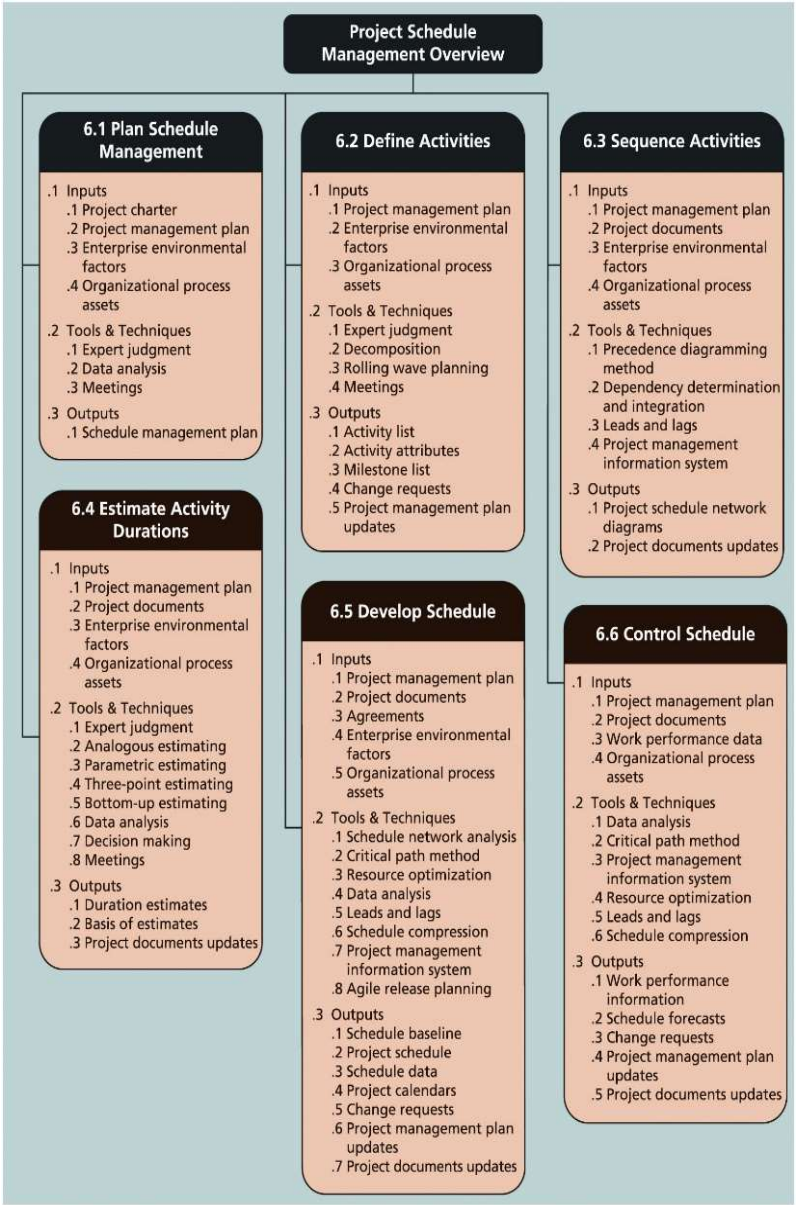


FIGURE 6-1 Project schedule management overview

Planning Schedule Management

- Elements of a schedule management plan
  - Project schedule model development
  - Scheduling methodology
  - Level of accuracy and units of measure
  - Control thresholds
  - Rules of performance measurement
  - Reporting formats
  - Process descriptions

Defining Activities

Defining activities involves identifying the specific actions that will produce the project deliverables in enough detail to determine resource and schedule estimates

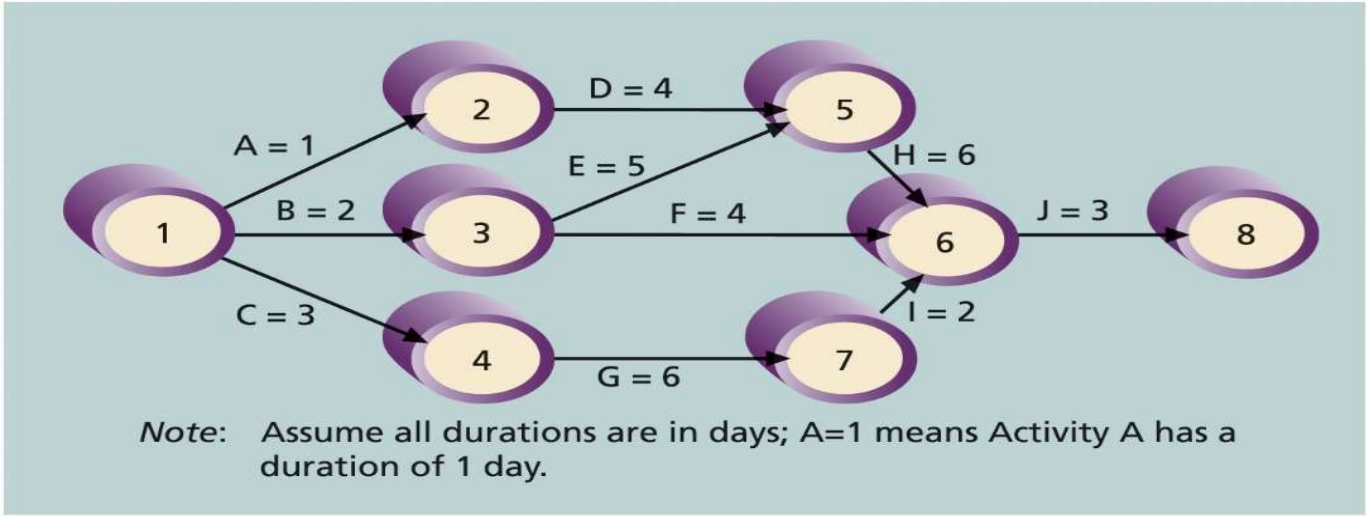
- Activity list: a tabulation of activities to be included on a project schedule
  - Activity name, activity identifier or number, and brief description of the activity
- Activity attributes provide more information
  - Predecessors, successors, logical relationships, leads and lags, resource requirements, constraints, imposed dates, and assumptions related to the activity

A milestone is a significant event that normally has no duration

- It often takes several activities and a lot of work to complete a milestone
- They're useful tools for setting schedule goals and monitoring progress
  - Examples: obtaining customer sign-off on key documents or completion of specific products

Sequencing Activities (1 of 3)

- Sequencing process involves evaluating the reasons for dependencies and the different types of dependencies
  - A dependency or relationship is the sequencing of project activities or tasks
    - Mandatory dependencies: inherent in the nature of the work being performed on a project, sometimes referred to as hard logic
    - Discretionary dependencies: defined by the project team, sometimes referred to as soft logic. and should be used with care since they may limit later scheduling options
    - External dependencies: involve relationships between project and non-project activities
- Network diagrams are the preferred technique for showing activity sequencing
  - Schematic display of the logical relationships among, or sequencing of, project activities
  - Two main formats are the arrow and precedence diagramming methods



Sequencing Activities (2 of 3)

Arrow diagramming method (ADM) (i.e., activity-on-arrow network diagrams)

- Activities are represented by arrows
- Nodes or circles are the starting and ending points of activities
- Only show finish-to-start dependencies
- Refer to the text for the step-by-step process of creating AOA diagrams

Precedence diagramming method (PDM)

- Network diagramming technique in which boxes represent activities

Types of dependencies or relationships between activities

- Finish-to-start
- Start-to-start
- Finish-to-finish
- Start-to-finish

Sequencing Activities (3 of 3)

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.

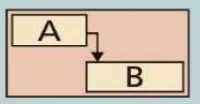
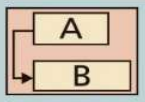
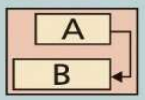
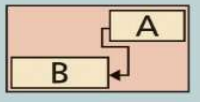
Task dependency	Example	Description
Finish-to-start (FS)		Task (B) cannot start until task (A) finishes.
Start-to-start (SS)		Task (B) cannot start until task (A) starts.
Finish-to-finish (FF)		Task (B) cannot finish until task (A) finishes.
Start-to-finish (SF)		Task (B) cannot finish until task (A) starts.

FIGURE 6-3 Task dependency types

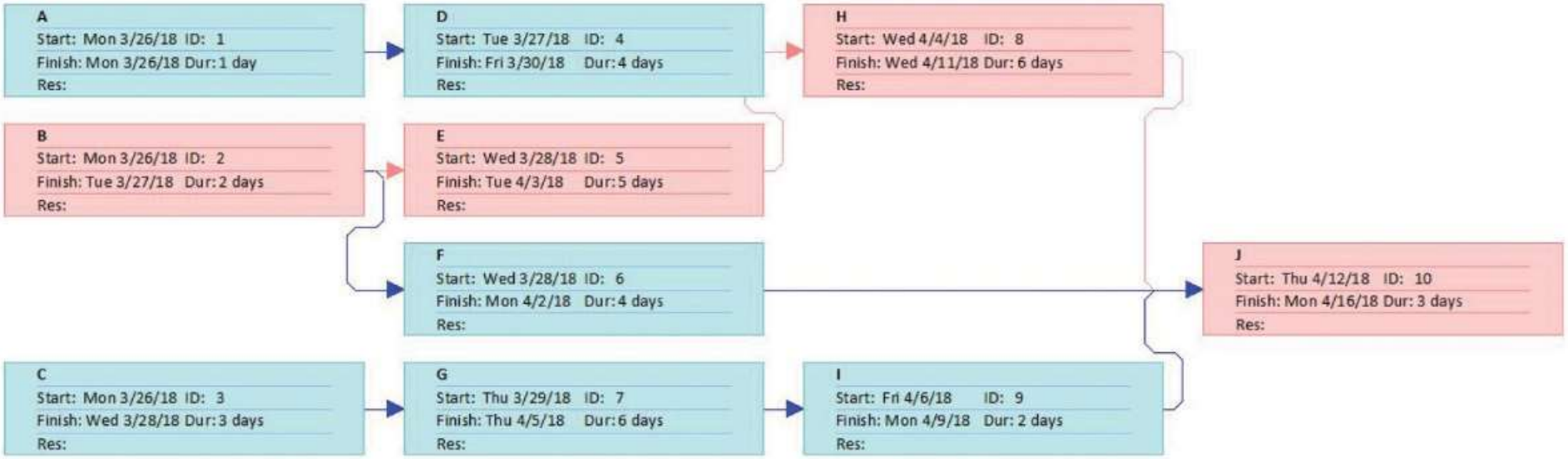


FIGURE 6-4 Precedence diagramming methods (PDM) network diagram for project X

Estimating Activity Durations

Duration includes the actual amount of time worked on an activity plus elapsed time

Effort is the number of workdays or work hours required to complete a task and does not normally equal duration

People doing the work should help create estimates

An expert should review them

A three-point estimate is an estimate that includes an optimistic, most likely, and pessimistic estimate

Three-point estimates are needed for PERT and Monte Carlo simulations

Advice for Young Professionals

- Some people find estimating to be challenging, especially for their own work
  - It is very important to develop this skill
    - Practice estimating how long it takes you to do different activities and then take actual measurements
    - Define the activity in detail to help make better estimates
    - If you realize that an activity estimate might not be a good one, let your team know as soon as possible so that adjustments can be made early in the project

Developing the Schedule

Uses results of the other time management processes to determine the start and end date of the project

- Ultimate goal is to create a realistic project schedule that provides a basis for monitoring project progress for the time dimension of the project

Important tools and techniques

- Gantt charts
- Critical path analysis
- Critical chain scheduling
- PERT analysis

Gantt Charts (1 of 4)

- Provide a standard format for displaying project schedule information by listing project activities and corresponding start and finish dates in a calendar form
  - Symbols
    - Black diamond: milestones
    - Thick black bars: summary tasks
    - Light gray horizontal bars: durations of tasks
    - Arrows: dependencies between tasks

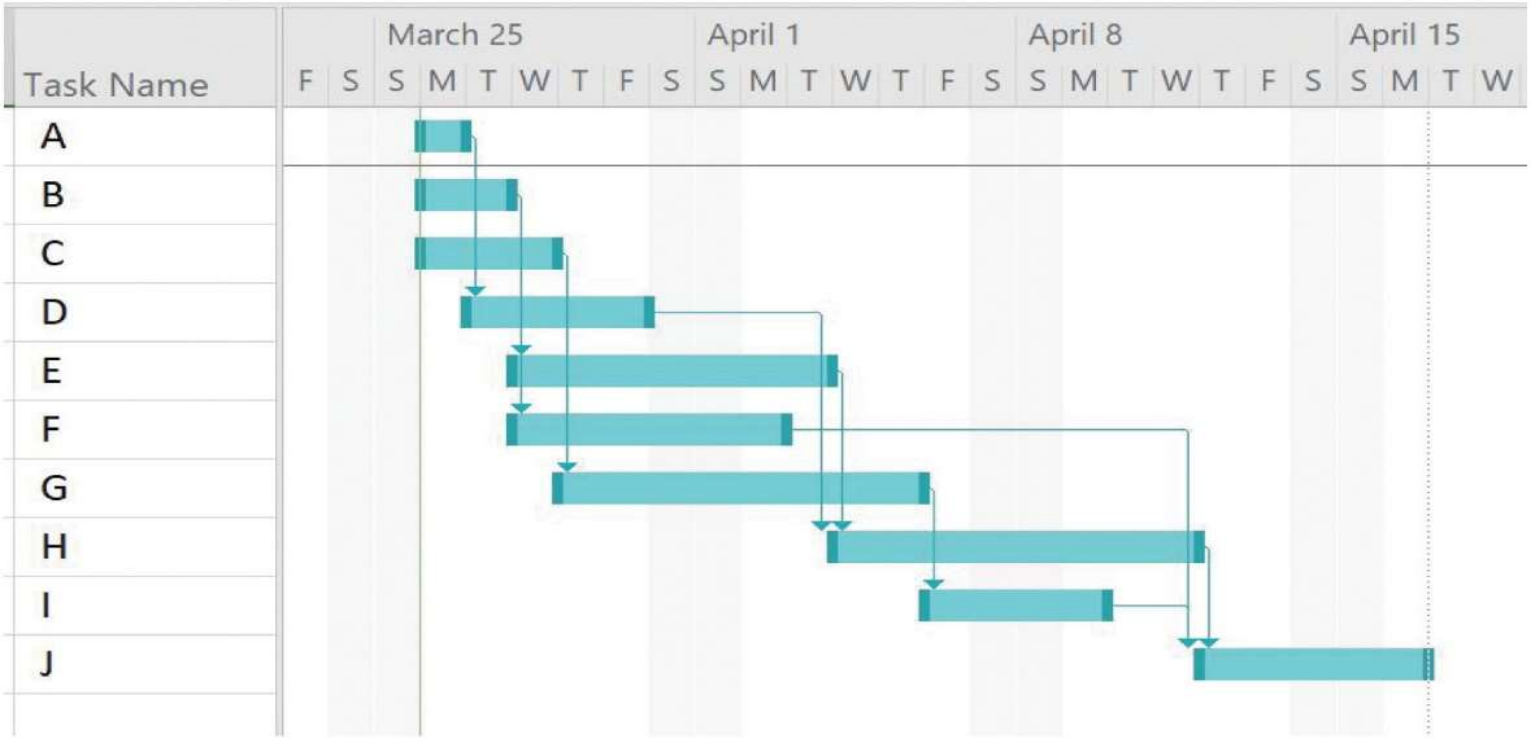


FIGURE 6-5 Gantt chart for project X

Gantt Charts (2 of 4)

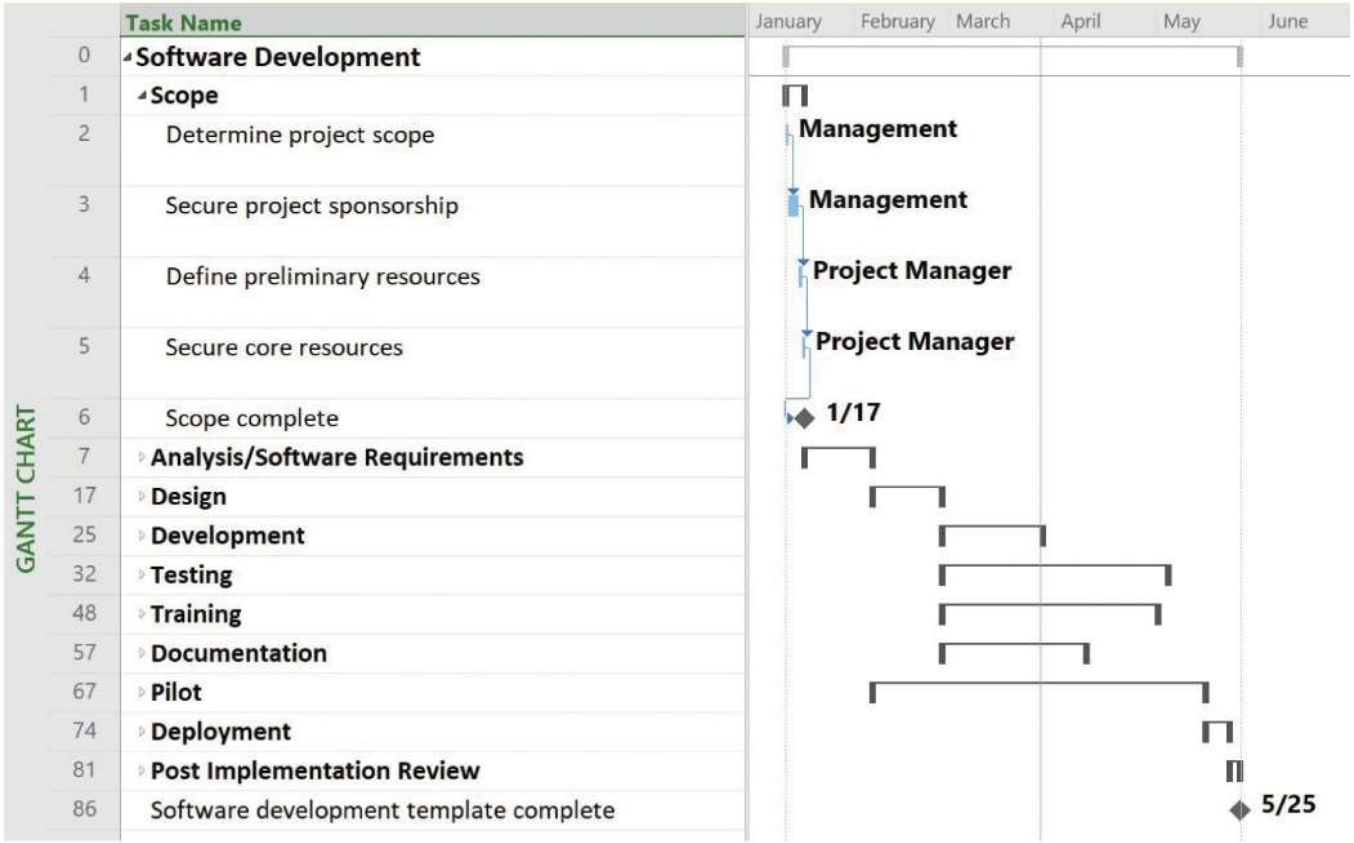


FIGURE 6-6 Gantt chart for software launch project

Gantt Charts (3 of 4)

Adding milestones to Gantt charts

- Many people like to focus on meeting milestones, especially for large projects
  - Milestones emphasize important events or accomplishments on projects

SMART Criteria for milestones

- Specific
- Measurable
- Assignable
- Realistic
- Time-framed

Gantt Charts (4 of 4)

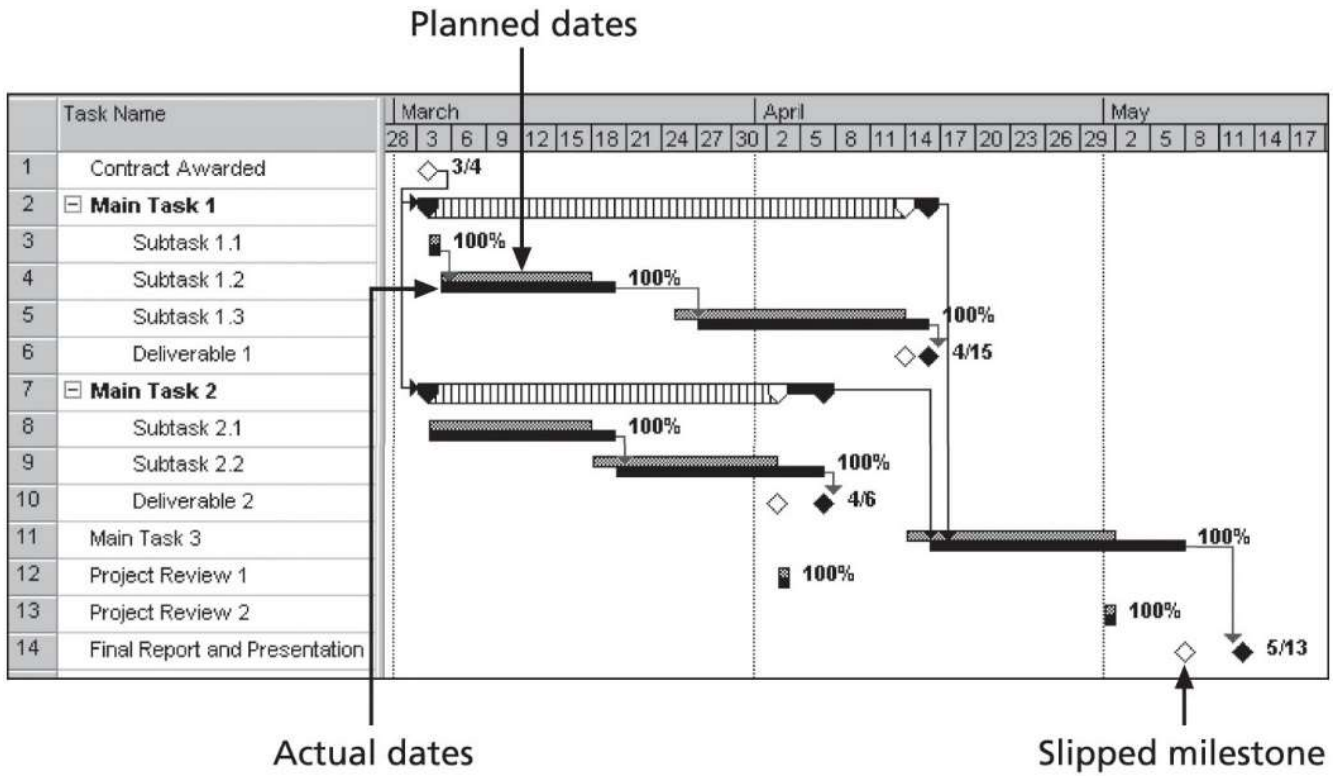


FIGURE 6-7 Sample tracking Gantt chart

Critical Path Method (CPM)

Network diagramming technique used to predict total project duration

Critical path: series of activities that determine the earliest time by which the project can be completed

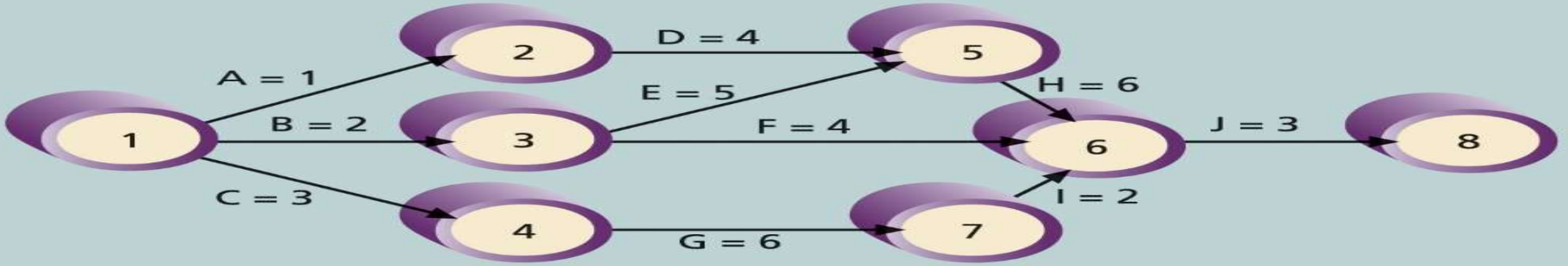
- The longest path through the network diagram and has the least amount of slack or float; amount of time an activity may be delayed without delaying a succeeding activity or the project finish date

Calculating the critical path

Develop a good network diagram and add the duration estimates for all activities on each path through the network diagram

- **Longest path is the critical path**

If one or more of the activities on the critical path takes longer than planned, the whole project schedule will slip unless the project manager takes corrective action



Note: Assume all durations are in days.

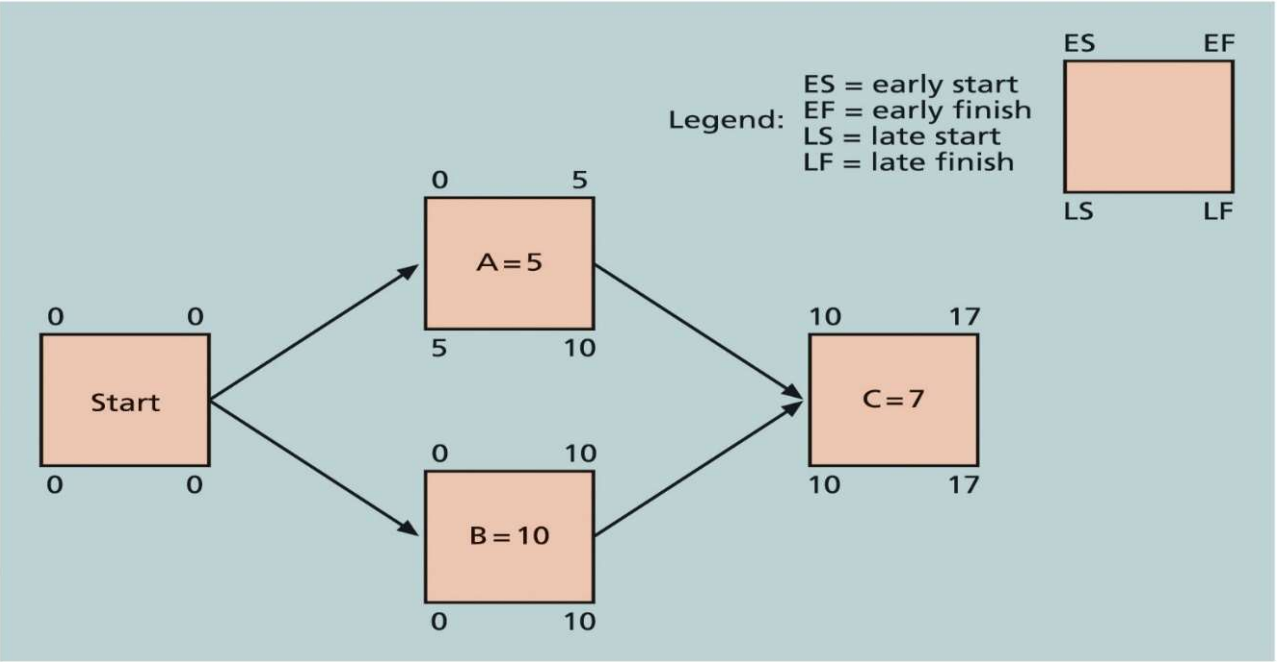
Path 1:	A-D-H-J	Length = 1+4+6+3 = 14 days
Path 2:	B-E-H-J	Length = 2+5+6+3 = 16 days
Path 3:	B-F-J	Length = 2+4+3 = 9 days
Path 4:	C-G-I-J	Length = 3+6+2+3 = 14 days

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 6-8 Determining the critical path for project X

Using Critical Path Analysis to Make Schedule Trade-Offs (1 of 2)

- Free slack or free float
  - *Amount of time an activity can be delayed without delaying the early start of any immediately following activities*
- Total slack or total float
  - *Amount of time an activity may be delayed from its early start without delaying the planned project finish date*
- Forward pass
  - Determines the early start and finish dates
- Backward pass
  - Determines the late start and finish dates



Using Critical Path Analysis to Make Schedule Trade-Offs (2 of 2)

Task Name	Start	Finish	Late Start	Late Finish	Free Slack	Total Slack
A	8/3/23	8/3/23	8/5/23	8/5/23	0d	2d
B	8/3/23	8/4/23	8/3/23	8/4/23	0d	0d
C	8/3/23	8/5/23	8/5/23	8/7/23	0d	2d
D	8/4/23	8/7/23	8/6/23	8/11/23	2d	2d
E	8/5/23	8/11/23	8/5/23	8/11/23	0d	0d
F	8/5/23	8/10/23	8/14/23	8/17/23	7d	7d
G	8/6/23	8/13/23	8/10/23	8/17/23	0d	2d
H	8/12/23	8/19/23	8/12/23	8/19/23	0d	0d
I	8/14/23	8/17/23	8/18/23	8/19/23	2d	2d
J	8/20/23	8/24/23	8/20/23	8/24/23	0d	0d

Table 6-1 Free and Total Float or Slack for Project X

Using the Critical Path to Shorten a Project Schedule

Main techniques for shortening schedules

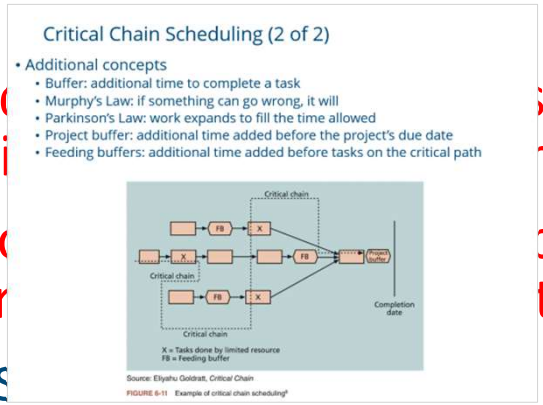
- Shortening durations of critical activities/tasks by adding more resources or changing their scope
- Crashing activities by obtaining the greatest amount of schedule compression for the least incremental cost
- Fast tracking activities by doing them in parallel or overlapping them

Importance of Updating Critical Path Data

- It is important to update the schedule with actual data
- Note actual activity durations as they are completed
- Revise estimates for activities in progress
- Monitor changes to make informed decisions

Critical Chain Scheduling (1 of 2)

- Is a metho… …source-levelling. Although dependent tasks mostly defi… …nes, the resource utilization plays a key role.
- A methodo… …path may be highly successful in environments, where ther… …tage.
- Considers… … when creating a project schedule and includes buffers to protect the project completion date
- For example, a project manager may push back the start of one task so that a skilled worker is not scheduled to perform two tasks at once.



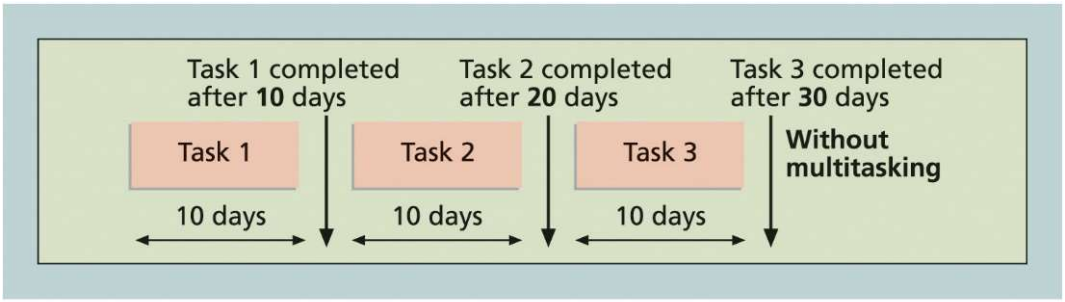


FIGURE 6-10a Three tasks without multitasking

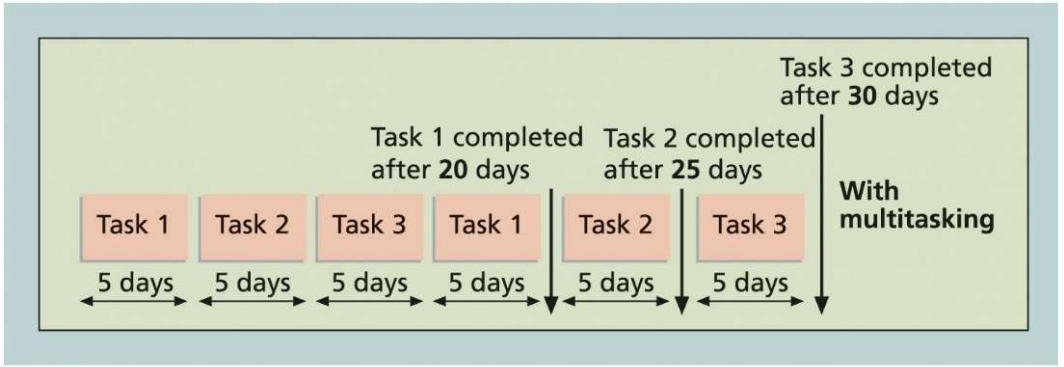
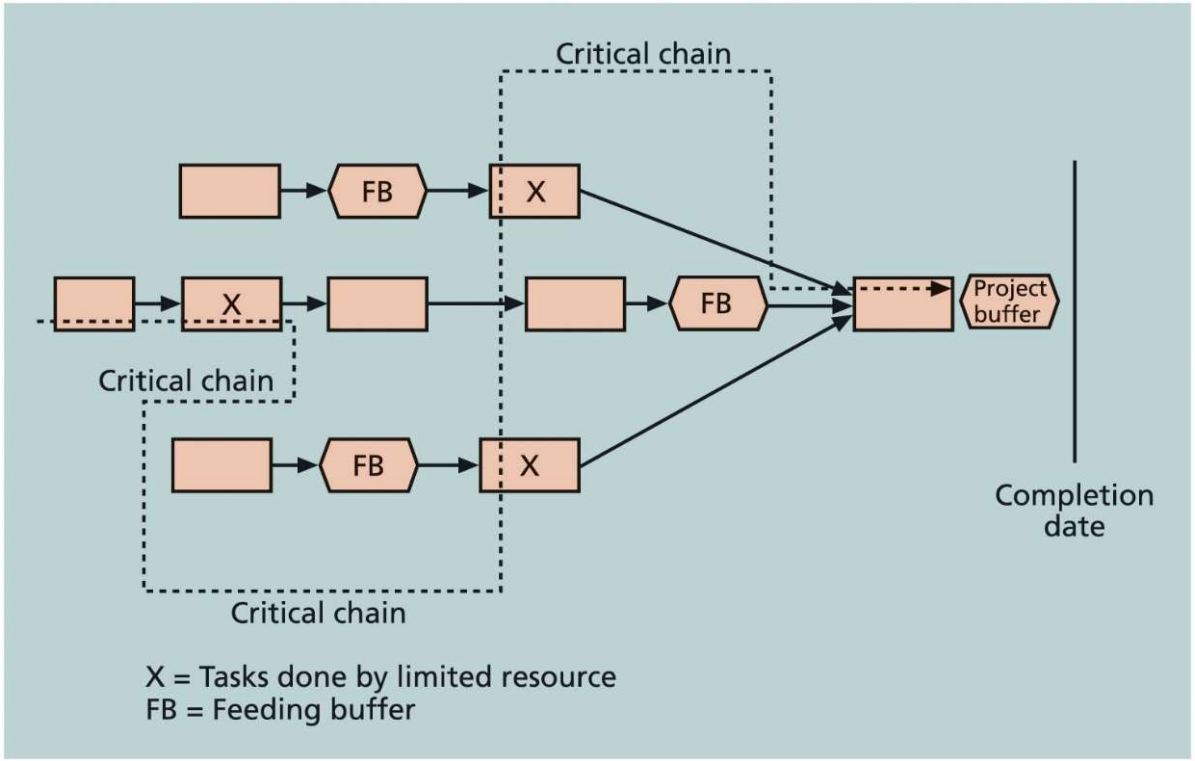


FIGURE 6-10b Three tasks with multitasking

Critical Chain Scheduling (2 of 2)

- Additional concepts
  - Buffer: additional time to complete a task
  - Murphy's Law: if something can go wrong, it will
  - Parkinson's Law: work expands to fill the time allowed
  - Project buffer: additional time added before the project's due date
  - Feeding buffers: additional time added before tasks on the critical path



Source: Eliyahu Goldratt, *Critical Chain*

FIGURE 6-11 Example of critical chain scheduling[8]

Program Evaluation and Review Technique (PERT)

PERT is an important tool used in project management. It is used to identify task dependencies and critical paths, plan resources, estimate task duration, and identify potential risks. It also helps to define and sequence activities, coordinate resources, and track progress.

The PERT weighted averages formula is (optimistic time + 4 * most likely time + pessimistic time)/6

Network analysis technique used to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates

Uses probabilistic time estimates: duration estimates based on using optimistic, most likely, and pessimistic estimates of activity durations	By using the PERT weighted average for each activity duration estimate, total project duration estimate takes into account the risk or uncertainty in the individual activity estimates

Agile and Schedule Management

Core values of the Platform for Agile Software Development

- Customer collaboration over contract negotiation
- Responding to change over following a plan

Example: product owner defines and prioritizes the work to be done within a sprint

- Collaboration and time management are designed into the process

Controlling the Schedule

Goals of schedule control

- Know the status of the schedule
- Influence the factors that cause schedule changes
- Determine that the schedule has changed
- Manage changes when they occur

Main inputs to schedule control

- Project management plan
- Project documents
- Work performance data
- Organizational process assets

Reality Checks on Scheduling and the Need for Discipline

- *Important activities*
  - Review the draft schedule or estimated completion date in the project charter
  - Prepare a more detailed schedule with the project team
  - Make sure the schedule is realistic and followed
  - Alert top management well in advance if there are schedule problems

Using Software to Assist in Project Schedule Management

- Software for facilitating communications helps people exchange schedule-related information
  - Decision support models help analyze trade-offs that can be made to address schedule issues
  - Project management software can help in various time management areas

Words of Caution on Using Project Management Software

Many people misuse project management software because they don't understand important concepts and have not had training

- Example: dependencies must be entered to have dates adjust automatically and to determine the critical path

Many project management software programs come with templates or sample files

- It is very easy to use these files without considering unique project needs
- Project managers and their teams should be careful not to rely too much on templates or sample files and ignore the unique concerns of their particular projects

Considerations for Agile/Adaptive Environments

Schedule management is radically different using Agile and Scrum

Unlike traditional project management, there is not one, detailed plan published as an approved document for review in the Agile method. The development team determines what work gets done during the sprint

Projects that rely heavily on the critical path method consider meeting the project's estimated completion date as a crucial component of success

Agile projects may not even need to estimate activity durations or project schedules at all; overall project completion time is not important

Chapter Summary

Project time management is often cited as the main source of conflict on projects

Most IT projects exceed time estimates

Main processes

Plan schedule management

Define activities

Sequence activities

Estimate activity resources

Estimate activity durations

Develop schedule

Control schedule