

# 7

## The Project Schedule and Budget

### CHAPTER OVERVIEW

Chapter 7 focuses on developing the project schedule and budget and on a number of project management tools for developing the project plan. After studying this chapter, you should understand and be able to:

- Describe the Project Management Body of Knowledge (PMBOK) area called project cost management.
- Develop a Gantt chart.
- Develop a project network diagram using the activity on the node (AON) technique.
- Identify a project's critical path and explain why it must be controlled and managed.
- Develop a PERT diagram.
- Describe the concept of precedence diagramming and identify finish-to-start, start-to-start, finish-to-finish, and start-to-finish activity relationships
- Describe the Project Management Body of Knowledge area called project cost management
- Describe the various costs for determining the project's budget.
- Define what is meant by the baseline project plan.

### GLOBAL TECHNOLOGY SOLUTIONS

Kellie Matthews stopped in the doorway of Tim Williams' office. Tim was just finishing a conversation on his cell phone, and he motioned for her to come in and sit down. After pressing the end button, he asked "How did your meeting go this morning?"

Kellie sat back in her chair. "I think it went well," she said. "It was with a local textbook distributor interested in purchasing and implementing a call center software package. There are a number of software packages available from different vendors, but the company is not really sure which one best suits its needs. Its information systems department is stretched pretty thin working on several projects already, so it is considering outsourcing this project. I have another meeting with management later this week, so keep your fingers crossed because we may have another client."

"I will," Tim said. "That might stretch things around here a little bit, but we'll worry about that bridge when we come to it."

Kellie agreed. "So how are things going with the Husky Air? Have you finished the schedule and budget?"

Tim chuckled and said, "I knew that you were going to ask that. Actually, we are making good progress. The phone call that I just finished was with Husky Air's CEO. He's pretty anxious to find out how much the project will cost and how long it will take to complete. We have a meeting next week to present the project charter and plan to him and several other senior managers."

"Will you be ready?" Kellie asked.

Tim picked up his coffee mug from his desk, took a sip, and then said, "We completed the work breakdown structure yesterday. That helped us to identify all of the tasks or activities, the resources that will be required, and each activity's estimated duration. Right now, we're trying to determine which activities need to be completed sequentially and which can be completed in parallel. That will help us develop a project network of activities that will allow us to develop a schedule and budget once we enter everything into the project management software package. To finally answer your question, I'm pretty confident that we'll have a draft of the project plan ready by next week."

Kellie leaned forward in her chair and asked, "That sounds reasonable. So what do you hope happens at next week's meeting?"

"If this were a perfect world, I'd hope that our client would approve everything and we could get started right away," he said, laughing. "But I know that's not likely to happen. I'm sure that once we present the schedule and budget to them next week, we'll have to make some changes. But, I'm confident that we're close to the original estimates outlined in the business case, so we should only have to make some minor modifications. Once approved, we then have our baseline project plan and we can get started on the real project work."

Kellie stood up to leave. "I have to return a few phone calls before lunch, but please keep me informed and let me know if I can help out," she said.

Tim was grateful and knew that he could count on Kellie's help. As Kellie was walking through the doorway and back to her office, Tim was turning to his computer to answer the six e-mails that had arrived in his inbox since he had last checked them thirty minutes ago.

#### *Things to Think About:*

1. How does the work breakdown structure (WBS) link the project's scope to the schedule and budget?
2. Why might a project manager expect a project plan to go through a number of iterations before being accepted by the project sponsor or client?
3. What role does project management software play in developing the project schedule and budget?

## INTRODUCTION

The last several chapters have been leading up to the development of the project schedule and budget. Chapter 3 introduced the project-planning framework (see Figure 7.1). To support this framework, subsequent chapters introduced several Project Management Body of Knowledge (PMBOK) areas, including project integration management, human resources management, project scope management, and project time management. In this chapter, you will be introduced to another knowledge area called project cost management, which will bring all of the concepts, tools, and techniques covered in the last several chapters together so that the project plan can be developed.

The project plan contains all of the details of the project's schedule and budget. It will be used to guide the project team and monitor the project's progress throughout the project life cycle. Project time management was introduced in the last chapter; however, our focus was on two important processes: Activity definition and activity duration estimation. These two processes are key ingredients for developing the work breakdown structure (WBS) that links the project's scope to the project plan. The development of a project plan, however, requires a schedule and budget. The project schedule builds upon the WBS by identifying the sequence of activities as well as the interdependencies and relationships. Once the activities, their expected durations, and sequence are identified, various project management tools can be used to map a network of activities to yield the project schedule. This information, in turn, can be entered into a project management software package to make developing the project plan more efficient and to provide a means to monitor and control the project schedule and budget as the plan is executed.

The project budget is determined by the project schedule, the cost of the resources assigned to each of the tasks, and by any other direct or indirect costs and reserves. In addition, a PMBOK area called **project cost management** focuses on the processes, procedures, and techniques to develop and manage the project budget. According to PMBOK, project cost management includes:

- *Resource planning*—Identifying the type of resources (people, technology, facilities, and so forth) and number of resources needed to carry out the project activities.
- *Cost estimating*—Based upon the activities, their time estimates, and resource requirements, an estimate can be developed.
- *Cost budgeting*—Once the time and cost of each activity is estimated, an overall cost estimate for the entire project can be made. Once approved, this estimate becomes the project budget.

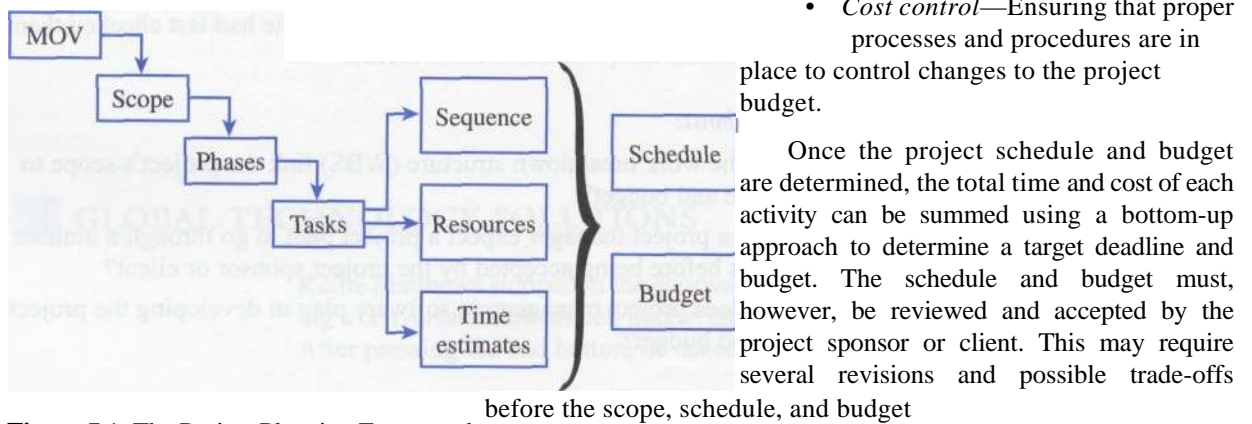


Figure 7.1 The Project Planning Framework

relationship is reasonable and acceptable to *all* of the project stakeholders. Once the schedule and budget are approved by the sponsor or client, the plan becomes the baseline project plan. This milestone is an important achievement that marks the completion of the second phase of the IT project methodology and gives the project manager and team the authority to begin carrying out the activities outlined in the plan.

## DEVELOPING THE PROJECT SCHEDULE

Overeager new manager promises his boss a thirty-day schedule for a project to automate passwords on company's mainframe, midrange, and desktop systems. "We can't do that," desktop support pilot fish tells manager when he sees the project plan. "Have you confirmed that the mainframe and midrange support groups can do the product evaluation in the three days you've allotted?" fish asks. "No," says manager, "but if they don't meet the plan, then it'll be their fault it fails, not mine."

From Shark Tank: That's One Way to Look at It, May 20, 2002.  
<http://www.computer-world.com/careertopics/careers/training/story/0,10801,71293,00.html>.

The WBS identifies the activities and tasks that must be completed in order to provide the project scope deliverables. Estimates provide a forecasted duration for each of these activities and are based upon the characteristics of the activity, the resources assigned, and the support provided to carry out the activity. Project networks, on the other hand, support the development of the project schedule by identifying dependencies and the sequencing of the activities defined in the WBS. The project network also serves as a key tool for monitoring and controlling the project activities once the project work begins.

In this section, several project management tools and techniques will be introduced to create a project network plan that defines the sequence of activities throughout the

### CRUNCH TIME

The original meaning of the word *deadline* referred to a line drawn around a military prison, beyond which prisoners were shot. A project deadline can be almost as threatening, and as a project manager, you may find yourself dodging political bullets forged by unreasonable expectations and demands with respect to the project's schedule and budget. Although tight schedules may be dictated by legal, regulatory, or competitive situations, some deadlines appear to be arbitrary. Arbitrary deadlines result in a *crunch schedule* that will give you less time than you would like to have to do things right. They can be harmful to your career. The trick is to know what and how to negotiate with the senior managers who sometimes make these demands. According to Doug DeCarlo, a project management consultant at ICS Group in Norwalk, Connecticut, crunch schedules normally happen when management dictates a final date for the project rather than asks when it can be done. These crunch schedules can and must be

negotiated. Doing so requires political savvy and alternatives. If a project deadline cannot be moved, then perhaps adding temporary help at an additional cost could help make the deadline. Another option may be to break the project into chunks, delivering only those chunks that can be produced on schedule. The political skill comes into play when you break a project into four chunks and have to explain to the fourth-chunk person why his or her part of the project is last. And, how should a project manager handle delays caused by political fighting, turf wars, and team members over whom you have no direct control? The answer is having documented project management processes that are agreed upon by upper management. Without this, a project manager may not have any legitimate authority.

SOURCE: Adapted from Rochelle Garner, Captain of Crunch, *Computerworld*, October 6, 1997. <http://www.computerworld.com/news/1997/story/0,11280,9205,00.html>.

project and their dependencies. These tools include Gantt charts, activity on the node (AON), critical path analysis, PERT, and the precedence diagramming method (PDM). Many of these tools are integrated into most project management software packages; however, it is important to have a fundamental understanding of how these various project management tools work in order to make the most of an automated tool.

## Gantt Charts

Working with the U.S. Army during World War I, Henry L. Gantt developed a visual representation that compares a project's planned activities with actual progress over time. Although Gantt charts have been around for a long time, they are still one of the most useful and widely used project management tools.

Figure 7.2 shows how a basic Gantt chart can be used for planning. Estimates for the tasks or activities defined in the WBS are represented using a bar across a horizontal time axis. Other symbols, for example, diamonds, can represent milestones to make the Gantt chart more useful.

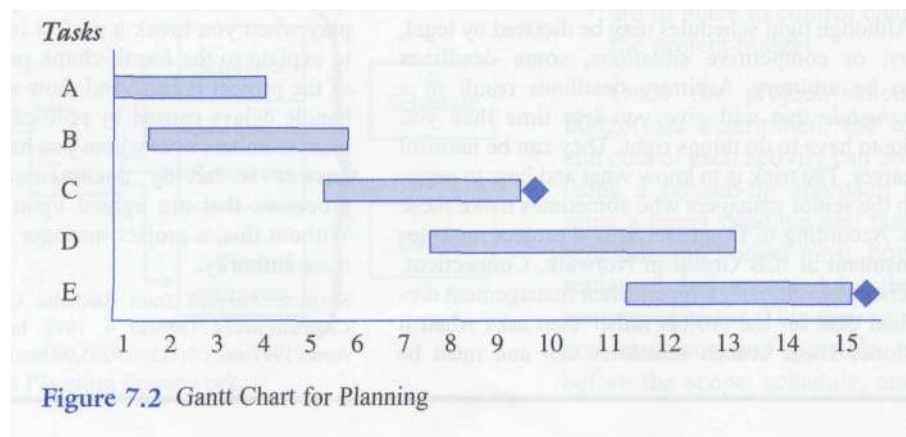
The Gantt Chart in Figure 7.2 shows the general sequence of activities or work tasks. In this project example, there are five tasks of varying durations and the project should be completed in fifteen time periods (e.g., days). In addition, the two shaded diamonds following tasks C and E indicate milestone events.

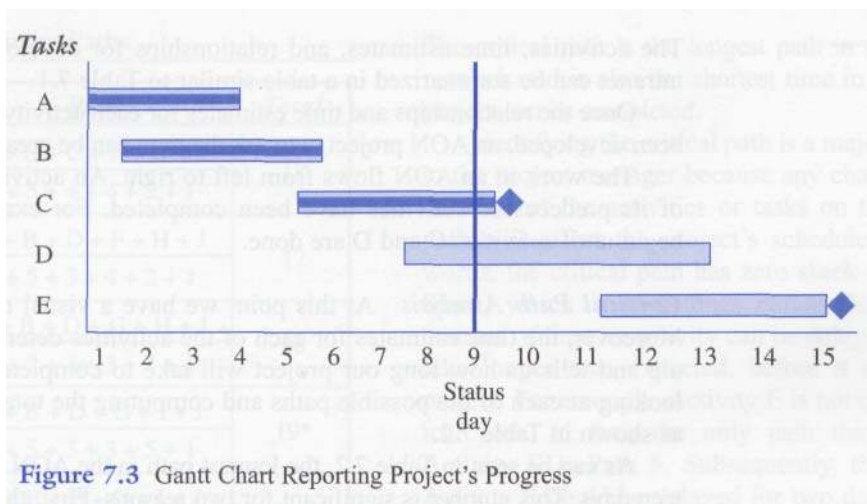
Gantt charts can also be useful for tracking and monitoring the progress of a project. As shown in Figure 7.3, completed tasks can be shaded or filled in, and one can get an accurate picture of where the project stands for a given status or reporting date. In Figure 7.3, tasks A and B have been completed, but it looks like Task C is somewhat behind schedule.

Although Gantt charts are simple, straightforward, and useful for communicating the project's status, they do not show the explicit relationships among tasks or activities. For example, we can see from Figure 7.3 that task C is somewhat behind schedule; however, the Gantt chart does not tell us whether there will be an impact on tasks D or E and whether this impact will push back the project's original deadline. The Gantt chart introduced in this section follows a more traditional form. As you will see, the Gantt chart used in most project management software packages today has been modified to overcome these limitations.

## Project Network Diagrams

Project network diagrams include several useful tools for planning, scheduling, and monitoring the project's progress. Similar to Gantt charts, project network diagrams





use the WBS as a basis to provide a visual representation of the workflow of activities and tasks. However, project network diagrams also provide valuable information about the logical sequence and dependencies among the various activities or tasks. Subsequently, a completion date or project deadline should be developed based on a sound estimating process rather than guesstimating a target date or a date set arbitrarily by upper management or the client.

In addition, project network diagrams provide information concerning when specific tasks must start and finish, and what activities may be delayed without affecting the deadline target date. In addition, the project manager can make decisions regarding scheduling and resource assignments to shorten the time required for those critical activities that will impact the project deadline.

*Activity on the Node (AON)*<sup>1</sup> An activity or task focuses on producing a specific project deliverable, generally takes a specific amount of time to complete, and requires resources. **Activity on the Node (AON)** is a project network diagramming tool that graphically represents all of the project activities and tasks, as well as their logical sequence and dependencies. Using AON, activities are represented as boxes (i.e. nodes) and arrows indicate precedence and flow.

To construct an AON network diagram, one begins with the activities and tasks that were defined in the WBS. Estimates for each activity or task defined in the WBS should have an associated time estimate. The next step is to determine which activities are **predecessors, successors, or parallel**. Predecessor activities are those activities that must be completed *before* another activity can be started—e.g., a computer's operating system must be installed before loading an application package. On the other hand, successor activities are activities that must follow a particular activity in some type of sequence. For example, a program must be tested and then documented after it is compiled. A parallel activity is an activity or task that can be worked on at the same time as another activity. Parallel activities may be thought of as an opportunity to shorten the project schedule; however, they also can be a trade-off since doing more than one thing at the same time can have a critical impact on project resources.

<sup>1</sup> A project network diagramming technique very similar to Activity on the Node (AON) is Activity on the Arrow (AOA). The AOA approach uses arrows and nodes similar to AON; however, arrows represent the activity and nodes represent an event. Although AON and AOA provide the same answers, AOA sometimes requires the use of *dummy activities* to make things work out properly. The choice of using either AON or AOA is largely a personal one.

The activities, time estimates, and relationships for developing a simple corporate intranet can be summarized in a table similar to Table 7.1.

Once the relationships and time estimates for each activity or task in the WBS have been developed, an AON project network diagram can be created, as in Figure 7.4.

The work in an AON flows from left to right. An activity cannot begin until all of its predecessor activities have been completed. For example, activity F cannot begin until activities C and D are done.

*Critical Path Analysis* At this point we have a visual road map of our project. Moreover, the time estimates for each of the activities determines the project schedule and tells us how long our project will take to complete. This is determined by looking at each of the possible paths and computing the total duration for each path, as shown in Table 7.2.

As can be seen in Table 7.2, the longest path in the AON network diagram is nineteen days. This number is significant for two reasons. First, this tells us that our project is estimated to take nineteen days (i.e., the project deadline will be nineteen days after the project starts). Second, and perhaps more importantly, Path 4 is also our **critical path**.

Table 7.1 Activity Analysis for AON

<i>Activity</i>	<i>Description</i>	<i>Estimated Duration (Days)</i>	<i>Predecessor</i>
A	Evaluate current technology platform	2	None
B	Define user requirements	5	A
C	Design Web page layouts	4	B
D	Set-up server	3	B
E	Estimate Web traffic	1	B
F	Test Web pages and links	4	C,D
G	Move Web pages to production environment	3	D,E
H	Write announcement of intranet for corporate newsletter	2	F,G
I	Train users	5	G
J	Write report to management	1	H,I

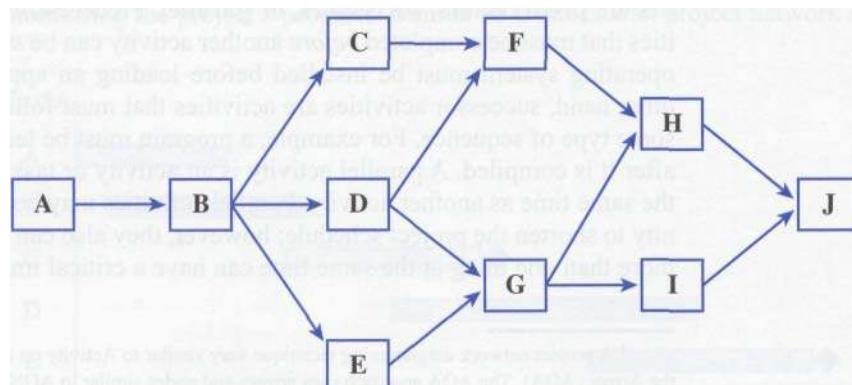


Figure 7.4 Activity on the Node (AON) Network Diagram

Table 7.2 Possible Activity Paths The critical path is the longest path in the project network and is also the shortest time in which the project can be completed.

Possible Paths	Path	Total
Path 1	A+B+C+F+H+J	18
	2+5+4+4+2+1	
Path 2	A+B+D+F+H+J	17
	2+5+3+4+2+1	
Path 3	A+B+D+G+H+J	16
	2+5+3+3+2+1	
Path 4	A+B+D+G+I+J	19*
	2+5+3+3+5+1	
Path 5	A+B+E+G+I+J	17
	2+5+1+3+5+1	

Identifying the critical path is a major concern to the project manager because any change in the duration of the activities or tasks on the critical path will affect the project's schedule. In other words, the critical path has zero **slack (or float)**. Slack, which is sometimes called float, is the amount of time an activity can be delayed, that is, take longer than expected, before it delays the project. For example, Activity E is not on the critical path. In fact, the only path that includes Activity E is Path 5. Subsequently, the start of Activity E could be delayed for two days or take up to three days to complete before the project schedule is affected. On the other hand, Activities A, B, D, G, I, and J have no float because delaying

their start or taking longer to complete that we estimated will increase the total duration of the project by the same amount.

As a result, knowing the critical path can influence a project manager's decisions. For example, a project manager can **expedite**, or **crash**, the project by adding resources to an activity on the critical path to shorten its duration. The project manager may even be able to divert resources from certain activities, for example, Activity E because this activity has some slack or float. Diverting resources will reduce the overall project schedule, but keep in mind that there may be a trade-off—shortening the schedule by adding more resources may inflate the project's budget.

Another way to shorten the project schedule is to look for parallel activity opportunities. Doing two, or several, activities that were originally planned to be completed in sequence at the same time can shorten the critical path. It is known as **fast tracking** the project.

Can the critical path change? The answer is absolutely! As a result, it is imperative that the project manager not only identify the critical path, but also monitor and manage it appropriately. In fact, it is very possible for a project to have more than one critical path.

**PERT Program Evaluation and Review Technique (PERT)** was developed in the late 1950s to help manage the Polaris submarine project. At about the same time, the Critical Path Method (CPM) was developed. The two methods are often combined and called PERT/CPM.

PERT uses the project network diagramming technique to create a visual representation of the scheduled activities that expresses both their logical sequence and interrelationships. PERT also uses a statistical distribution that provides probability for estimating when the project and its associated activities will be completed. This probabilistic estimate is derived by using three estimates for each activity: optimistic, most likely, and pessimistic.

An optimistic estimate is the minimum time in which an activity or task can be completed. This is a best-case scenario where everything goes well and there is little or no chance of finishing earlier. A most likely estimate, as the name implies, is the normally expected time required to complete the task or activity. A pessimistic estimate is



a worst-case scenario and is viewed as the maximum time in which an activity can or should be completed.

One can use the following equation to compute a mean or weighted average for each individual activity that will become the PERT estimate:

$$\text{Activity Estimate} = \frac{\text{Optimistic Time} + (4 \times \text{Most Likely Time}) + \text{Pessimistic Time}}{6}$$

The total expected time to complete the project can be easily found by summing each of the individual activity estimates or:

$$\text{Total Expected Time of Project} = \sum_{i=1}^n \text{Activity Estimates}$$

For example, on our project used earlier, a project manager and team came up with the estimates presented in Table 7.3.

Analyzing the various paths using PERT provides the critical paths presented in Table 7.4. As can be seen in Table 7.4, the critical path is still Path 4 and the expected completion date of the project is 20.5 or 21 days if we round up. In this case, the deadline increased from nineteen days using the AON method to twenty-one days using the statistical technique associated with PERT. In the first case, the most likely estimates were used, while PERT took into account not only the most likely estimates, but also optimistic and pessimistic estimates as well. PERT is well suited for developing simulations whereby the project manager can conduct a sensitivity analysis for schedule planning and risk analysis. But, like any planning and scheduling tool, its usefulness is highly correlated to the quality of the estimates used.

**Precedence Diagramming Method (PDM)** Another tool that is useful for understanding the relationships among project activities is the **Precedence Diagramming Method (PDM)**. This tool is also based on the AON project diagram technique and is based on four fundamental relationships shown in Figure 7.5.

- **Finish-To-Start (FS)**—A finish-to-start relationship is the most common relationship between activities and implies a logical sequence. Here, activity or task B cannot begin until task A is completed. For example, a program is

Table 7.3 Activity Analysis for PERT

Activity	Predecessor	Optimistic	Most Likely	Pessimistic	Expected
		Estimates	Estimates	Estimates	Duration
		(Days) a	(Days) b	(Days) c	$(a + 4b + c)$
A	None	1	2	4	2.2
B	A	3	5	8	5.2
C	B	2	4	5	3.8
D	B	2	3	6	3.3
E	B	1	1	1	1.0
F	C,D	2	4	6	4.0
G	D,E	2	3	4	3.0
H	F,G	1	2	5	2.3
I	G	4	5	9	5.5
J	H,I	0.5	1	3	1.3

Table 7.4 Possible PERT Activity Paths

Possible Paths	Path	Total
Path 1	A + B + C + F + H + J	18.8
	2.2 + 5.2 + 3.8 + 4.0 + 2.3 + 1.3	
Path 2	A + B + D + F + H + J	18.3
	2.2 + 5.2 + 3.3 + 4.0 + 2.3 + 1.3	
Path 3	A + B + D + G + H + J	18.6
	2.2 + 5.2 + 3.3 + 4.0 + 2.3 + 1.3	
Path 4	A + B + D + G + I + J	20.5*
	2.2 + 5.2 + 3.3 + 3.0 + 5.5 + 1.3	
Path 5	A + B + E + G + I + J	18.2
	2.2 + 5.2 + 1.0 + 3.0 + 5.5 + 1.3	

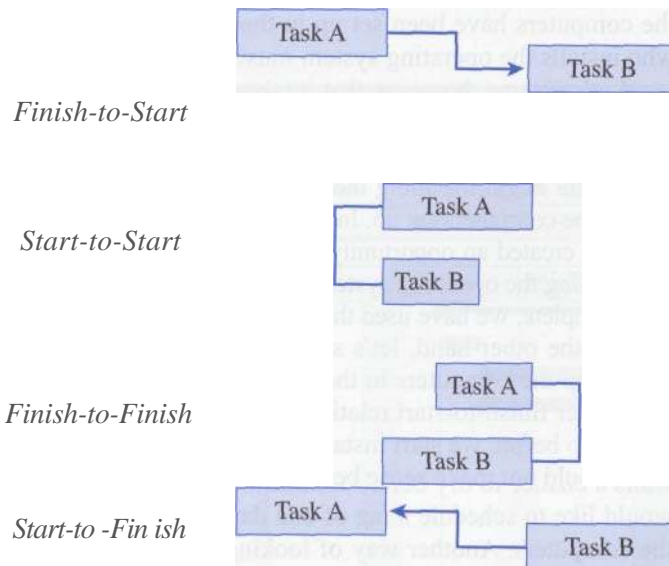


Figure 7.5 PDM Relationships

tested after it is written. Or, in other words, the code is written and then tested. This relationship is similar to the successor and predecessor relationships used in the AON method.

**Start-To-Start (SS)**—A start-to-start relationship between tasks or activities occurs when two tasks can or must start at the same time. Although the tasks start at the same time, they do not have to finish together—i.e., the tasks can have different durations. A start-to-start relationship would be one type of parallel activity that can shorten a project schedule.

**Finish-To-Finish (FF)**—Another type of parallel activity is the finish-to-finish relationship. Here, two activities can start at different times, have different durations, but are planned to be completed at the same time. Once both

of the FF activities are completed, the next activity or set of activities can be started, or if no more activities follow, the project is complete.

- *Start-To-Finish (SF)*—The start-to-finish relationship is probably the least common and can be easily confused with the finish-to-start relationship. A SF relationship, as illustrated in Figure 7.5, is exactly the opposite of a FS relationship. In addition, a SF relationship means that task A cannot end until task B starts. An example of a SF relationship in real life might be a nurse working at a hospital. This person may have to work until they are relieved by another nurse who arrives to start the next shift.

An advantage of using PDM is that the project manager can specify **lead** and **lag** times for various activities. More specifically, lead time allows for the overlapping of activities. For example, a project plan may have two activities or tasks that have been identified as a finish-to-start relationship. These two activities may be the setup of computers in a lab followed by the installation of an operating system on those computers. If we had two people, one to set up the computers and one to install the operating systems on each computer, the project plan might specify a finish-to-start relationship where the installation of the operating systems cannot begin until all of the computers have been set up in the lab. Based upon this project plan, the person who installs the operating system must wait and watch while the other person works.

Let's assume, however, that it takes about half the time to install an operating system as it does to set up a computer. Furthermore, there is no reason why the software person cannot begin installing the operating system when the hardware person has about half of the computers set up. In this case, both tasks will finish about the same time, and we have created an opportunity to shorten the project schedule. By scheduling the task of installing the operating systems when the task of setting up the computers is fifty percent complete, we have used the concept of lead time to our advantage.

On the other hand, let's suppose further that before our hardware person starts setting up the computers in the lab, we want the lab walls to be painted. This would be another finish-to-start relationship because we would like to schedule the painting of the lab before we start installing the computers. Using lead time in this case, however, would not make sense because we do not want the hardware person and painters getting in each other's way. In this case, we may even want to give the freshly painted walls a chance to dry before we allow any work to be done in the lab. Therefore, we would like to schedule a lag of one day before our hardware person starts setting up the computers. Another way of looking at this is to say we are going to schedule a negative lead day in our project schedule.

## PROJECT MANAGEMENT SOFTWARE TOOLS

A number of software tools are available to make project planning and tracking much easier. In fact, it would be almost unthinkable to plan and manage even a small project without the aid of such a tool. In this section, you will see some examples of how these software tools incorporate and integrate the project management tools and concepts described in the previous section. The overview is intended to show you what these tools do, rather than tell you how to use them.

As you can see in Figure 7.6, the Gantt chart view integrates not only the Gantt chart, but also the project network diagram and PDM techniques. Tasks A and B show a finish-to-start relationship, while tasks B and C show a start-to-start relationship.

## GETTING BACK TO THE BASICS OF IT PROJECT MANAGEMENT

The passing of the dot-com boom, along with a downturn in the economy, has led many U.S. companies back to the basics of IT project management. As a result, you probably will not find very many projects with sleepless and caffeine-pumped developers (supported by an open check-book) working around the clock to be the first to market a snazzy Web site. Many experts agree that economic pressures have required IT projects to return to the fundamentals of project management that emphasize strict schedule and budget control, status reporting, continual user feedback, and documented processes and methodologies. According to Bob Wourms, a director of the consulting firm PM Solutions in Havertown, Pennsylvania, time-to-market and market share were critical a few years ago.

Today, however, the focus is on profitability, which requires the project manager keep the project on time and on budget. It also involves sticking to a goal and knowing when you're done. For example, an electric utility company called PacificCorp in Portland, Oregon, recently embarked on a \$10-million customer service and call center project to support its 1.5 million customers. The goal of the eighteen-month project was for PacificCorp's 325 call center agents to handle 80 percent of all incoming calls in less than twenty seconds.

SOURCE: Adapted from Julia King, "Back to Basics," *Computerworld*, April 22, 2002. <http://www.computerworld.com/managementtopics/roi/story/0,10801,70253,00.html>.

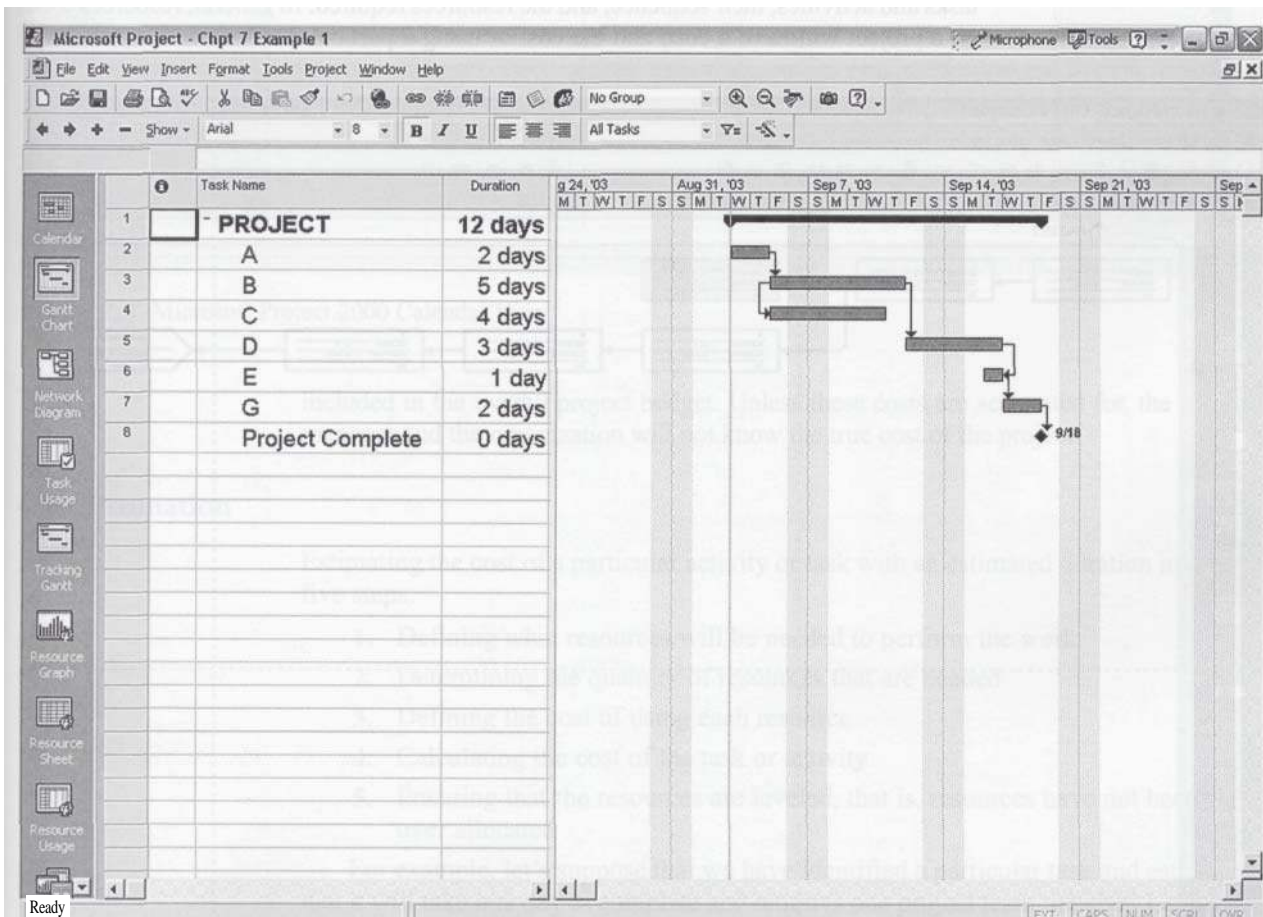


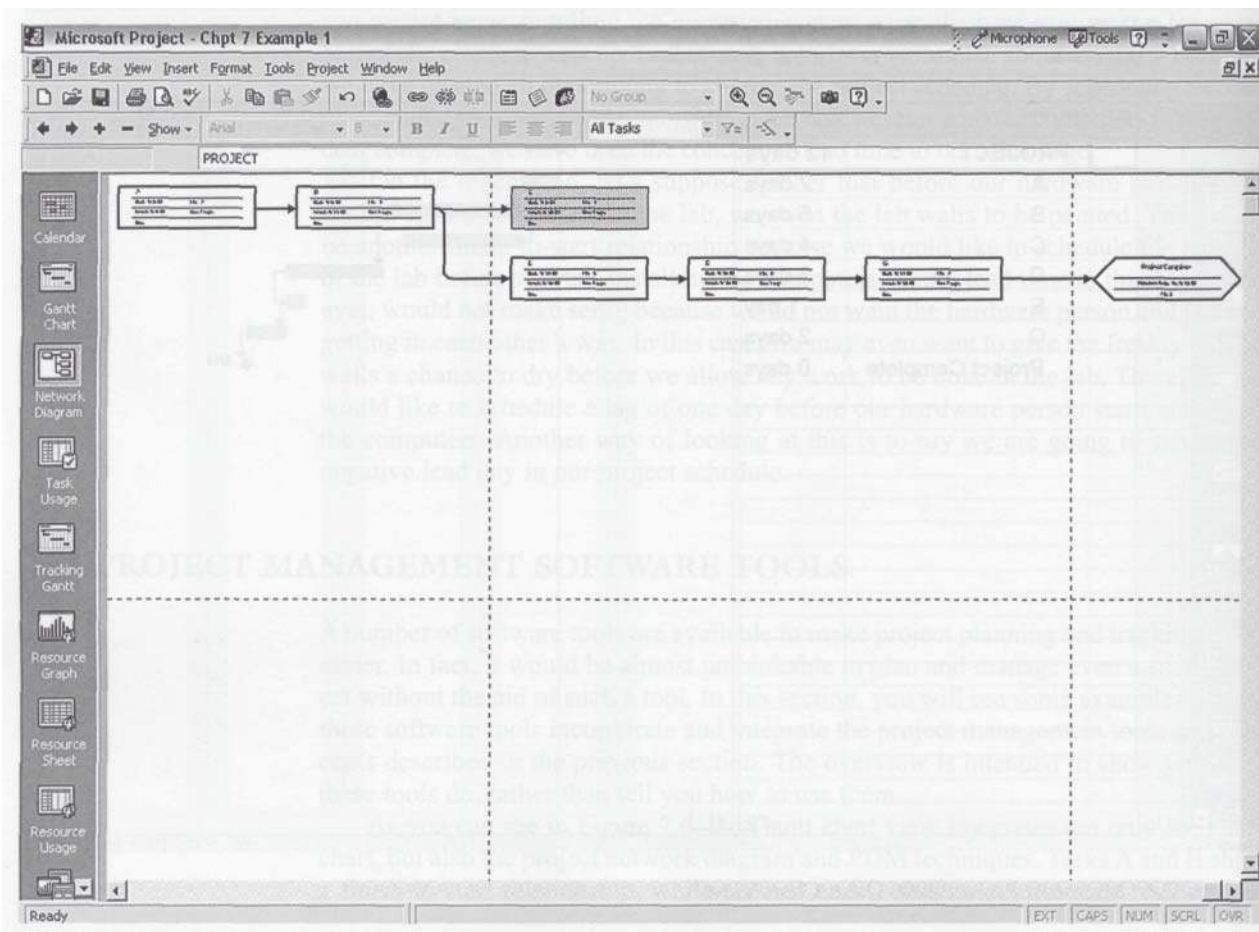
Figure 7.6 Microsoft Project 2000 Gantt Chart View

Tasks D and E show a finish-to-finish relationship. The task Project Complete has a duration of zero days and, therefore, represents a milestone. The Network Diagram View in Figure 7.7 then highlights the project's critical path. One of the most useful tools for scheduling and planning a project is a simple calendar. Figure 7.8 illustrates a Calendar View of the project.

Developing the project schedule and budget is an important planning process that requires that we sometimes define and estimate a large number of activities several months into the future. But, of course, predicting the future is difficult, and detailed project plans will have to be changed frequently to be useful. A technique called **rolling wave** planning is becoming common to help deal efficiently with project planning. Instead of developing a large, detailed project plan requiring frequent updates, the project manager can prepare an overall summary plan, or master schedule, and then develop detailed schedules for only a few weeks or a few months at a time (Hagan 2002). A list of helpful software that is available is listed in Table 7.5.

## DEVELOPING THE PROJECT BUDGET

The project's budget is a function of the project's tasks or activities, the duration of those tasks and activities, their sequence, and the resources required. In general, resources used on a project will have a cost, and the cost of using a particular task or activity must be



**Figure 7.7** Microsoft Project 2000 Network Diagram View and Critical Path

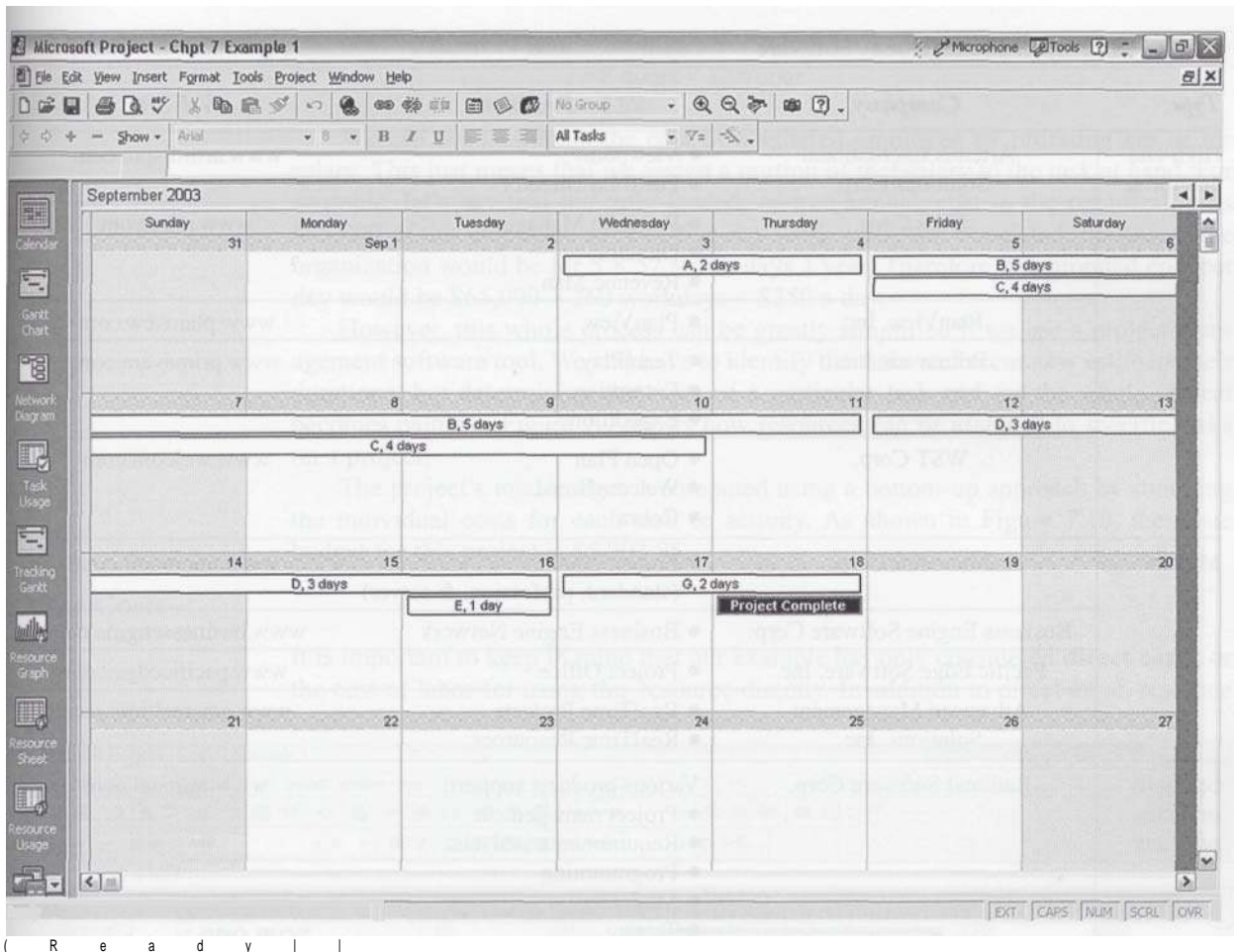


Figure 7.8 Microsoft Project 2000 Calendar View

included in the overall project budget. Unless these costs are accounted for, the project manager and the organization will not know the true cost of the project.

## Cost Estimation

Estimating the cost of a particular activity or task with an estimated duration involves five steps:

1. Defining what resources will be needed to perform the work
2. Determining the quantity of resources that are needed
3. Defining the cost of using each resource
4. Calculating the cost of the task or activity
5. Ensuring that the resources are leveled, that is, resources have not been over allocated

For example, let's suppose that we have identified a particular task and estimated that it will take one day to complete and requires one project team member. Let's also assume, for simplicity, that no other resources are needed.

This estimate may require that we define a cost for using this particular resource. For example, if our team member earns \$20 an hour, that sum is what our employee sees on his or her paycheck (before taxes and other deductions). The organization,

Table 7.5 Project Management Software

Type	Company	Products	Web Site
High-end enterprise	Artemis International Solutions Corp.	<ul style="list-style-type: none"> <li>● Viewpoint</li> <li>● Portfolio Director</li> </ul>	www.artimispm.com
	Niku Corp.	<ul style="list-style-type: none"> <li>● Portfolio Manager</li> <li>● Director</li> <li>● Revenue Man</li> </ul>	www.niku.com
	PlanView, Inc.	<ul style="list-style-type: none"> <li>● PlanView</li> </ul>	www.planview.com
	Primavera, Inc.	<ul style="list-style-type: none"> <li>● TeamPlay</li> <li>● Enterprise</li> <li>● Expedition</li> </ul>	www.primavera.com
	WST Corp.	<ul style="list-style-type: none"> <li>● Open Plan</li> <li>● WelcomHome</li> <li>● Cobra</li> </ul>	www.welcom.com
Midtier	Microsoft Corp.	<ul style="list-style-type: none"> <li>● Project 2000 (standard, profession, &amp; server)</li> </ul>	www.microsoft.com
	Business Engine Software Corp.	<ul style="list-style-type: none"> <li>● Business Engine Network</li> </ul>	www.businessengine.com
	Pacific Edge Software, Inc.	<ul style="list-style-type: none"> <li>● Project Office</li> </ul>	www.pacificedge.com
	Advanced Management Solutions, Inc.	<ul style="list-style-type: none"> <li>● RealTime Projects</li> <li>● RealTime Resources</li> </ul>	www.amsrealtime.com
Specialty or niche products	Rational Software Corp.	Various products support: <ul style="list-style-type: none"> <li>● Project management</li> <li>● Requirements analysis</li> <li>● Programming</li> <li>● Modeling</li> <li>● Testing</li> <li>● Documentation</li> </ul>	www.rational.com
	QSM, Inc.	Products support: <ul style="list-style-type: none"> <li>● Schedule &amp; cost estimation</li> <li>● Project tracking</li> <li>● Benchmarking</li> <li>● Process improvement</li> <li>● Forecasting</li> </ul>	www.qsm.com
	Software Productivity Research, Inc.	Products support: <ul style="list-style-type: none"> <li>● Estimation</li> <li>● Benchmarking</li> <li>● Function Point Analysis</li> </ul>	www.spr.com

Table 7.5 Project Management Software

SOURCE: G. H. Anthes, "Competitors," *Computerworld*, March 18, 2002.<http://www.computerworld.com/hardwaretopics/storage/story/0,10801,69118,00.html>.

however, may also provide certain benefits to the employee (i.e., health care, life insurance, and so forth) that should be included in the cost for using this particular resource. Since these costs are going to vary from organization to organization, let's assume that our friends in the accounting department have conducted a cost accounting analysis for us and that the true cost of using this particular employee (i.e. hourly wage plus benefits) is \$25 an hour. Subsequently, if we pay our employee for one day's work (i.e., an eight-hour day), the cost of completing this particular task is:

$$\begin{aligned} \text{Cost of task} &= \text{Estimated duration} \times \text{True cost of the resource} \\ &= 8 \text{ hours} \times \$25/\text{hour} \\ &= \$200 \end{aligned}$$

We can even estimate the cost of a salaried employee by prorating her or his salary. This just means that we assign a portion of that salary to the task at hand. For example, let's say that the fully loaded, or true annual, cost to the organization is \$65,000. If this employee works a five-day work week, the associated true cost to the organization would be for  $5 \times 52 = 260$  days a year. Therefore, the prorated cost per day would be  $\$65,000 \div 260 \text{ workdays} = \$250$  a day.

However, this whole process can be greatly simplified if we use a project management software tool. We still have to identify the tasks and accurately estimate their durations, but determining the costs of a particular task and for the whole project becomes painless. Figure 7.9 shows how resources can be assigned to specific tasks on a project.

The project's total budget is computed using a bottom-up approach by summing the individual costs for each task or activity. As shown in Figure 7.10, the basic budget for this project is \$5,203.85.

### Other Costs

It is important to keep in mind that our example has only considered **direct costs**, or the cost of labor for using this resource directly. In addition to direct labor, resource

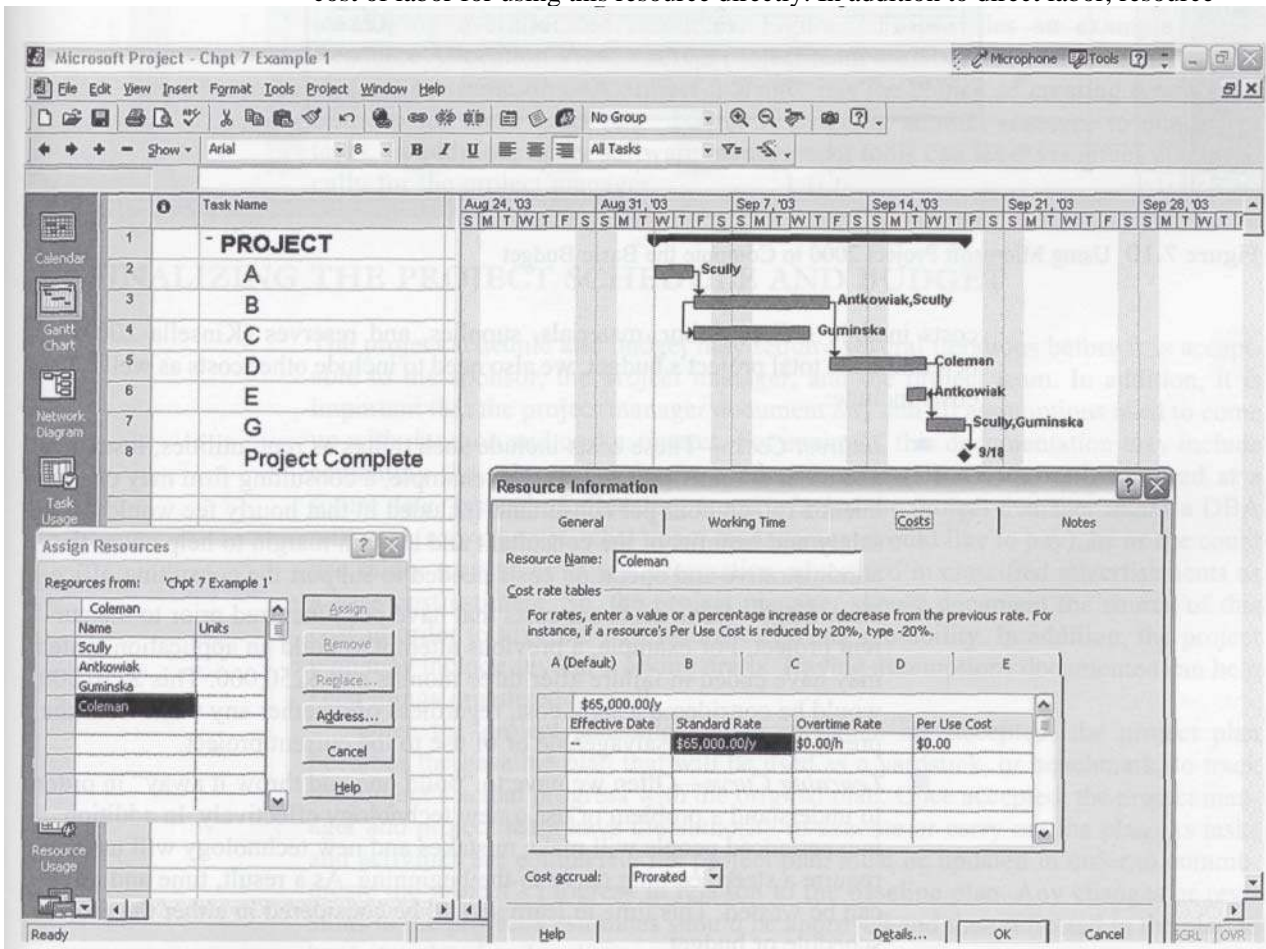
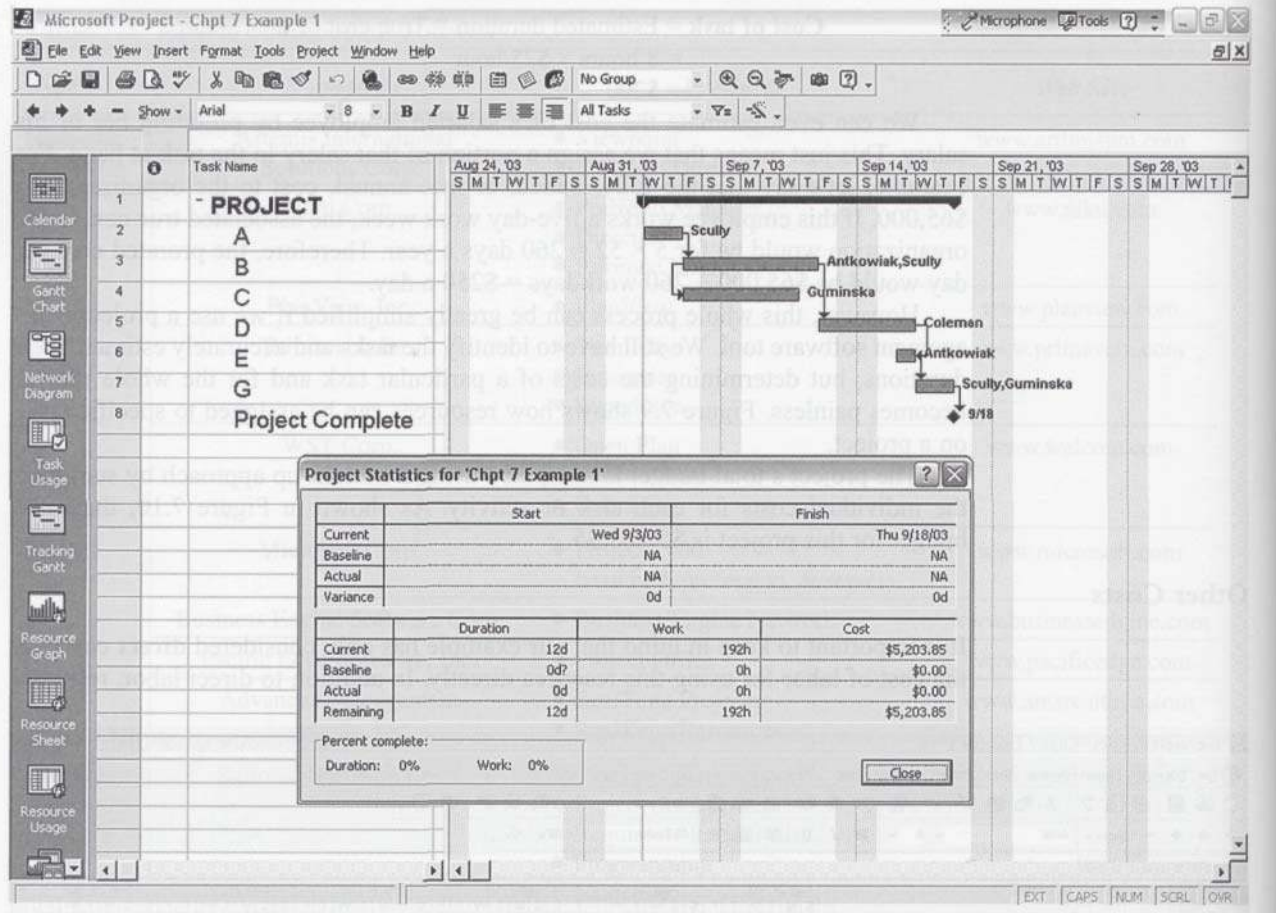


Figure 7.9 Using Microsoft Project to Assign Resources to Tasks





**Figure 7.10** Using Microsoft Project 2000 to Compute the Basic Budget

costs include indirect labor, materials, supplies, and reserves (Kinsella 2002). To determine the total project's budget, we also need to include other costs as well. These costs include:

- *Indirect Costs*—These costs include such things as rent, utilities, insurance, and other administrative costs. For example, a consulting firm may charge a client \$150 an hour per consultant. Included in that hourly fee would be the salary and benefits of the consultant and enough margin to help cover the administrative and operation costs needed to support the consulting office.
- *Sunk Costs*—Sunk costs are costs that have been incurred prior to the current project. For example, a previous attempt to build an application system may have ended in failure after three months and \$250,000. This \$250,000 would be considered a sunk cost, regardless of whether any work from the previous project is salvageable or of use to the current project.
- *Learning Curve*—Often we have to "build one and throw it away" in order to understand a problem or use a new technology effectively. In addition, inexperienced people will make mistakes and new technology will usually require a steep learning curve in the beginning. As a result, time and effort can be wasted. This time to learn should be considered in either the project schedule or budget.

*Reserves*—Reserves provide a cushion when unexpected situations arise. Contingency reserves are based on risk and provide the project manager with a degree of flexibility. On the other hand, a project budget should have some management contingencies built in as well. Of course, reserves are a trade-off. Upper management or the client will view these as fat that can be trimmed from the project budget; however, the wise project manager will ensure that a comfortable reserve is included in the project's budget. For example, it would be sad to think that the project's budget would not allow the project manager to buy pizza or dinner for the team once in a while as a reward for working late to meet an important milestone.

## Resource Allocation

Once the resources have been assigned to the project, it is important that the project manager review the project plan to ensure that the resources are level. In other words, resources cannot be over allocated—i.e., a resource cannot be assigned to more than one task at the same time. Although the project manager may catch these mistakes early on, it is important that the level of resources be reviewed once the project schedule and resource assignments have been made. Not catching these mistakes early can have a demoralizing effect on the team and lead to unplanned (i.e., unbudgeted) costs. A project management tool such as Microsoft Project provides the means for identifying overallocated resources. Figure 7.11 provides an example of the Resource Allocation View where a project team member has been assigned to two tasks at the same time. A project manager has the choice of creating a new relationship for these tasks (e.g., FS) or reassigning another resource to one of the tasks. In addition, many software management tools can level resources automatically for the project manager.

## | FINALIZING THE PROJECT SCHEDULE AND BUDGET

The project schedule and budget may require several iterations before it is acceptable to the sponsor, the project manager, and the project team. In addition, it is important that the project manager document any and all assumptions used to come up with duration and cost estimates. For example, this documentation may include estimating the salary of a database administrator (DBA) who will be hired at a future date. Instead of allocating a cost of what the project manager *thinks* a DBA will cost (or worse yet, what upper management would like to pay), he or she could use salary surveys or salary information advertised in classified advertisements as a base cost estimate. So, the project manager should document the source of this cost in order to give the cost estimates greater credibility. In addition, the project plan may include several working drafts. Having assumptions documented can help keep things organized as well.

Once the project schedule and project plan are accepted, the project plan becomes the baseline plan that will be used as a yardstick, or benchmark, to track the project's actual progress with the original plan. Once accepted, the project manager and project team have the authority to execute or carry out the plan. As tasks and activities are completed, the project plan must be updated in order to communicate the project's progress in relation to the baseline plan. Any changes or revisions to the project's estimates should be approved and then reflected in the plan to keep it updated and realistic.

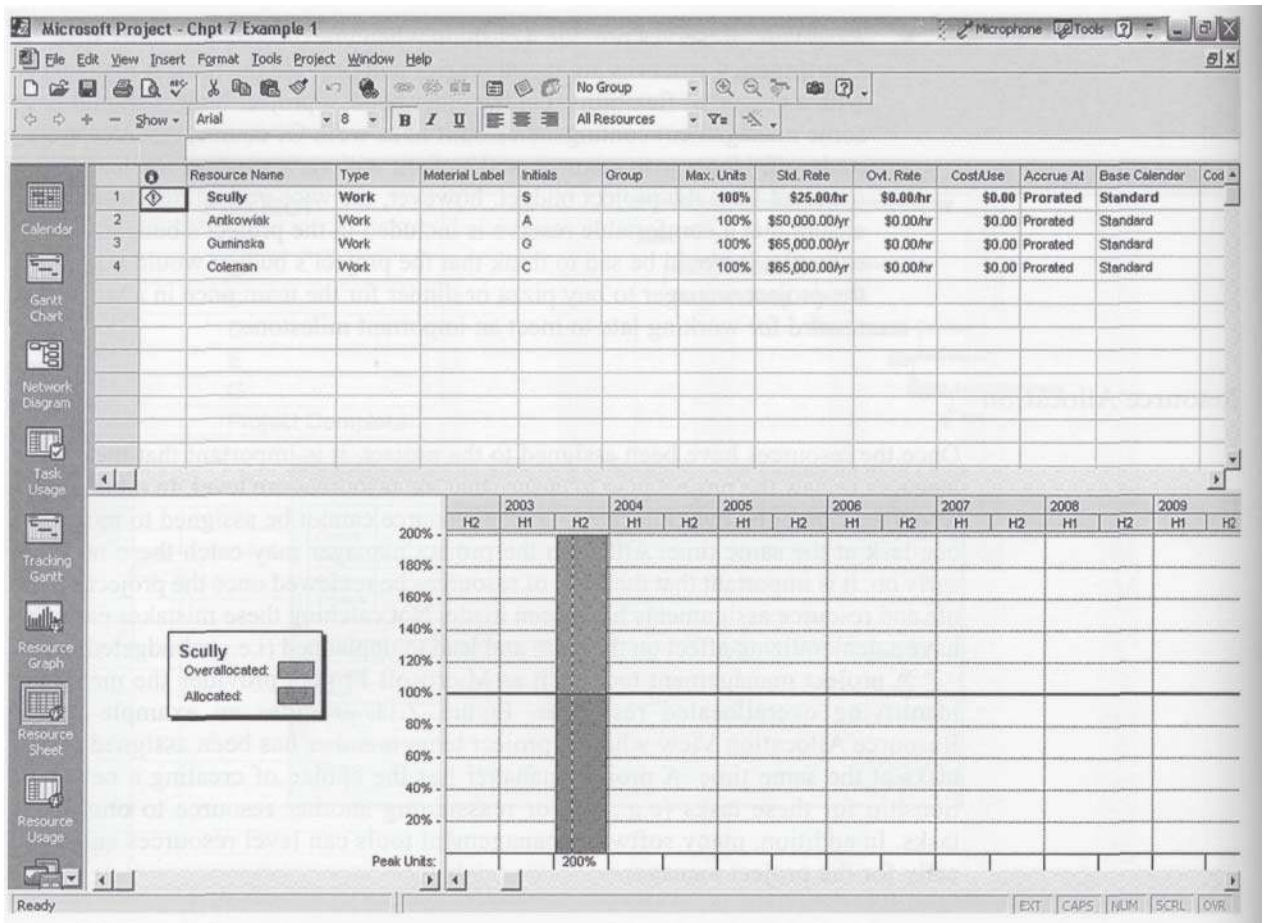


Figure 7.11 Example of Resource Overallocation

## CHAPTER SUMMARY

Once project activities or tasks are identified and activity durations are estimated, the sequencing of these activities will help determine the project schedule and estimated completion date. Several techniques were introduced in this chapter. The use of project management software tools can help simplify the development of the project schedule. In addition, these tools can help the project manager identify and monitor activities that are on the critical path. They can help the project manager make decisions with respect to allocation of resources or the rescheduling of activities. In addition, these tools provide a useful information system capable of communicating the actual progress of the project to the original baseline plan.

In general, if a project uses a resource, the cost associated with that resource must be included in the

project's budget and must be accounted for as a cost to the project. Project costs are both directly and indirectly related to the resources needed to complete a particular task or activity or support other resources that do. It is important that the right resources and the right quantity of resources be assigned to the project activities.

Together, the approved project schedule and project budget make up the baseline project plan. Approval of this plan by the project client or upper management gives the project manager and team the authority to carry out this plan. Actual progress is then compared to this plan to determine whether the project is on track, ahead of plan, or behind the plan. In order to keep the plan realistic, revisions or changes to the plan should be approved and made.

## REVIEW QUESTIONS

1. Describe the PMBOK area of project cost management.
2. Discuss why no project ever failed because of someone's inability to draw a nice looking project network diagram.
3. What are some advantages project network diagrams have over traditional Gantt charts?
4. Define predecessor, successor, and parallel activities. Give a real world example of each.
5. How can parallel activities help shorten the project schedule? Are there any trade-offs?
6. What is meant by slack (or float)?
7. What is the difference between *crashing and fast tracking* a project's schedule?
8. What is the difference between AON and PERT?
9. Define the following and give a real world example of each (other than the ones described in this book):  
Finish-to-Start; Start-to-Start; Finish-to-Finish; Start-to-Finish
10. What is the difference between lead and lag? Give real world examples (other than the ones used in this book) of how a project manager may use lead and lag in a project schedule.
11. Describe the steps necessary for estimating the cost of a particular activity or task that has an estimated duration.
12. What does prorating the cost of a resource mean?
13. Why should the project manager ensure that the project resources are leveled?
14. Why should assumptions used in estimating be documented?
15. What is a baseline plan?
16. When does the project manager or team have the authority to begin executing the project plan?

## EXTEND YOUR KNOWLEDGE

Develop a network diagram using the AON technique and calculate the critical path using the information in the table to the right. Enter the information from the above table into a project management software package. What is the critical path?

<i>Task/ Activity</i>	<i>Estimated Duration</i>	<i>Predecessor</i>
A	1 day	None
B	3 days	A
C	4 days	B
D	2 days	B
E	1 day	C
F	3 days	C,D
G	3 days	E
H	1 day	F
I	2 days	G, H
J	5 days	I

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