Chapter 6: Project Schedule Management

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Note: See the text itself for full citations

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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
- Schedule issues are the main reason for conflicts on projects, especially during the second half of projects

Project Time Management Processes

1. **Planning schedule management :** determining the policies, procedures, and documentation that will be used for planning, executing, and controlling the project schedule
2. **Activity definition**: identifying the specific activities/tasks that the project team members and stakeholders must perform to produce the project deliverables
3. **Activity sequencing**: identifying and documenting the relationships between project activities
4. **Activity resource estimating**: estimating how many **resources** a project team should use to perform project activities
5. **Activity duration estimating**: estimating the number of work periods that are needed to complete individual activities
6. **Schedule development**: analyzing activity sequences, activity resource estimates, and activity duration estimates to create the project schedule
7. **Schedule control**: controlling and managing changes to the project schedule

Project Time Management Summary

1. Planning Schedule Management

- The project team uses expert judgment, analytical techniques, and meetings to develop the schedule management plan.
- The schedule management plan, like the scope management plan, can be informal and broad or formal and detailed, based on the needs of the project.
- A schedule management plan includes the following information: project schedule model development, the scheduling methodology and the scheduling tool to use when developing the project schedule model, level of accuracy and unit of measure. hr, days, months

2. Defining Activities

- The project team reviews the schedule management plan, scope baseline, enterprise environmental factors, and organizational process assets to begin defining activities. Outputs of this process include an activity list, activity attributes, a milestone list, and project management plan updates.

- The goal of defining activities is to ensure that the project team completely understands all the work it must do as part of the project scope so the team can start scheduling the work.

2. Defining Activities: Milestones

- A **milestone** is a *significant* event that normally has no duration
  - Not every deliverable or output created for a project is a milestone
- 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 include obtaining customer sign-off on key documents or completion of specific products such as software modules or the installation of new hardware

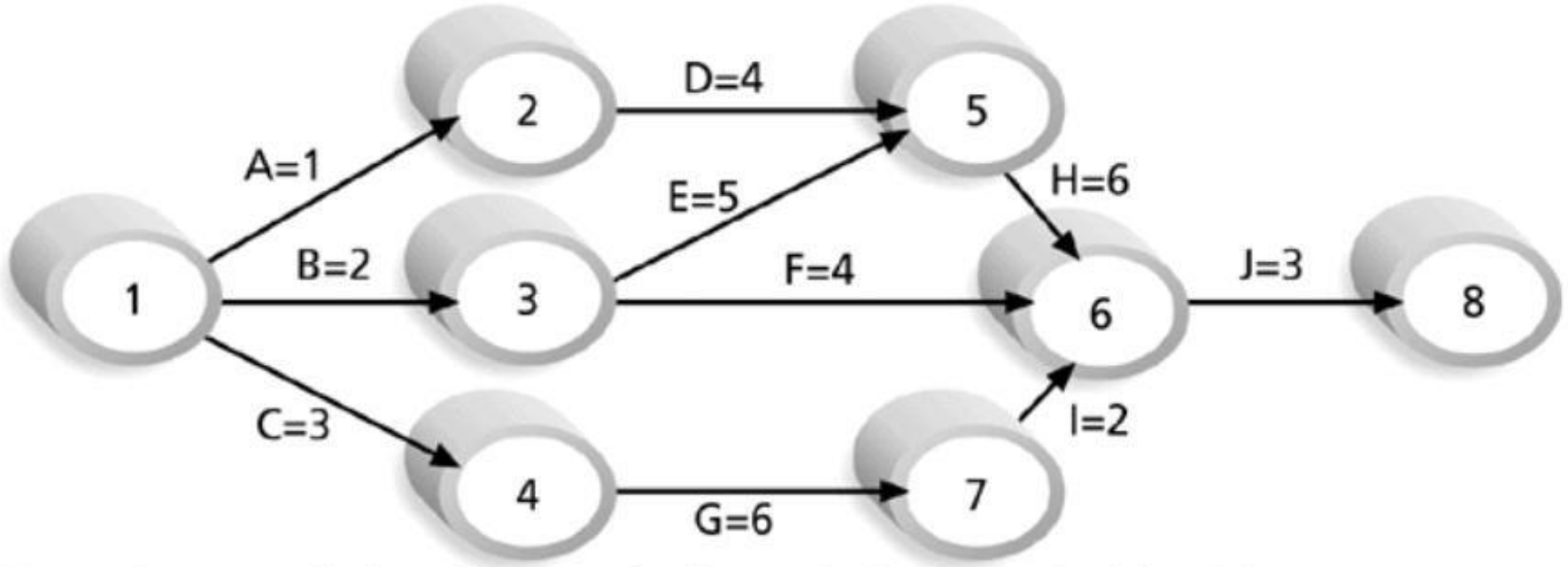
3. Sequencing Activities

- After defining project activities, the next step in project time management is sequencing them or determining their dependencies.
- A dependency or relationship pertains to the sequencing of project activities or tasks.
- Three basic reasons for creating dependencies among project activities: mandatory dependencies, discretionary dependencies, external dependencies.

3. Sequencing Activities: Network Diagrams

- Network diagrams are the preferred technique for showing activity sequencing
- A **network diagram** is a schematic *display of the logical relationships* among, or sequencing of, project activities
- Two main formats are:
    - arrow diagramming methods
    - precedence diagramming methods

Sample Activity-on-Arrow (AOA) Network Diagram for Project X



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

Arrow Diagramming Method (ADM)

- Also called activity-on-arrow (AOA) network diagrams
- Activities are represented by arrows
- Nodes or circles are the starting and ending points of activities
- Can only show finish-to-start dependencies
- Can omit activities that have no dependencies

Process for Creating AOA Diagrams

1. Find all of the activities that start at node 1: Draw their finish nodes and draw arrows between node 1 and those finish nodes; put the activity letter or name and duration estimate on the associated arrow
2. Continue drawing the network diagram, working from left to right: Look for bursts and merges
   - **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
3. Continue drawing the project network diagram until all activities are included on the diagram that have dependencies
4. As a rule of thumb, all arrowheads should face toward the right, and no arrows should cross on an AOA network diagram

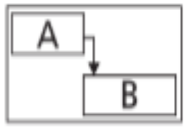
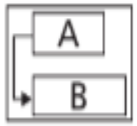
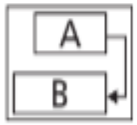
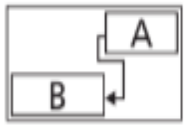
Precedence Diagramming Method (PDM)

- Activities are represented by boxes
- Arrows show relationships between activities
- More popular than ADM method and used by project management software
- Better at showing different types of dependencies

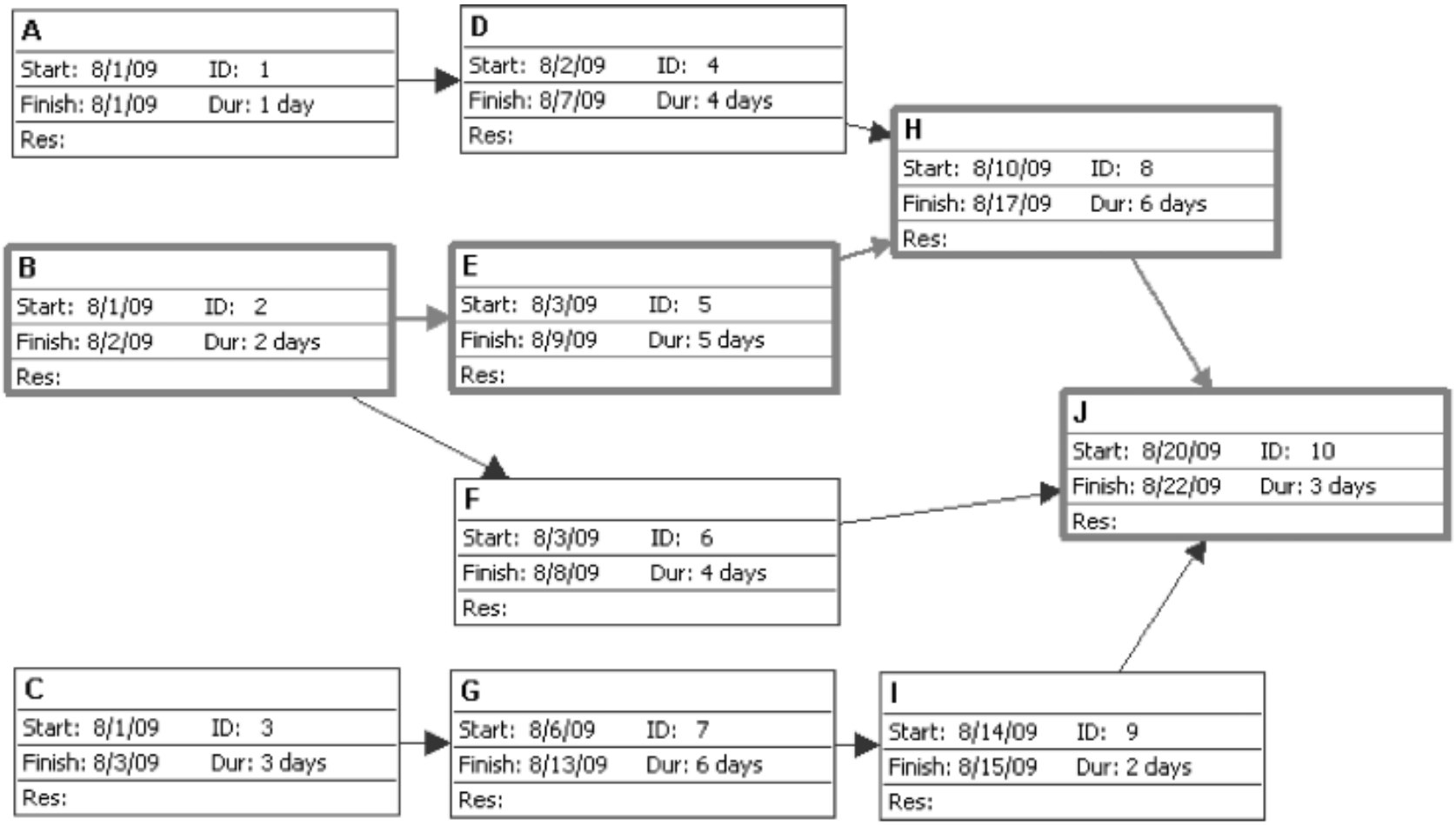
Precedence Diagramming Method (PDM)

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.

Sample PDM Network Diagram



4. Estimating Activity Resources

- Before estimating activity durations, you must have a good idea of the quantity and type of resources that will be assigned to each activity
- Consider important issues in estimating resources
  - How difficult will it be to do specific activities on this project?
  - What is the organization's history in doing similar activities?
  - Are the required resources available or need to be acquired?
- A HR **resource breakdown structure** is a hierarchical structure that identifies the project's resources by category and type

5. Estimating Activity Duration

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

  extra for emergency margin

- **Effort** is the number of workdays or work hours required to complete a task
- Effort does not normally equal duration
- People doing the work should help create estimates, and an expert should review them

5. Estimating Activity Duration cont.

- Instead of providing activity estimates as a discrete number, such as four weeks, it's often helpful to create a **three-point estimate**
  - An estimate that includes an optimistic, most likely, and pessimistic estimate, such as three weeks for the optimistic, four weeks for the most likely, and five weeks for the pessimistic estimate
- Three-point estimates are needed for PERT and Monte Carlo simulations

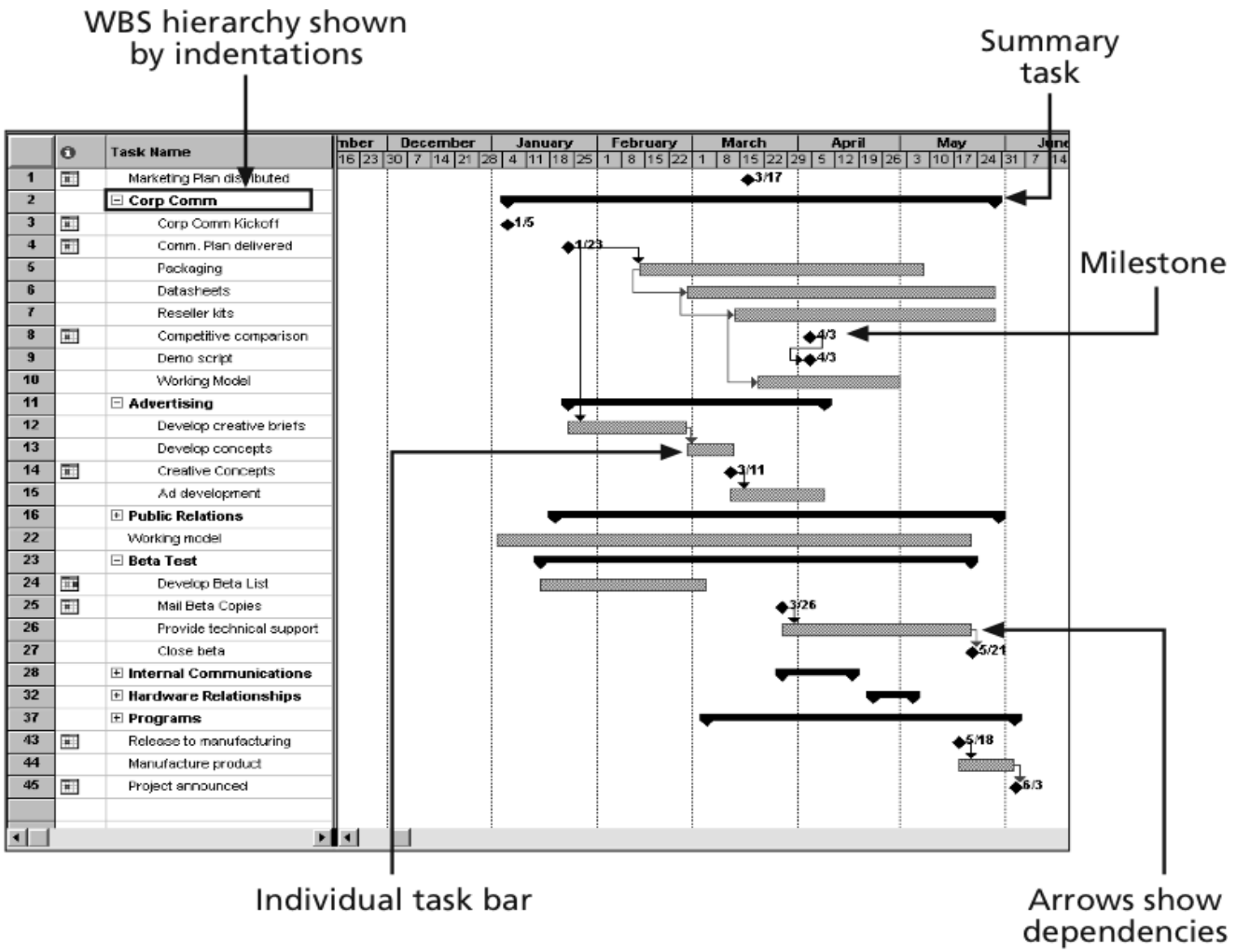
6. Schedule Development

- 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 include *Gantt charts*, *critical path analysis*, *critical chain scheduling*, and *PERT analysis*

6. Schedule Development: Gantt Charts

- **Gantt charts** provide a standard format for displaying project schedule information by listing *project activities* and their corresponding *start* and *finish* dates in a calendar format
- Symbols include:
  - Black diamonds: milestones
  - Thick black bars: summary tasks
  - Lighter horizontal bars: durations of tasks
  - Arrows: dependencies between tasks

Gantt Chart for Software Launch Project



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
- Normally create milestone by entering tasks with a zero duration, or you can mark any task as a milestone

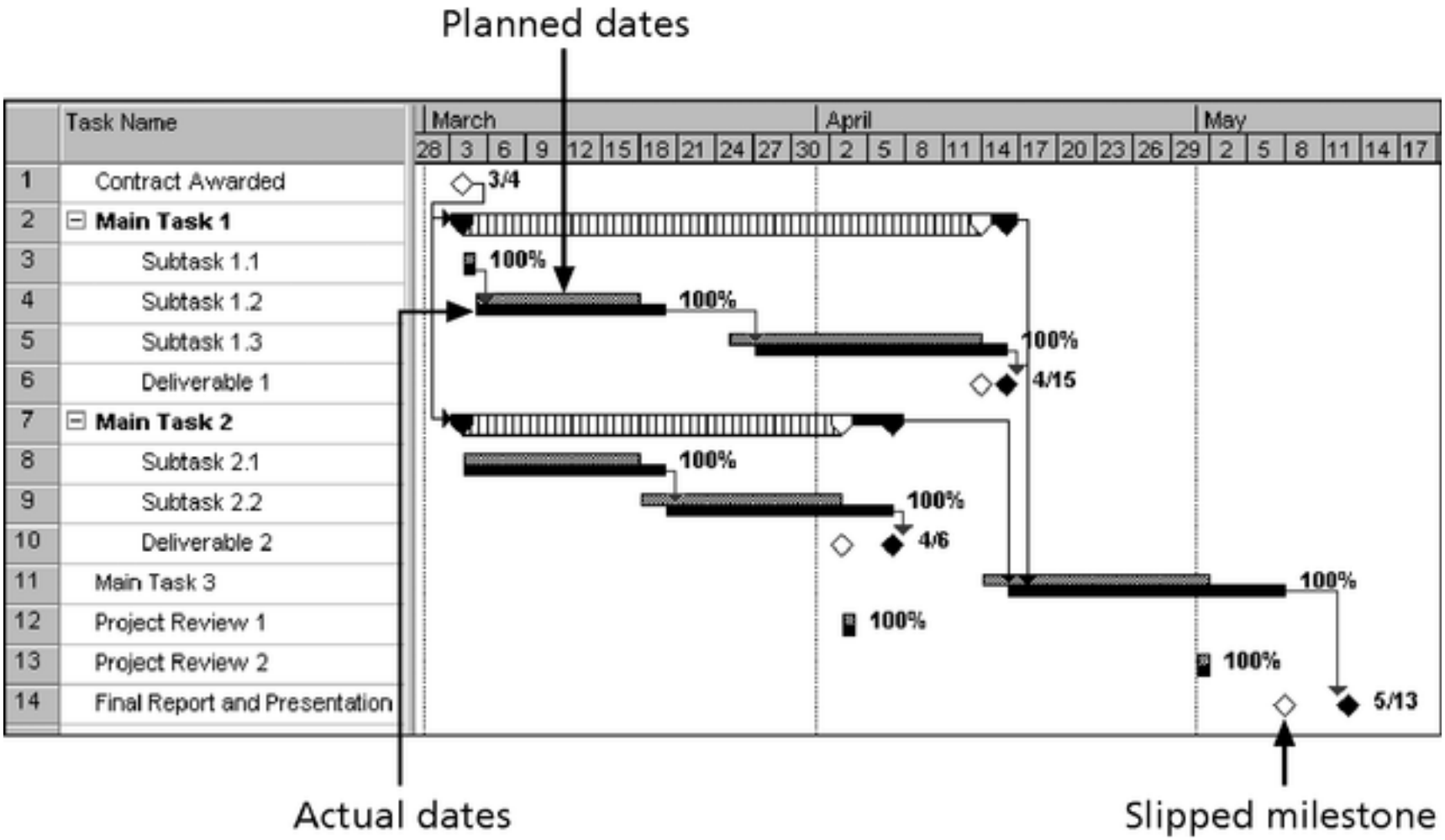
SMART Criteria

- Milestones should be:
  - **S**pecific
  - **M**easurable
  - **A**ssignable
  - **R**ealistic
  - **T**ime-framed

Best Practice

- The five key points of using project milestones include the following:
  1. Define milestones early in the project and include them in the Gantt chart to provide a visual guide
  2. Keep milestones small and frequent
  3. The set of milestones must be all-encompassing (included/ related to the project)
  4. Each milestone must be binary, meaning it is either complete or incomplete
  5. Carefully monitor the critical path

Sample Tracking Gantt Chart



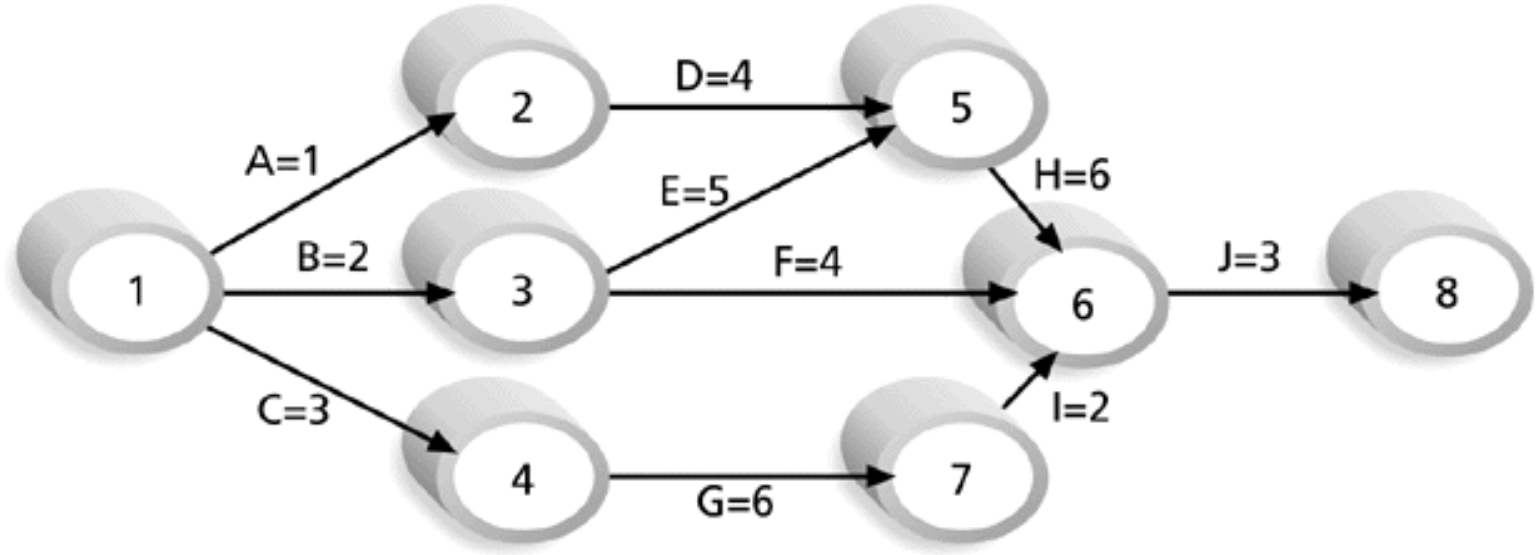
6. Schedule Development: Calculating the Critical Path

- First develop a good network diagram
- Add the duration estimates for all activities on each path through the network diagram
- The 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

6. Schedule Development: Critical Path Method (CPM)

- **CPM** is a network diagramming technique used to predict total project duration
- A **critical path** for a project is the series of activities that determines the *earliest time* by which the project can be completed
- The critical path 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

Determining the Critical Path for Project X



Note: Assume all durations are in days.

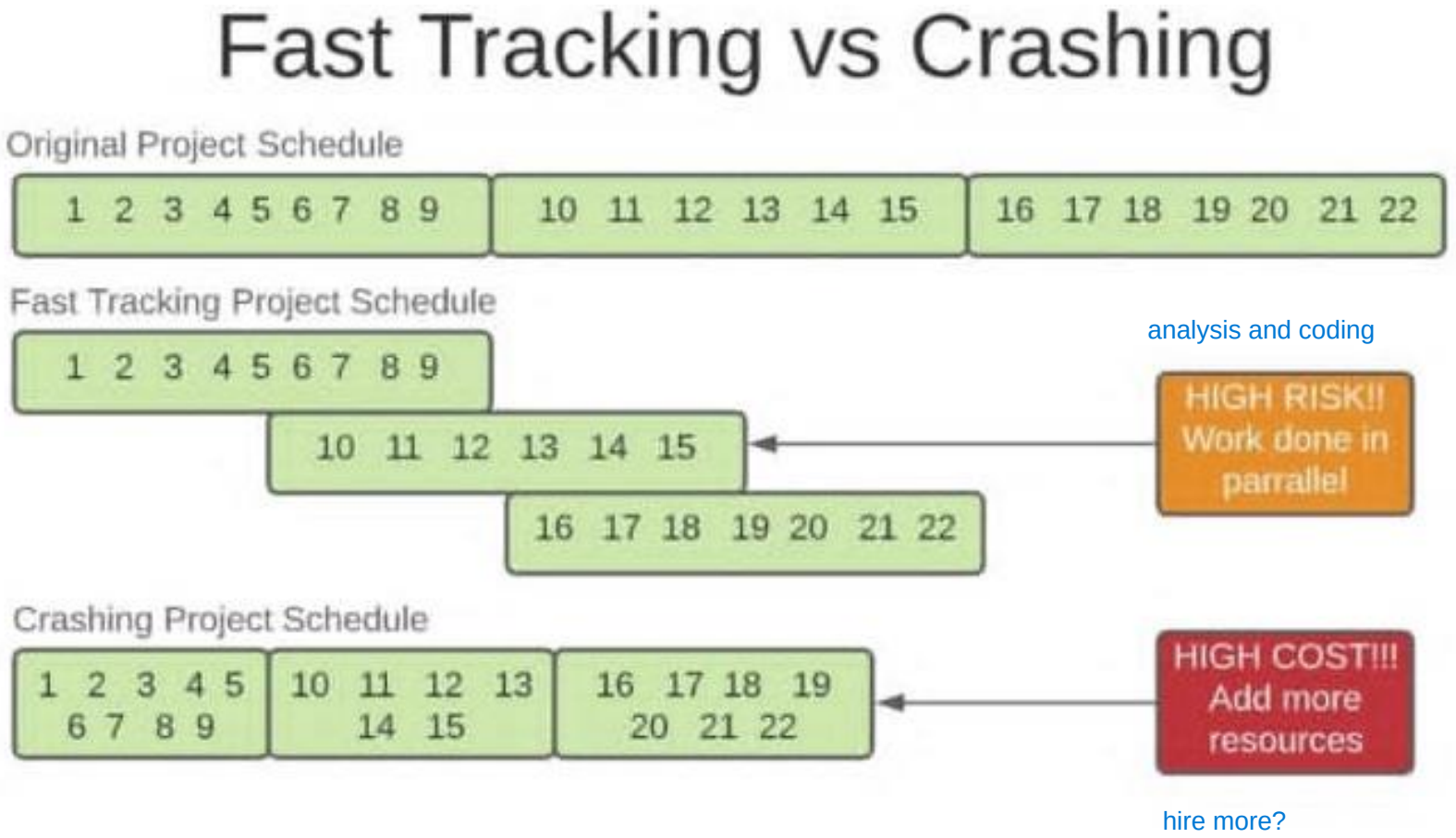
Path 1:	A-D-H-J	Length = 1+4+6+3 = 14 days
Path 2:	**B-E-H-J**	**Length = 2+5+6+3 = 16 days**
Path 3:	B-F-J	Length = 2+4+3 = 9 days
Path 4:	C-G-I-J	Length = 3+6+2+3 = 14 days

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.

6. Schedule Development: Project Crashing and Fast Tracking

- Projects will sometimes have deadlines that are impossible to meet using normal procedures
- By using exceptional methods it may be possible to finish the project in less time than normally required
- However, this usually increases the cost or the risk of the project.
- Reducing a project's completion time is called *crashing*
- Performing task in parallel is called *fast tracking*

Project Crashing and Fast Tracking



Project Crashing

- Crashing a project starts with using the *normal time* to create the critical path
- The *normal cost* is the cost for completing the activity using normal procedures
- If the project will not meet the required deadline, extraordinary measures must be taken
- The *crash time* is the shortest possible activity time and will require additional resources
- The *crash cost* is the price of completing the activity in the earlier-than-normal time

Four Steps to Project Crashing

1. Find the normal critical path and identify the critical activities

2. Compute the crash cost per week (or other time period) for all activities in the network using the formula

$$\text{Crash cost/Time period} = \frac{\text{Crash cost} - \text{Normal cost}}{\text{Normal time} - \text{Crash time}}$$

Four Steps to Project Crashing

3. Select the activity on the critical path with the smallest crash cost per week and crash this activity to the maximum extent possible or to the point at which your desired deadline has been reached
4. Check to be sure that the critical path you were crashing is still critical. If the critical path is still the longest path through the network, return to step 3. If not, find the new critical path and return to step 2.

General Foundry Example

- General Foundry has been given 14 weeks instead of 16 weeks to install the new equipment
- The critical path for the project is 15 weeks
- What options do they have?
- The normal and crash times and costs are shown in Table 13.9
- Crash costs are assumed to be linear and Figure 13.11 shows the crash cost for activity *B*
- Crashing activity *A* will shorten the completion time to 14 but it creates a second critical path B,D,G,H.
- Any further crashing must be done to both critical paths

General Foundry Example

- Normal and crash data for General Foundry

choose one of them to crash

ACTIVITY	TIME (WEEKS)		COST ($)		CRASH COST PER WEEK ($)	CRITICAL PATH?
	NORMAL	CRASH	NORMAL	CRASH		
A	2	1	22,000	23,000	1,000	Yes
B	3	1	30,000	34,000	2,000	No
C	2	1	26,000	27,000	1,000	Yes
D	4	3	48,000	49,000	1,000	No
E	4	2	56,000	58,000	1,000	Yes
F	3	2	30,000	30,500	500	No
G	5	2	80,000	86,000	2,000	Yes
H	2	1	16,000	19,000	3,000	Yes

Table 13.9

same as aoa

General Foundry Example

the assumption of lineaerty is critical

- Crash and normal times and costs for activity *B*

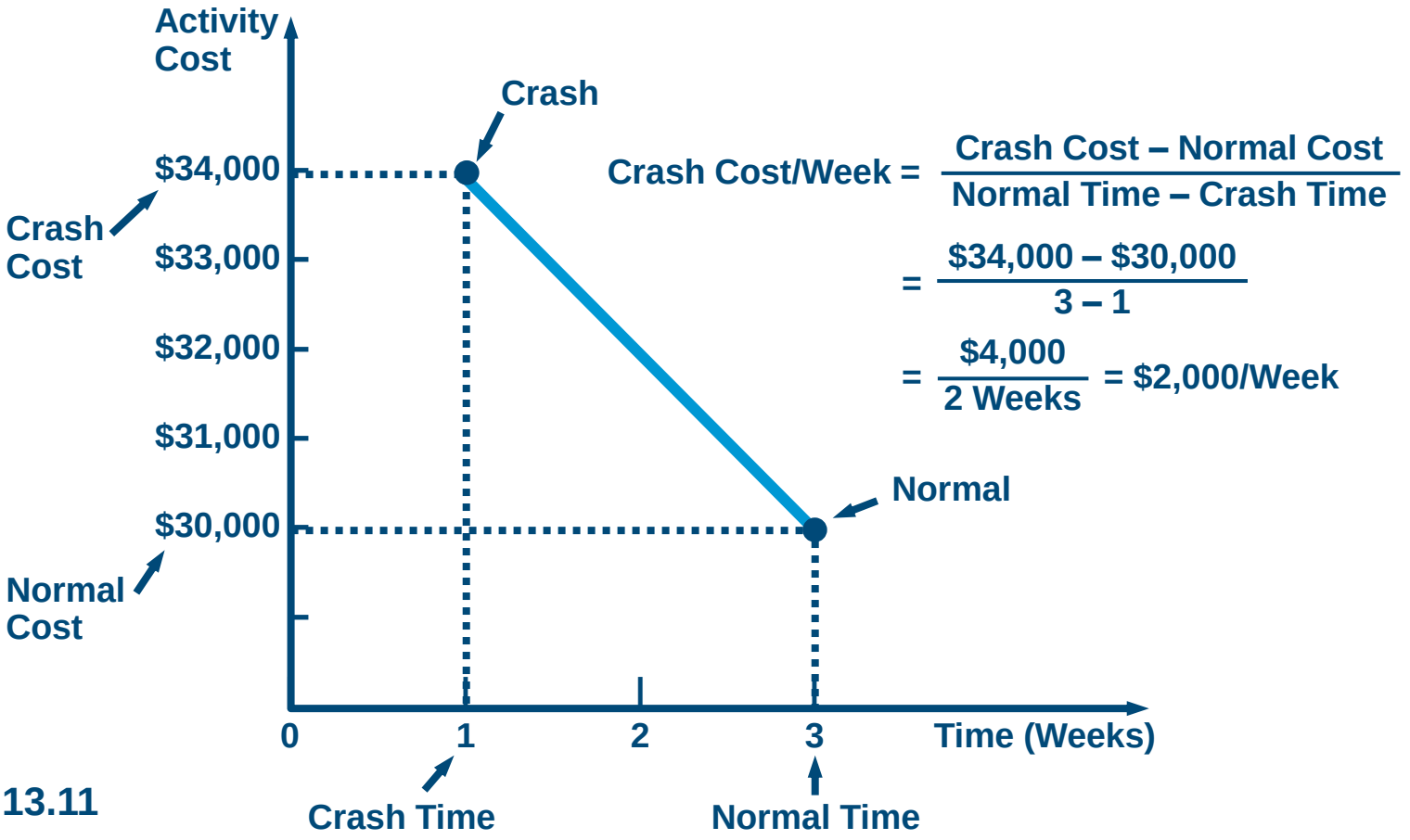


Figure 13.11

Using the Critical Path to Shorten a Project Schedule

risky

- **Fast tracking** activities by doing them in parallel or overlapping them instead of doing them in sequence
  - Instead of waiting for all analysis to be completed before starting coding, some coding could begin for those tasks that have been fully analyzed
  - Drawback – starting a task too soon could lengthen the project because other tasks whose analysis has not been completed could impact this task and cause rework

6. Schedule Development: Program Evaluation and Review Technique (PERT)

- **PERT** is a network analysis technique used to estimate project duration when there is a high degree of uncertainty about the individual activity duration estimates
- PERT uses **probabilistic time estimates**
  - Duration estimates based on using optimistic, most likely, and pessimistic estimates of activity durations, or a three-point estimate
  - PERT attempts to address the risk associated with duration estimates by developing schedules that are more realistic
    - It involves more work than CPM since it requires several duration estimates

critical path method

PERT Formula and Example

- PERT weighted average **=**

$$\frac{\text{optimistic time} + 4\text{X most likely time} + \text{pessimistic time}}{6}$$

- Example:

PERT weighted average =

$$\frac{8 \text{ workdays} + 4 \text{ X } 10 \text{ workdays} + 24 \text{ workdays}}{6} = \textbf{12 days}$$

where optimistic time= 8 days,

most likely time = **10 days**, and

pessimistic time = 24 days

Therefore, you'd use **12 days** on the network diagram instead of 10 when using PERT for the above example

7. Controlling the Schedule

- The final process in project time management is controlling the schedule. The goal of schedule control is to know the status of the schedule, influence the factors that cause schedule changes, determine that the schedule has changed, and manage changes when they occur.

Using Software to Assist in Time Management

- Software for facilitating communications helps people exchange schedule-related information
- Decision support models help analyze trade-offs that can be made
- 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
- You must enter dependencies to have dates adjust automatically and to determine the critical path
- You must enter actual schedule information to compare planned and actual progress

Chapter Summary

- Project time management is often cited as the main source of conflict on projects, and most IT projects exceed time estimates

- Main processes include
  - Plan schedule management
  - Define activities
  - Sequence activities
  - Estimate activity resources
  - Estimate activity durations
  - Develop schedule
  - Control schedule