Concepts in this chapter support the following Project Management Knowledge Areas of A Guide to the Project Management Body of Knowledge (PMBOK® Guide):

- Project Integration Management

---

**REAL WORLD PROJECT MANAGEMENT**

**Feds and Contractor Share Blame for Afghan Plant Delays**

Scheduled to be completed in April 2009, the 105-megawatt, dual-fuel Tarakhil Power Plant near Kabul has experienced many delays and cost overruns. The U.S. Special Inspector General of Afghanistan Reconstruction blamed federal and contractor management failures in a January 2010 report. The expected completion date was delayed for over a year from the April 2009 date.
This chapter presents an overview of project management concepts. You will become familiar with the

- Definition of a project and its attributes
- Key constraints within which a project must be managed
- Life cycle of a project
- Definition of project management
- Elements of the project management process
- Implications of global project management
- Project Management Institute
- Benefits of project management

The original statement of work lacked specific deliverables and deadlines, which resulted in the project’s being a string of task orders without an established schedule and secured resources. The initial costs of the project were estimated at $125 million for 18 diesel generators in an existing plant. Fifteen contract modifications resulted in scope changes and budget increases. The final plan was estimated to cost $260 million with the construction of a new facility. The typical cost estimate for diesel plant construction in the Middle East and Asia has been $105 million, $1 million per megawatt planned.

Modifications and issue resolutions would take months and years, resulting in a six-month delay for site work. To fast-track the project, turbines were built in Germany at an increased expense and flown to the site. The total project costs were nearing $300 million, a $40 million overrun of the final plan.

Critics of the project suggest that the power plant may never be used due to the high costs of operation; this project is expected to cost Afghan taxpayers three times as much as comparable projects for operation. It has been suggested that the U.S. Agency for International Development and its contractors made the same mistakes that they had made in similar projects because they did not apply what they had learned on the other projects. Planners ignored alternative recommendations from local officials that were less expensive, selected expensive technologies that may not be sustainable, and hired a complex system of multiple contractors with unrealistic time expectations for completion and high costs.

The original contract guaranteed a profit for the Kansas-based contractor through cost-plus contracting. Subcontracts were awarded on fixed price bases to a network of firms. Subcontractors may never be fully reimbursed for changes or delays that the original contractor caused.

The contractor’s failure to properly identify needs, examine and secure resources, manage risks, and secure a schedule of performance put the project at risk. These failures lie in the critical components of planning, scheduling, organization, teamwork, communication, and leadership. Development of these project management skills will be discussed in detail in this book.

Your chances of avoiding the pitfalls of these contractors and subcontractors will be greatly improved by mastering these project management concepts. And mastery will improve your chances of successful project completion and management.

LEARNING OUTCOMES

After studying this chapter, the learner should be able to:

- Define what a project is
- List and discuss the attributes of a project
- Explain what is meant by project objective
- Define what is meant by project deliverable
- Provide examples of projects
- Discuss project constraints
- Describe the phases of the project life cycle
- Define and apply project management
- Discuss the steps of the planning process
- Identify the three elements of the executing process
- Discuss some implications of global project management
- Discuss the Project Management Institute
- List benefits of project management techniques

Project Attributes

A project is an endeavor to accomplish a specific objective through a unique set of interrelated tasks and the effective utilization of resources. The following attributes help define a project:

- A project has a clear objective that establishes what is to be accomplished. It is the tangible end product that the project team must produce and deliver. The project objective is usually defined in terms of end product or deliverable, schedule, and budget. It requires completing the project work scope and producing all the deliverables by a certain time and within budget. For example, the objective of a project might be to introduce a new portable food preparation appliance in 10 months and within a budget of $2 million.

  The project objective may also include a statement of the expected benefits or outcomes that will be achieved from implementing the project. It is why the project is being done. For example, a project with the objective to develop a new product may have an expected outcome to sell a certain number of units of that new product within a year, or to increase market share by a specific percent. The project objective might be to expand market share by 3 percent by introducing a new portable food preparation appliance within 10 months with a budget of $2 million. In this case, the outcome of increased market share would not be known until some time period has elapsed after the new product development project is completed. Another example is a project with an objective to put on an event to raise funds for a particular cause, such as diabetes research, but the expected benefit of the event is to raise a certain amount of money, such as $20,000. In this case, the completion of the project—holding the fundraising event—enables the benefit to be achieved.

- A project is carried out through a series of interdependent tasks—that is, a number of non-repetitive tasks that need to be accomplished in a certain sequence in order to achieve the project objective.

- A project utilizes various resources to carry out the tasks. Such resources can include different people, organizations, equipment, materials, and facilities. For example, a project to perform a complex series of surgical operations may involve doctors with special expertise, nurses, anesthesiologists, surgical
instruments, monitoring equipment, prosthetic devices or transplant organs, and special operating facilities.

- A project has a *specific time frame, or finite life span*. It has a start time and a date by which the objective must be accomplished. For example, the refurbishing of an elementary school might have to be completed between June 20 and August 20.

- A project may be a *unique or one-time endeavor*. Some projects, like designing and building a space station, are unique because they have never been attempted before. Other projects, such as developing a new product, building a house, or planning a wedding, are unique because of the customization they require. For example, a wedding can be a simple, informal occasion, with a few friends in a chapel, or a spectacular event, staged for royalty.

- A project has a **sponsor or customer**. The sponsor/customer is the entity that provides the funds necessary to accomplish the project. It can be a person, an organization, or a partnership of two or more people or organizations. When a contractor builds an addition to a house, the homeowner is the customer who is funding or paying for the project. When a company receives funds from a government agency to develop a robotic device for handling radioactive material, the sponsor is the government agency. When a company’s board of directors provides funds for a team of its employees to upgrade the firm’s management information system, the board is the sponsor of the project. In this last case, the term *customer* may take on a broader definition, including not only the project sponsor (the company’s management) but also other *stakeholders*, such as the people who will be the end users of the information system. The person managing the project and the project team must successfully accomplish the project objective to satisfy the project sponsor as well as the users of the project’s end product—an upgraded information system.

- Finally, a project involves a *degree of uncertainty*. Before a project is started, a plan is prepared based on certain assumptions and estimates. It is important to document these assumptions because they will influence the development of the project work scope, schedule, and budget. A project is based on a unique set of interdependent tasks and estimates of how long each task should take, various resources and assumptions about the availability and capability of those resources, and estimates of the costs associated with the resources. This combination of assumptions and estimates causes uncertainty that the project objective will be completely accomplished. For example, the project scope may be accomplished by the target completion date, but the final cost may be much higher than anticipated because of low initial estimates for the cost of certain resources. As the project proceeds, some of the assumptions will be refined or replaced with factual or updated information. For example, once the conceptual design of a company’s annual report is finalized, the amount of time and costs needed to complete the detailed design and produce the final document can be better estimated.

The following are some examples of projects:

- Staging a theatrical production
- Developing and introducing a new product
- Planning a wedding
- Designing and implementing a computer system
- Issuing a new $1.00 coin
Modernizing a factory
Consolidating two manufacturing plants
Converting a basement to a family room
Hosting a conference
Designing and producing a brochure
Executing an environmental cleanup of a contaminated site
Holding a high school reunion
Building a shopping mall
Performing a series of surgeries on an accident victim
Organizing a community festival
Rebuilding a town after a natural disaster
Hosting a dinner for 20 relatives
Designing a business internship program for high school students
Building a tree house

Reinforce Your Learning
2. Identify three projects in which you have been involved during your lifetime.

Balancing Project Constraints
The successful accomplishment of the project objective could be constrained by many factors, including scope, quality, schedule, budget, resources, risks, and customer satisfaction.

The project scope is all the work that must be done in order to produce all the project deliverables (the tangible product or items to be provided), satisfy the customer that the deliverables meet the requirements or acceptance criteria, and accomplish the project objective. For example, the project scope might be all of the work involved in clearing the land, building a house, and landscaping to the specifications agreed upon by the contractor and the buyer. Or a project to install new high-speed specialized automation equipment in a factory might include designing the equipment, building it, installing it, testing it to make sure it meets acceptance criteria, training workers to operate and maintain the equipment, and providing all the technical and operating documentation for the equipment.

Quality expectations must be defined from the onset of the project. The project work scope must be accomplished in a quality manner and meet specifications. For example, in a house-building project, the customer expects the workmanship to be of the highest quality and all materials to meet specifications. Completing the work scope but leaving windows that are difficult to open and close, faucets that leak, or a landscape full of rocks will result in an unsatisfied customer and perhaps a payment or legal dispute. Mechanisms, such as standards, inspections, audits, and so forth must be put in place to assure quality expectations are being met throughout the project and not just checked or inspected at the end of the project, when it might be costly to correct. All project deliverables should have quantitative acceptance criteria.

The schedule for a project is the timetable that specifies when each task or activity should start and finish. The project objective usually states the time by which the project scope must be completed in terms of a specific date agreed upon by the sponsor and the organization performing the project. The project schedule indicates the dates when specific tasks must be started and finished in
order to meet the project completion date (for example, when a new bridge is to be open to traffic or when a new product must be launched at an industry exposition).

The **budget** of a project is the amount the sponsor or customer has agreed to pay for acceptable project deliverables. The project budget is based on estimated costs associated with the quantities of various resources that will be used to perform the project. It might include the salaries of people who will work on the project, materials and supplies, equipment, rental of facilities, and the fees of subcontractors or consultants who will perform some of the project tasks. For example, for a wedding project, the budget might include estimated costs for flowers, gown, tuxedo, caterer, cake, limousine rental, videographer, reception facility, and so on.

Various **resources** are needed to perform the project tasks and accomplish the project objective. Resources include people, materials, equipment, facilities, and so on. Human resources include people with specific expertise or skills. Certain quantities of each type of resource with specific expertise are required at specific periods of time during the project. Similarly, particular equipment may be required during a certain portion of a project, such as equipment needed to excavate the land before construction can start on a new office building. The resource requirements for a project must be aligned with the types and quantities of resources available at the time periods when they are required.

There could be **risks** that adversely affect accomplishing the project objective. For example, designing an information system using the newest technology may pose a risk that the new technology may not work as expected. Or there may be a risk that a new pharmaceutical product may not receive regulatory approval. A risk management plan must be developed that identifies and assesses potential risks and their likelihood of occurrence and potential impact, and delineates responses for dealing with risks if they do occur.

Ultimately, the responsibility of the project manager is to make sure the **customer is satisfied**. This goes beyond just completing the project scope within budget and on schedule or asking if the customer or sponsor is satisfied at the end of the project. It means not only meeting the customer’s expectations but also developing and maintaining an excellent working relationship throughout the project. It requires ongoing communication with the customer or sponsor to keep the customer informed and to determine whether expectations have changed. Regularly scheduled meetings or progress reports, phone discussions, and e-mail are examples of ways to accomplish such communication. Customer satisfaction requires involving the sponsor as a partner in the successful outcome of the project through active participation during the project. The project manager must continually be aware of the degree of the customer’s satisfaction. By maintaining regular communication with the customer or sponsor, the project manager demonstrates genuine concern about the customer’s expectations; it also prevents unpleasant surprises later.

Successfully completing the project requires finishing the scope of work within budget and a certain time frame, while managing resource utilization, meeting quality specifications, and managing risks—and this must all be done while assuring customer or sponsor satisfaction. During the project, it is sometimes challenging to balance or juggle these factors, which often constrain one another and could jeopardize accomplishing the project objective. See Figure 1.1. To help assure the achievement of the project objective, *it is important to develop a plan before starting the project work*, rather than jumping in and starting without a plan. Lack of a plan decreases the chances of successfully accomplishing the full project scope within budget and on schedule.
Once a project is started, unforeseen circumstances may jeopardize the achievement of the project objective with respect to scope, budget, or schedule. They include:

- The cost of some of the materials is more than originally estimated.
- Inclement weather causes a delay.
- Additional redesign and modifications to a new sophisticated medical instrument are required to get it to meet performance specifications and government testing requirements.
- Delivery of a critical component for an aviation control system is delayed several months.
- A key project team member with unique technical knowledge decides to retire, which creates a gap in critical expertise.

Any of the above examples could affect the balance of scope, quality, schedule, budget, resources, risks, and customer satisfaction (or impact these factors individually), jeopardizing successful accomplishment of the project objective. The challenge for the project manager is to not only continually balance these factors throughout the performance of the project but also prevent, anticipate, or overcome such circumstances if and when they occur. Good planning and communication are essential to prevent problems from occurring or to minimize their impact on the achievement of the project objective when they do occur. The project manager needs to be proactive in planning and communicating and provide
leadership to the project team to keep these constraining factors in balance and to accomplish the project objective.

**Project Life Cycle**

The generic *project life cycle* has four phases: initiating, planning, performing, and closing the project. Figure 1.2 shows the four phases and the relative level of effort and time devoted to each phase. The time span of each phase and the associated level of effort will vary depending on the specific project. Project life cycles vary in length from a few weeks to several years, depending on the content, complexity, and magnitude of the project.

In the **initiating phase**, projects are identified and selected. They are then authorized, using a document referred to as a *project charter*. The **planning phase** includes defining the project scope, identifying resources, developing a schedule and budget, and identifying risks, all of which make up the *baseline plan* for doing the project work. In the **performing phase**, the project plan is executed, and work tasks are carried out to produce all the *project deliverables* and to accomplish the project objective. During this phase, the project progress is monitored and controlled to assure the work remains on schedule and within budget, the scope is fully completed according to specifications, and all deliverables meet acceptance criteria. Also, any changes need to be documented, approved, and incorporated into an updated baseline plan, if necessary. In the **closing phase**, project evaluations are conducted, lessons learned are identified.

---

**Reinforce Your Learning**

3. What are seven factors that constrain the achievement of a project objective?

---

**FIGURE 1.2** Project Life Cycle Effort

![Project Life Cycle Effort Diagram](image-url)
and documented to help improve performance on future projects, and project documents are organized and archived.

INITIATING

This first phase of the project life cycle involves the identification of a need, problem, or opportunity and can result in the sponsor authorizing a project to address the identified need or solve the problem. Projects are initiated when a need is identified by a sponsor—the people or the organization willing to provide funds to have the need satisfied. For example, a company may need to reduce the high scrap rate from its manufacturing process that makes its costs higher and production times longer than those of its competitors, or a community with a growing population may need to build a new school. In some cases, it could take several months to clearly define a need, gather data, and define the project objective. For example, the management of a hospital may want to establish an on-site day care center for the children of its employees as part of its strategy to attract and retain employees. However, it may take some time to gather data regarding the need and analyze various approaches to addressing the need. It is important to define the right need. For example, is the need to provide an on-site day care center, or is it to provide child care for the children of the hospital’s employees? That is, is “on-site” necessarily part of the need?

The need for projects is often identified as part of an organization’s strategic planning process. Projects are a means to implement elements of specific strategies or actions, such as build an offshore wind farm, deploy a nutrition assistance program in a developing country, construct a new manufacturing facility in South America, or implement a corporate-wide online training program. Organizations may have many projects they would like to pursue, but they may be limited by the amount of available funds. Although an individual may need an addition to his house, need a new car, and want to go on a two-week vacation, he may not have the money to do all of those things. Therefore, organizations must employ a process to select which projects to pursue. Once projects are selected, they are formally authorized using a document referred to as a project charter. The charter may include the rationale or justification for the project; project objective and expected benefits; general requirements and conditions such as amount of funds authorized, required completion date, major deliverables, and required reviews and approvals; and key assumptions.

If the organization decides to use external resources (a contractor) to perform the project, the organization will prepare a document called a request for proposal (RFP). Through the RFP, the sponsor or customer asks contractors to submit proposals on how they might address the need and the associated costs and schedule to do so. An individual who needs a new house may spend time identifying requirements for the house—size, style, number of rooms, location, maximum amount she wants to spend, and date by which she would like to move in. She may then write down these requirements and ask several contractors to provide house plans and cost estimates. A company that has identified a need to develop a multifaceted advertising campaign for a new food product might document its requirements in an RFP and send it to several advertising firms. The advertising firms would submit proposals to the company. The company would then evaluate the competing proposals and select an advertising firm (the contractor) to do the advertising campaign (the project) and sign an agreement or contract with that firm.
PLANNING

Before jumping in and starting the project, the project team or contractor must take sufficient time to properly plan the project. It is necessary to lay out a roadmap, or game plan, that shows how the project scope will be accomplished within budget and on schedule. Trying to perform a project without a plan is like attempting to assemble a backyard grill without first reading the instructions. Individuals who think planning is unnecessary or a waste of time invariably need to find time later on to redo things. It is important to plan the work and then work the plan. Otherwise, chaos and frustration will result, and the risk of project failure will be higher.

Once a project is authorized and/or a contract is signed with an external contractor, the next phase of the project life cycle is to do detailed planning for how to accomplish the project. The planning involves determining what needs to be done (scope, deliverables), how it will get done (activities, sequence), who will do it (resources, responsibility), how long it will take (durations, schedule), how much it will cost (budget), and what the risks are. The result of this effort is a baseline plan that is a roadmap for accomplishing the project within the requirements and constraints in the project charter or contract. This plan will also be used as a benchmark to which actual progress can be compared.

Taking the time to develop a well-thought-out plan is critical to the successful accomplishment of any project. Many projects have overrun their budgets, missed their completion dates, or only partially satisfied their technical specifications because there was no viable baseline plan in place before they were started. It is important that the people who will be involved in performing the project also participate in planning the work. They are usually the most knowledgeable about which detailed activities need to be done. Also, by participating in the planning of the work, these individuals become committed to accomplishing it according to the plan. Participation builds commitment.

PERFORMING

The third phase of the project life cycle is performing the project. Once the baseline plan has been developed, work can proceed. The project team, led by the project manager, will execute the plan and perform the activities to produce all the deliverables and to accomplish the project objective. The pace of project activity will increase as more and various resources become involved in performing the project tasks. During the course of performing the project, different types of resources will be utilized. For example, if the project is to design and construct an office building, the project effort might first involve a few architects and engineers in developing the building plans. Then, as construction gets under way, the resources needed will substantially increase to include steelworkers, carpenters, electricians, painters, and the like. The level of effort will decrease after the building is finished, and a smaller number of different workers will finish up the landscaping and final interior touches.

This phase results in the accomplishment of the project objective, leaving the customer satisfied that the full scope of the work and deliverables were completed according to specifications, within budget, and on time. For example, the performing phase is complete when a project team within a company has completed a project that consolidated two of its facilities into one, or when an external contractor has completed the design and installation of a customized information system that satisfactorily passes performance tests and is accepted by the customer.
While the project work is being performed, it is necessary to **monitor and control the progress** of the project work to ensure that everything is going according to plan and the project objective will be accomplished. This involves measuring actual progress and comparing it to planned progress according to the baseline plan. To measure actual progress, it is important to keep track of which tasks have actually been started and completed, when they were started and completed, the earned value of the work completed, if the project deliverables are meeting the expected quality criteria, and how much money has been spent or committed. If, at any time during the project, comparison of actual progress to planned progress reveals that the project is behind schedule, overrunning the budget, or not meeting the technical specifications, corrective action must be taken to get the project back on track.

Before a decision is made to implement corrective action, it may be necessary to evaluate several alternative actions to make sure the corrective action will bring the project back within the scope, schedule, and budget constraints of the project objective. Be aware, for instance, that adding resources to make up time and get back on schedule may result in overrunning the planned budget. If a project gets too far out of control, it may be difficult to accomplish the project objective without sacrificing the scope, budget, schedule, or quality. The key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis throughout the performing phase and taking any needed corrective action immediately. Hoping that a problem will go away without corrective intervention is naive. The earlier a problem is identified and corrected, the better. Based on actual progress, it is possible to forecast a schedule and budget for completion of the project. If these parameters are beyond the limits of the project objective, corrective actions need to be implemented at once.

Changes are going to occur during the performing phase. So it is important to **manage and control changes** to minimize any negative impact on the successful accomplishment of the project objective. A change control system needs to be established to define how changes will be documented, approved, and communicated. Agreement must be reached between the sponsor or customer and the project manager or contractor, as well as between the project manager and the project team, regarding the way changes will be handled. These procedures should address communication between the project manager and the sponsor or customer and between the project manager and the project team. If changes are consented to verbally rather than approved in writing and there is no indication given of the impact the changes will have on the work scope, budget, or schedule, there are bound to be problems down the road. Project team members should be careful about casually agreeing to changes without knowing whether they will necessitate additional person-hours of work. If the customer does not agree to pay for extra effort, the contractor must absorb the additional costs and also risk overrunning costs for a particular task or the project.

Some changes are trivial, but others may significantly affect the project work scope, budget, or schedule. Deciding to change the color of a room before it is painted is a trivial change. Deciding that you want a two-story house after the contractor has already put up the framing for a single-story house is a major change, and would certainly increase the cost and probably delay the completion date.

The impact a change has on accomplishing the project objective may be affected by when the change is identified. Generally, **the later in the project that changes are identified, the greater their effect on accomplishing the project**

---

**Reinforce Your Learning**

7. In the performing phase, the project plan is ________________ to produce all the ________________ and to accomplish the ________________.
The aspects most likely to be affected are the project budget and the completion date. This is particularly true when work that has already been completed needs to be “undone” to accommodate the required change. For example, it would be very expensive to change the plumbing or wiring in a new office building after the walls and ceilings are completed because some of them would need to be torn out and new ones installed. However, if such a change was made much earlier in the project—for instance, while the building was still being designed—the accommodation would be easier and less costly. The drawings could be changed so that the plumbing and wiring would be installed correctly the first time.

The project manager, project team, contractor, or sponsor/customer may initiate changes. Some changes could be necessary as a result of the occurrence of a previously defined risk, such as a new product development not meeting certain test criteria, which would mean additional redesign work.

When it is determined that corrective actions or changes are necessary, decisions must be made regarding how to update the baseline plan. These decisions often mean a trade-off involving time, cost, scope, and quality. For example, reducing the duration of an activity may require either increasing costs to pay for more resources or reducing the scope of the task (and possibly not meeting the customer’s technical requirements). Similarly, reducing project costs may require using materials of a lower quality than originally planned. Once a decision is made on which actions to take, they must be incorporated into the schedule and budget. It is necessary to develop a revised schedule and budget to determine whether the planned corrective measures or changes result in an acceptable schedule and budget. If not, further revisions must be made until an acceptable revised baseline plan is agreed upon.

The performing phase of the project life cycle ends when the sponsor or customer is satisfied that the project objective has been accomplished and that the requirements have been met, and accepts the project deliverables.

**CLOSING**

The final phase of the project life cycle is closing the project. The process of closing the project involves various actions, including collecting and making final payments, evaluating and recognizing staff, conducting a post-project evaluation, documenting lessons learned, and archiving project documents.

The project organization should ensure that copies of appropriate project documentation are properly organized, filed and archived so that they can be readily retrieved for use in the future. For example, using some actual cost and schedule information from a completed project may be helpful when developing the schedule and estimated costs for a proposed project.

An important task during this phase is evaluating performance of the project. The project team should identify lessons learned and make recommendations for improving performance on future projects. To encourage the use of this information, a knowledge base system should be established that includes and easily accessible repository to retrieve lessons learned and information from previous projects.

Feedback should also be obtained from the sponsor or customer to determine whether the anticipated benefits from the project were achieved, assess the level of customer satisfaction, and obtain any feedback that would be helpful in future business relationships with this customer or other customers.
Project Management Process

**Project management** is planning, organizing, coordinating, leading, and controlling resources to accomplish the project objective. The project management process involves *planning the work and then working the plan*. A coaching staff may spend hours preparing a unique plan for a game; the team then executes the plan.
to try to accomplish the objective—victory. Similarly, the project management process involves two major functions: first establishing a plan and then executing that plan to accomplish the project objective.

Once the sponsor has prepared a project charter to authorize going forward with a project, the front end effort in managing a project must be focused on establishing a realistic baseline plan that provides a roadmap for how the project
The project objective establishes what is to be accomplished. The planning process determines what needs to be done (scope, deliverables), how it will get done (activities, sequence), who will do it (resources, responsibility), how long it will take (durations, schedule), and how much it will cost (budget). It includes the following steps:

1. **Establish project objective.** The objective must be agreed upon by the sponsor or customer and the organization that will perform the project.

2. **Define scope.** A project scope document must be prepared. It should include customer requirements, define the major work tasks or elements, as well as provide a list of deliverables and associated acceptance criteria that can be used to verify that the work and deliverables meet specifications.

3. **Create a work breakdown structure.** Subdivide the project scope into pieces or work packages. Although projects may seem overwhelming when viewed as a whole, one way to conquer even the most monumental endeavor is to break it down into smaller components. A work breakdown structure (WBS) is a hierarchical decomposition of the project scope into work elements or items to be executed by the project team that will produce the project deliverables. Figure 1.3 is an example of a work breakdown structure.
4. Assign responsibility. The person or organization responsible for each work item in the work breakdown structure must be identified in order to inform the project team of who is responsible and accountable for the performance of each work package and any associated deliverables. For example, Figure 1.3 indicates who is responsible for each work item.

5. Define specific activities. Review each work package in the work breakdown structure and develop a list of the detailed activities that need to be performed for each work package and to produce any required deliverables.

6. Sequence activities. Create a network diagram that shows the necessary sequence and dependent relationships of the detailed activities that need to be performed to achieve the project objective. Figure 1.4 is an example of a network diagram.

7. Estimate activity resources. Determine the types of resources, such as the skills or expertise required to perform each activity, as well as the quantity of each resource that may be needed. Resources include people, materials, equipment, etc., that may be required to perform each activity. Resource estimates must consider the availability of each type of resource, whether it is internal or external (such as subcontractors), and the quantity available over the duration of the project. Designate a specific individual to be responsible for each activity.

8. Estimate activity durations. Make a time estimate for how long it will take to complete each activity, based on the estimate of the resources that will be applied.
9. **Develop project schedule.** Based on the estimated duration for each activity and the logical relationships of the sequence of activities in the network diagram, develop the overall project schedule, including when each activity is expected to start and finish, as well as the latest times that each activity must start and finish in order to complete the project by the project required completion date. Figure 1.5 is an example of a project schedule.

10. **Estimate activity costs.** Activity costs should be based on the types and quantities of resources estimated for each activity as well as the appropriate labor cost rate or unit cost for each type of resource.

11. **Determine budget.** A total budget for the project can be developed by aggregating the cost estimates for each activity. Similarly, budgets can be determined for each work package in the work breakdown structure by aggregating the cost estimates for the detailed activities for each work package. Other costs, such as project or organizational administrative, indirect, or overhead costs should also be included in the budget and be appropriately allocated to each activity or work package. Once the total budget is determined for the overall project or for each work package, a time-phased budget needs to be developed to distribute the budget over the duration of the project or work package based on the project schedule for

---

**FIGURE 1.5 Project Schedule Consumer Market Study Project**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Identify Target Consumers</td>
<td>Susan</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>–8</td>
<td>–5</td>
<td>–8</td>
</tr>
<tr>
<td>2 Develop Draft Questionnaire</td>
<td>Susan</td>
<td>10</td>
<td>3</td>
<td>13</td>
<td>–5</td>
<td>5</td>
<td>–8</td>
</tr>
<tr>
<td>3 Pilot-Test Questionnaire</td>
<td>Susan</td>
<td>20</td>
<td>13</td>
<td>33</td>
<td>5</td>
<td>25</td>
<td>–8</td>
</tr>
<tr>
<td>4 Review Comments &amp; Finalize Qn.</td>
<td>Susan</td>
<td>5</td>
<td>33</td>
<td>38</td>
<td>25</td>
<td>30</td>
<td>–8</td>
</tr>
<tr>
<td>5 Prepare Mailing Labels</td>
<td>Steve</td>
<td>2</td>
<td>38</td>
<td>40</td>
<td>38</td>
<td>40</td>
<td>0</td>
</tr>
<tr>
<td>6 Print Questionnaire</td>
<td>Steve</td>
<td>10</td>
<td>38</td>
<td>48</td>
<td>30</td>
<td>40</td>
<td>–8</td>
</tr>
<tr>
<td>7 Develop Data Analysis Software</td>
<td>Andy</td>
<td>12</td>
<td>38</td>
<td>50</td>
<td>88</td>
<td>100</td>
<td>50</td>
</tr>
<tr>
<td>8 Develop Software Test Data</td>
<td>Susan</td>
<td>2</td>
<td>38</td>
<td>40</td>
<td>98</td>
<td>100</td>
<td>60</td>
</tr>
<tr>
<td>9 Mail Questionnaire &amp; Get Responses</td>
<td>Steve</td>
<td>65</td>
<td>48</td>
<td>113</td>
<td>40</td>
<td>105</td>
<td>–8</td>
</tr>
<tr>
<td>10 Test Software</td>
<td>Andy</td>
<td>5</td>
<td>50</td>
<td>55</td>
<td>100</td>
<td>105</td>
<td>50</td>
</tr>
<tr>
<td>11 Input Response Data</td>
<td>Jim</td>
<td>7</td>
<td>113</td>
<td>120</td>
<td>105</td>
<td>112</td>
<td>–8</td>
</tr>
<tr>
<td>12 Analyze Results</td>
<td>Jim</td>
<td>8</td>
<td>120</td>
<td>128</td>
<td>112</td>
<td>120</td>
<td>–8</td>
</tr>
<tr>
<td>13 Prepare Report</td>
<td>Jim</td>
<td>10</td>
<td>128</td>
<td>138</td>
<td>120</td>
<td>130</td>
<td>–8</td>
</tr>
</tbody>
</table>
when each activity is expected to start and finish. Figure 1.6 is an example of a time-phased project budget.

Once the project schedule and budget are developed, it must be determined whether the project can be completed within the required time, with the allotted funds, and with the available resources. If not, adjustments must be made to the project scope, activity resource or duration estimates, or resource assignments until an achievable, realistic baseline plan, the roadmap for accomplishing the project scope on time and within budget, can be established.

The result of the planning process is a baseline plan. Taking the time to develop a well-thought-out plan is critical to the successful accomplishment of any project. Many projects have overrun their budgets, missed their completion dates, or only partially met their requirements because there was no viable baseline plan before the project was started.

The baseline plan for a project can be displayed in graphical or tabular format for each time period (week, month) from the start of the project to its completion. Plans are discussed and illustrated in Chapters 4–7. Information should include:

- The start and completion dates for each activity
- The amounts of the various resources that will be needed during each time period
- The budget for each time period, as well as the cumulative budget from the start of the project through each time period
Once a baseline plan has been established, the plan must be executed. The executing process involves performing the work according to the plan, monitoring and controlling the work, and managing changes so that the project scope is achieved within the budget and schedule, to the customer’s satisfaction. It includes the following elements:

1. **Perform the work.** All the activities in the baseline plan, as depicted in the network diagram, must be performed in accordance with the project schedule and technical specifications. All deliverables must be produced and meet their acceptance criteria. Accomplishing this requires coordination of the project team, including external resources, and regular communication with all stakeholders, including the sponsor or customer, to make sure that expectations are being met.

2. **Monitor and control progress.** While the project work is being performed, it is necessary to monitor progress to ensure that everything is going according to plan. It is also necessary to measure actual progress and compare it to planned progress. If, at any time during the project, the comparison of actual progress to planned progress reveals that the project is behind schedule, overrunning the budget, or not meeting the technical specifications, corrective action must be taken to get the project back on track within the scope, schedule, and budget constraints of the project objective. Be aware, for instance, that adding resources to make up time and get back on schedule may result in overrunning the planned budget. If a project gets too far out of control, it may be difficult to achieve the project objective without sacrificing the scope, budget, schedule, or quality. The key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis and taking any needed corrective action immediately. Hoping that a problem will go away without corrective intervention is naı́ve. Based on actual progress, it is possible to forecast a schedule and budget for completion of the project. If these parameters are beyond the limits of the project objective, corrective actions need to be implemented at once.

3. **Control changes.** During the performance of the project work, changes will occur for a variety of unexpected reasons, such as some activities taking longer than expected to complete, resources not being available when needed, materials costing more than anticipated, or the occurrence of identified risks. Also, the project manager, contractor, or the sponsor/customer can request changes to the project scope based on new information or the result of project reviews. Changes are fine if the customer and the project manager or contractor agree on them, and both parties are aware of the impact the changes may have on the scope, schedule, budget, and accomplishment of the project objective. It is important to manage and control changes to minimize any negative impact on the successful accomplishment of the project objective. A change control system needs to be established to define how changes will be documented, approved, and communicated. All stakeholders need to agree on such a system, and it must be communicated to all project participants.

Attempting to perform a project without first establishing a baseline plan is foolhardy. It is similar to starting a vacation without a roadmap, itinerary, and budget. You may end up in the middle of nowhere—out of money and out of time!
Global Project Management

Globalization adds a unique dimension to managing projects. It changes the dynamics of the project and adds a layer of complexity that can adversely affect the project outcome if the project participants are not aware of what they might encounter regarding cultural differences and multinational economic transactions. For example, there could be a project contractual outsourcing requirement to spend a percentage of the project budget on wages and materials in the customer’s country by employing indigenous labor to perform certain project tasks and using in-country suppliers for project materials. Factors external to the project itself, or to the project or customer organizations, can create a dynamic and perhaps unstable environment over the life of the project, introduce sources of risk, and affect the success of the project. Such influencing factors can include:

- Currency fluctuations and exchange rates
- Country-specific work codes and regulations, such as hours per day, holidays, and religious observances
- Corporate joint ventures and partnerships creating entities with a presence and facilities in multiple countries
- Political relations between countries
- Availability of high-demand workforce skills

Large international events, such as the Olympics or rebuilding a region after a natural disaster, require multilingual project teams. Global projects can be multinational and multilingual, with participants who are located in various countries and who speak different languages. These aspects can create barriers to communication, team development, and project performance.

Global project management requires an additional set of competencies. It is helpful for the project manager and team to have foreign language skills and also knowledge and understanding of other countries and cultures, as well as geography, world history, and international economics (currencies, exchange rates, export/import transactions, etc.). There is a need to have awareness and understanding of the culture and customs (meal times, eye contact, possible differing roles of men and women, dress codes, religious practices, lines of authority, communication protocol, etc.) and etiquette (e.g., in some countries crossing your legs when sitting is considered an insult, or shaking hands or touching someone of the opposite sex is frowned upon) of the countries of the various project participants (project team, customer, subcontractors, and suppliers). It is also vital to have an awareness of the geopolitical environment of the countries of the various project participants, in particular the country of the customer, or where the project is being delivered or implemented.

Technology enables project participants to be just a “click” away, despite being thousands of miles apart physically. It also helps to reduce the impact that time zone differences among the locations of various project participants can have on project communication. One way to facilitate communication in multilingual project teams is to utilize software that translates e-mails and documents among the languages of the various project participants.

Globalization and the Internet have also brought new opportunities for firms, as seen in multi-sourcing project work elements to more competitive participants worldwide as well as in purchasing materials and services from suppliers around the globe.
Cultural awareness and sensitivity are not only important but also imperative for successful global project management. Learning and understanding the culture and customs of other project participants demonstrate respect, help build trust, aid in developing an effective project team, and are critical for successful global project management.

See the section on Valuing Team Diversity in Chapter 11 and the section on Collaborative Communication Tools in Chapter 12 for additional related information. Also see Appendix C for a list of project management associations around the globe.

Project Management Associations

The Project Management Institute (PMI) is a premier worldwide not-for-profit association for practitioners in the project management profession and individuals who want to learn more about the profession. Founded in 1969, PMI has approximately 350,000 members in more than 170 countries and about 250 chapters in more than 70 countries. Additionally, the association has a number of online communities of practice where peers can collaborate on specific topics of interest.

PMI publishes *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, which provides a framework of processes and guidelines for the application of project management concepts, practices, and techniques. The association also created the *PMI Code of Ethics and Professional Conduct*, which sets standards and establishes expectations for professional behavior.

PMI offers a certification program that provides the opportunity to earn credentials in various project management disciplines. There are approximately 400,000 individuals worldwide who are PMI credential holders. Additional and current information about the Project Management Institute can be found at http://www.pmi.org.

There are also many other project management associations around the globe. Appendix C provides a list of approximately 60 such associations. Their website addresses can be found on this book’s student companion website.

Benefits of Project Management

The ultimate benefit of implementing project management techniques is having a satisfied customer—whether you are the customer of your own project, such as remodeling your basement, or a business (contractor) being paid by a customer to perform a project. Completing the full project scope in a quality manner, on time, and within budget provides a great feeling of satisfaction. For a contractor, it could lead to additional business from the same customer in the future or to business from new customers referred by previously satisfied customers.

“Hey! Great for the customer, but what about me? What’s in it for me?” If you are the project manager, you have the satisfaction of knowing you led a successful project effort. You also have enhanced your reputation as a project manager and positioned yourself for expanded career opportunities. If you are a member of a project team that successfully accomplished a project, you feel the satisfaction of being on a winning team. You not only contributed to the project’s success but also probably expanded your knowledge and enhanced your skills along the way. If you choose to remain an individual contributor, you will be able to make a greater contribution to future, more complicated projects. If you are interested in eventually managing projects, you will be in a position to take on additional project responsibilities. When projects are successful, everybody wins!
Causal Inferences on the Cost Overruns and Schedule Delays of Large-Scale U.S. Federal Defense and Intelligence Acquisition Programs

Cost overruns and schedule slips have plagued large-scale U.S. federal defense and intelligence acquisition programs. National security is impacted by the cost overruns and schedule delays by limiting war-fighters to outdated technology when facing emerging threats. The funds that pay the overruns could be used for other innovations and programs.

The Government Accountability Office reported in 2008 on 95 weapon systems. The cost overruns were $295 billion, and the average schedule delay was 21 months. Evaluation of contractor proposals and experience to translate customer needs into specific capabilities were found to be primary causes in many of the cases. Other causes included limitations in developing credible project baselines; realistic estimates of the project costs, schedules, and performance; and contract mechanisms with the appropriate incentive structures to motivate contractors to finish on time and under budget.

Project managers establish project objectives, define the project scope, create the work breakdown structure, assign responsibility, define specific activities, and sequence activities. As part of the project management of these programs, the project manager determined the appropriate resources, including materials, technology, and people. One of the cost overruns was approximately $130 million. An incorrect commercial product was selected as the solution without examination of how the commercial product fit the project plan. The lesson learned from the project was that decision makers must review project progress to interpret the warning signs of problems such as the selection of an incorrect solution and address those problems earlier.

Personnel costs related to the projects averaged $12 million per week. A one-month delay could cost as much as $48 million while decisions were being made and solutions were being sought. Had decision-making procedures been in place and techniques for gathering the necessary information been established, the lost opportunity that these project teams experienced would have been reduced.

The study found the organizations with the greatest cost overruns had nearly non-existent succession planning programs to develop new project managers. Mentoring and succession planning helps organizations grow and retain personnel and help with project performance, the monitoring and controlling of processes, and the controlling of changes. Communication with stakeholders is enhanced with the passing of knowledge from more senior project personnel to junior project personnel. (The Project Management Institute offers opportunities for mentoring and sharing project expertise.)

Problems such as those experienced by these large-scale U.S. federal defense and intelligence acquisition programs resulted from poor project management and poor communication between project personnel and key stakeholders. A solution to reducing such cost overruns and schedule slips in the future in order to deliver projects within their proposed costs, schedule, and performance estimates is dependent on the adoption and execution of project management skills and techniques.

**SUMMARY**

A project is an endeavor to accomplish a specific objective through a unique set of interrelated tasks and the effective utilization of resources. It has a clear objective that establishes what is to be accomplished in terms of the end product or deliverable, schedule, and budget. A project also has interdependent tasks, uses various resources, has a specific time frame, is a unique one-time endeavor, has a sponsor or customer, and involves a degree of uncertainty. The successful accomplishment of the project objective could be constrained by many factors, including scope, quality, schedule, budget, resources, risks, and customer satisfaction.

The project life cycle has four phases: initiating, planning, performing, and closing the project. In the initiating phase, projects are identified and selected. They are then authorized using a document referred to as a project charter. The planning phase includes defining the project scope, identifying resources, developing a schedule and budget, and identifying risks, all of which make up the baseline plan for doing the project work. In the performing phase, the project plan is executed and work tasks are carried out to produce all the project deliverables and to accomplish the project objective. During this phase, the project progress is monitored and controlled to assure the work remains on schedule and within budget, the scope is fully completed according to specifications, and all deliverables meet acceptance criteria. Also, any changes need to be documented, approved, and incorporated into an updated baseline plan if necessary. In the closing phase, project evaluations are conducted, lessons learned are identified and documented to help improve performance on future projects, and project documents are organized and archived.

Project management is planning, organizing, coordinating, leading, and controlling resources to accomplish the project objective. The project management
process involves two major functions: first establishing a plan and then executing that plan to accomplish the project objective. The planning process includes the following steps: establish the project objective, define scope, create a work breakdown structure, assign responsibility, define specific activities, sequence activities, estimate activity resources, estimate activity durations, develop a project schedule, estimate costs, and determine the budget. The executing process involves three elements: perform the work, monitor and control progress, and control changes.

Globalization changes the dynamics of a project and adds a layer of complexity that can adversely affect the project outcome if the project participants are not aware of what they might encounter regarding cultural differences and multinational economic transactions. Factors external to the project itself, or to the project or customer organizations, can create a dynamic and perhaps unstable environment over the life of the project, introduce sources of risk, and affect the success of the projects. Global projects can be multinational and multilingual, with participants who are located in various countries and who speak different languages. Technology (e.g., computers, Internet access) enables project participants to be just a mouse-click away, despite being thousands of miles apart physically. Global project management requires an additional set of competencies. Cultural awareness and sensitivity are not only important but also imperative for successful global project management. Learning and understanding the culture and customs of other project participants demonstrate respect, help build trust, aid in developing an effective project team, and are critical for successful global project management.

The Project Management Institute is a premier worldwide not-for-profit association for practitioners in the project management profession. It publishes *A Guide to the Project Management Body of Knowledge (PMBOK® Guide)*, which provides a framework of processes and guidelines for the application of project management concepts, practices, and techniques.

The ultimate benefit of implementing project management techniques is having a satisfied customer—whether you are the customer of your own project or a business (contractor) being paid by a customer to perform a project. Completing the full project scope in a quality manner, on time, and within budget provides a great feeling of satisfaction to everyone involved in the project.

### QUESTIONS

1. Define project.
2. Define the term project objective, and give some examples.
3. List some examples of resources that are used on a project.
4. What role does a customer have during the project life cycle? Why is it important to satisfy the customer?
5. What aspects of a project might involve some degree of uncertainty? Why?
6. Define scope, schedule, cost, and customer satisfaction. Why are these considered to be constraints?
7. List and describe the main phases of the project life cycle.
8. List and describe the steps required to develop a baseline plan.
9. Why must a manager monitor the progress of a project? What can be done if a project is not proceeding according to plan?
10. Describe how a global project can be more complex than a project performed within just one country. How might these elements affect the successful outcome of the global project?
11. List some benefits of using project management techniques.
12. Consider a project in which you are currently involved (or in which you have recently been involved).
   a. Describe the objectives, scope, schedule, cost, and any assumptions made.
   b. Where are you in the project life cycle?
   c. Does this project have a baseline plan? If yes, describe it. If not, create it.
   d. Are you or is anyone else monitoring the progress of the project? If so, how? If not, how could you do so?
   e. Describe some unexpected circumstances that could jeopardize the success of the project.
   f. Describe the anticipated benefits of the project.

INTERNET EXERCISES

For the website addresses of the organizations mentioned in these exercises, make an Internet connection and go to www.cengagebrain.com. At the Cengagebrain.com home page, search for the ISBN of your title (from the back cover of your book) using the search box at the top of the page. This will take you to the product page where free companion resources can be found. It is suggested that you save this website in your “Favorites” list for easy access in the future.

1. Using your favorite Web search engine, perform a search for “project management.” Explore at least five of the links that your search produces. Give the Web address for each site and describe what information each site contains.

2. Do several additional Web searches by adding, after the words “project management,” some of the key words listed in this chapter. For example, search for “project management objectives,” “project management life cycle,” “project management process,” “project management work breakdown structures,” and so on. What did you find?

3. Since it was founded in 1969, the Project Management Institute (PMI) has grown to almost 350,000 members in more than 170 countries. The Pennsylvania-based PMI is, by far, the leading not-for-profit professional association in the area of project management. It establishes standards, sponsors seminars, develops educational programs, has a professional certification program, and publishes Project Management Journal and PM Network. Check out the PMI website for information regarding memberships, certification, education, and publications. Describe the benefits of having a membership. Apply for membership online if you are interested (student rates are available).

4. PMI is an international organization with chapters worldwide. Search for PMI Global Congresses. Describe what you find, including upcoming international conferences. Also, explore the link for your local PMI chapter. Print out the information for PMI chapters in your local area. In addition, explore the link for Resources. Browse through the Virtual Library, Research, Publications, and Standards links. PM Network, PMI Today, and the Project Management Journal are excellent sources of project management information published by PMI. Select an article that interests you, locate it in the library or online, and provide a one-page summary.

5. Executive PlanetTM provides valuable tips on business etiquette, customs, and protocol for doing business worldwide. Go to the organization’s website and explore the business culture guides for three different countries. Summarize key points regarding etiquette and customs for each of the three countries.
CASE STUDY 1

A Not-for-Profit Organization

At a local college, the officers of the student community service organization—which collects and buys food and distributes it to people in need—are having their February meeting. Sitting in the meeting room are Beth Smith, the organization’s president, and two officers: Rosemary Olsen, vice president, and Steve Andrews, volunteer coordinator. Beth announces, “Our funds are almost exhausted. The demands on the food bank have been increasing. We need to figure out how to get more funds.”

“We need to have a fundraising project,” responds Rosemary.

Steve suggests, “Can’t we ask the city government if they can increase their allocation of funds to us?”

“They’re strained. They may even cut our allocation next year,” replies Beth.

“How much do we need to get us through this year?” asks Rosemary.

“About $10,000,” answers Beth, “and we are going to start needing that money in about two months.”

“We need a lot of things besides money. We need more volunteers, more space for storage, and more food donations,” says Steve.

“Well, I guess we can make that all part of the fund-raising project. This is going to be fun!” says Rosemary excitedly.

“This project is growing. We’ll never get it done in time,” Beth says.

Rosemary responds, “We’ll figure it out and get it done. We always do.”

“Is a project what we need? What are we going to do next year—another project?” asks Steve. “Besides, we’re having a hard time getting volunteers anyway. Maybe we need to think about how we can operate with less money. For example, how can we get more food donations on a regular basis so we won’t have to buy as much food?”

Rosemary jumps in. “Great idea! You can work on that while we also try to raise funds. We can’t leave any stone unturned.”

“Time out,” says Beth. “These are all very good ideas, but we have limited funds and volunteers and a growing demand. We need to do something now to make sure we don’t have to close our doors in two months. I think we all agree we need to undertake some type of initiative. But I’m not sure we all agree on the objective.”

CASE QUESTIONS

1. What are the needs that have been identified?
2. What is the project objective?
3. What assumptions, if any, should be made regarding the project to be undertaken?
4. What are the risks involved in the project?

GROUP ACTIVITY

Contact a local not-for-profit organization in your community. Tell its officers that you are interested in learning about their operations. Ask them to describe a project that they are currently working on. What are the objectives? The constraints? The resources?

If possible, have your team contribute a few hours to the project. Through this process, you will be helping someone in need and learning about a real-world project at the same time. Prepare a report summarizing the project and what you learned from this experience.
CASE STUDY 2  

E-Commerce for a Small Supermarket

Matt and Grace own a small supermarket in a rural town with a large and growing elderly population. Because of their remote location, they don’t have any competition from the large chain stores. A small private liberal arts college, with about 1,500 students, is also located in the town.

“I think we need a website for our store,” Matt tells Grace.

“Why?” asks Grace.

“Everybody has one. It’s the wave of the future,” responds Matt.

“I’m still not clear, Matt. What would be on our website?” Grace asks.

“Well, for one thing we could have a picture of our market with me and you standing in front of it,” says Matt.

“What else?” asks Grace.

Matt answers, “Ah, maybe people could look up stuff and order it through the website. Yeah, those college kids would think that’s great; they’re into using computers all the time. That will increase our business. They’ll buy food from our store rather than the pizza and burgers they always eat or get delivered from Sam’s Sub Shop. And those people who live in the senior citizens’ apartments would use it, too. I heard they’re teaching them how to use computers. And maybe we can even set up a delivery service.”

“Hold on,” says Grace. “Those college students get pizza and subs from Sam’s at all hours of the night, long after we’re closed. And I think the senior citizens enjoy getting out. They have a van that brings some of them here each day to shop, and they really don’t buy much anyway. And how will they pay for what they order through the website? I’m all for keeping up with things, but I’m not sure this makes sense for our little supermarket, Matt. What would we be trying to accomplish with a website?”

“I just explained it to you, Grace. It’s the way all businesses are going. We either keep up with things or we’ll be out of business,” replies Matt.

“Does this have anything to do with that Chamber of Commerce meeting you went to in Big Falls last week, where you said they had some consultant talking about e-business or something?” asks Grace.

“Yeah, maybe,” Matt says. “I think I’ll give him a call and tell him to stop by and tell him what I want.”

“How much is all this going to cost us, Matt?” asks Grace. “I think we need to think about this some more. You know we are probably going to have to pave the parking lot this summer.”

Matt answers, “Don’t worry. It’ll all work out. Trust me. Our business will increase so much, it’ll pay for itself in no time. Besides, it can’t cost that much; this consultant probably does these kinds of projects all the time.”

CASE QUESTIONS

1. What are the needs that have been identified?
2. What is the project objective?
3. What are some things Matt and Grace should do before they talk with the consultant?
4. What should the consultant tell Matt and Grace?

GROUP ACTIVITY

Select two course participants to use this case script to role-play Matt and Grace in front of the class. Then divide the course participants into groups of three or
four to discuss the case questions. Each group must choose a spokesperson to present its responses to the entire class.

**OPTIONAL ACTIVITY**
Have each course participant contact a business that went “online” and ask the business what led it to that decision and if the project met its initial expectations.

**REFERENCES**


CHAPTER 2

Identifying and Selecting Projects

Concepts in this chapter support the following Project Management Knowledge Areas of A Guide to the Project Management Body of Knowledge (PMBOK® Guide):

- Project Integration Management
- Project Procurement Management
This chapter discusses the initiating phase of the project life cycle. You will become familiar with

- How projects are identified and selected
- A project charter

King County and Phoenix Schools Prioritized Safe Routes to School

The National Center for Safe Routes to School, a clearinghouse for the Federal Highway Administration’s Safe Routes to School Program, developed a three-step project identification process to determine the highest-priority locations and countermeasures for Safe Routes to School projects.

The first step was to prioritize schools that could benefit from the projects. First priority was given to schools with a history of child pedestrian-related crashes. Other factors in this first step were public and school officials’ concerns for child pedestrian safety and current and potential pedestrian use of routes to walk or bicycle to school.

Other considerations for project identification were traffic volume, travel speed, existing infrastructure, and road crossings. The project identification team also considered geography, socioeconomic distribution, and costs of implementations. Decisions were made to fund many less expensive countermeasures in numerous locations rather than to spend a large amount of money in a single location; these decisions were intended to have the greatest benefit for safe routes to school for the most number of students and schools.

King County, Washington, was one region that collected data for the project identification process. The district is made up of five urban schools and one rural school. The principals reported the number of students that walked to school from the nearly 500 students that attended each school. The project identification team had a worksheet to gather the information in a systematic and consistent manner. Additional information that could help with future planning was sought during this data-gathering phase.

Phoenix, Arizona, has more than 500 schools in its jurisdiction in 28 school districts. To help maintain the need for infrastructure improvements, the city asks superintendents and transportation directors in the school districts about any changes that are planned for the next year. One particular school district was tested with the prioritization tool that the project identification team used. The result of the study was the need to develop a walking and bicycling route map for students and parents.

The benefit of examining all schools with the same metrics is to give a side-by-side comparison that shows where the greatest needs exist for safety infrastructure improvements. The project identification team efficiently identified the priority locations to help serve the greatest number of students with the limited project funds that were available.

A systematic approach to project identification is the start of the project life cycle with the recognition of the need, problem, or opportunity for which a project or projects are identified to solve a problem or address an expressed need. This systematic approach has been very effective when used to evaluate, prioritize, and select projects that are completed by internal teams and by contractors.


This chapter discusses the initiating phase of the project life cycle. You will become familiar with

- How projects are identified and selected
- A project charter
Project Identification

The initiating phase of the project life cycle starts with recognizing a need, problem, or opportunity for which a project or projects are identified to address the need. Projects are identified in various ways: during an organization’s strategic planning, as part of its normal business operations, in response to unexpected events, or as a result of a group of individuals deciding to organize a project to address a particular need.

Business strategies can be driven by the market opportunities, competition, and/or technology. For example, there may be an emerging market opportunity for a project to develop a new educational product for preschool-age children. Or a company that is losing market share to a competitor may need a project to redesign its product in order to incorporate the latest technology and more customer-friendly features. Another business may see a rapidly growing market for its products in Asia, and thus it identifies a project to build a factory in India to meet the demand for its products. Not-for-profit organizations or associations can also define strategies to advance their mission. Based on a survey of its members, a national association may need a project to develop a new website to better serve its members. A philanthropic foundation may want to address a critical healthcare need in a particular country and therefore identifies a project to build a clinic.

Projects can also be identified as part of a company’s normal operational or maintenance needs. As an example, a business needs to reduce its indirect costs and identifies a project to consolidate its office space from several locations into one. In order to reduce the risk of noncompliance with new government regulations, a company identifies a project to install a new wastewater treatment system.

There are circumstances when projects are identified as a result of unexpected events—such as an earthquake that caused the collapse of a bridge—that create the need for a project to be undertaken—in this case, to build a new bridge. Another situation would be if a fire destroyed an elementary school, and projects were needed to determine how to continue to provide instruction for the students and to build a new school.

In some cases, volunteers may come together and decide they want to do a project for a particular reason. It could be to raise funds for a local food bank or to organize a festival to celebrate the anniversary of the town’s founding.
Projects are identified in various ways by different organizations. It is important to clearly define the need. This may require gathering data about the need or opportunity to help determine if it is worth pursuing. For example, if a company needs to change the layout of its manufacturing facility to make room for new production equipment that has to be incorporated into the production flow, the manufacturing manager may simply ask one of the supervisors to put together a proposal for “what it’s going to take to reconfigure the production line.” Or if a business wants to pursue a new market for one of its products, it may first conduct a market assessment or survey. It is important to try to quantify the need to help evaluate whether the expected benefits from implementing a project outweigh the costs or consequences of conducting the project. Once the magnitude of the expected benefit or improvement has been estimated, the organization needs to estimate the cost for a project to implement the improvement. For example, if a business estimates that it could save $100,000 a year by reducing its scrap rate from 5 percent to 1 percent, it might be willing to make an investment of $200,000 for new automated production equipment, thus breaking even after two years of operation. However, the business may not be willing to spend $500,000 for a solution. Businesses have a limited amount of funds available and, therefore, usually want to spend those funds on projects that will provide the greatest return on investment or overall benefit.

Sometimes organizations identify several or many needs but have limited funds and people available to pursue potential projects to address all of those needs. In such cases, the company must go through a decision-making process to prioritize and select those projects that will result in the greatest overall benefit.

**Project Selection**

Project selection involves evaluating potential projects, and then deciding which of these should move forward to be implemented. The benefits and consequences, advantages and disadvantages, plusses and minuses of each project need to be considered and evaluated. They can be quantitative and qualitative, tangible and intangible. Quantitative benefits could be financial, such as an increase in sales or a reduction in costs. There also may be intangible benefits associated with a project, such as improving the company’s public image or employee morale. On the other hand, there are quantitative consequences associated with each project, such as the cost required to implement the project or disruption to work throughput while the project is being implemented. Some consequences may be less tangible, such as legal barriers or reaction from a particular advocacy group.

The steps in the project selection process include:

1. **Develop a set of criteria against which the project will be evaluated.** These criteria will probably include both quantitative and qualitative factors. For example, if a pharmaceutical company has identified several potential projects to develop new products, it might evaluate each potential project against the following criteria:
   - Alignment with company goals
   - Anticipated sales volume
   - Increase in market share
   - Establishment of new markets
Sometimes the potential projects may not all be similar, such as several alternative new products. They could be very different and all compete for a company’s limited funds. One project may be to put a new roof on the factory, another to implement a new information system, and a third to develop a new product to replace one that is outdated and for which sales are rapidly declining.

2. **List assumptions** that will be used as the basis for each project. For example, if one project is to build an on-site day care center for children and elderly relatives of company employees, one assumption might be that the company would be able to obtain a bank loan to build such a center.

3. **Gather data and information for each project** to help ensure an intelligent decision regarding project selection. For example, it may be necessary to gather some preliminary financial estimates associated with each project, such as estimated revenue projections and implementation and operating costs. These costs may then be analyzed using certain mathematically based financial models so that they can be compared on an equal basis. Such financial or economic models can include methodologies used to calculate simple payback, discounted cash flow, net present value, internal rate of return, return on investment, or life cycle costs associated with each project being considered.

   In addition to gathering quantitative data, it may also be necessary to obtain other information regarding each potential project. This could include getting information from various stakeholders who would be affected by the project. These stakeholders could be employees, consumers, or community residents, depending on the specific project. Methods of gathering this information could include surveys, focus groups, interviews, or analysis of available reports. For example, if the projects being considered have to do with introducing several alternative food preparation products into the market, it may be valuable to conduct some focus groups with consumers to determine their needs and preferences. In the case of building an on-site day care center, it may be worthwhile to survey employees to determine how many employees would use the day care center for children or elderly relatives, and how often (all day, second shift, before or after school), ages of children, the health care needs of elderly relatives, and so forth.

4. **Evaluate each project against the criteria.** Once all the data and information have been collected, analyzed, and summarized for each potential project, they should be given to all the individuals who are responsible for performing the evaluation. It is beneficial to have several individuals involved in the evaluation and selection process in order to get various viewpoints. Each person on the evaluation and selection team or committee should have a
different background and experiences to bring to the decision-making process. There may be someone from marketing who knows consumer preferences; someone from finance who knows costs and the company’s financial condition; someone from production who understands what process and equipment changes may be needed; someone from research and development who can provide expertise on how much additional technology development may be required; and someone from human resources to represent any impact on the workforce or the community.

Although it may take longer and be more stressful to gain group consensus on project priorities and selection, it will most likely be a better quality decision than if the decision is made by just one individual. Acceptance of the decision will also be greater.

One approach to the evaluation and selection process would be to have the evaluation and selection committee meet to develop a set of evaluation criteria. They may also develop some type of rating system (such as High-Medium-Low, 1 to 5, 1 to 10) against which to rate each potential project against each criterion. Then each committee member should be provided with any data and information that have been collected, analyzed, and summarized. Before the entire committee meets, each member can individually assess the benefits and consequences of each project against the evaluation criteria. This will give each member sufficient time for thoughtful preparation prior to a meeting of the entire committee.

It is advisable to develop a project evaluation form listing the criteria with space for comments and a rating box for each criterion. Each evaluation and selection committee member could then complete a form for each project prior to coming to a meeting of the entire committee. Figure 2.1 is an example of a project evaluation and selection form that is suitable for comparing and selecting among projects that are similar, such as if a company is deciding to select one of three potential product development projects for three of its houseware appliance product lines. Which one of the three potential product development projects in Figure 2.1 would you select? When the potential projects are not similar, such a form may not be useful since the evaluation criteria may be different for each project, and it may be difficult to identify a set of criteria that is appropriate for all potential projects being evaluated. An example would be trying to identify common criteria for evaluating and comparing dissimilar projects such as a marketing campaign, a production control system, refurbishing the company’s offices, a website, building a new warehouse, and development of a new pharmaceutical product.

In most cases, the project selection will be based on a combination of quantitative evaluation and what each person feels in her or his “gut” based on experience. Although the final decision may be the responsibility of the company owner, president, or department head, having a well-understood evaluation and selection process and a well-rounded committee will increase the chances of making the best decision that will result in the greatest overall benefit.

Once the project selection decision has been made, the next step is for the sponsor to prepare a project charter to authorize moving forward with the project. If it is determined that project work should be outsourced to a contractor or consultant rather than using the organization’s own internal resources, then a request for proposal (RFP) will also need to be prepared to solicit proposals from potential contractors.
Once a project is selected, it is formally authorized using a document referred to as a project charter, sometimes called a project authorization or project initiation document. In this document, the sponsor provides approval to go forward with the project and commits the funding for the project. The project charter also summarizes the key conditions and parameters for the project and establishes the framework for developing a detailed baseline plan for performing the project. The content and format of the charter or authorization is not standard, but varies depending on the company or organization. It usually includes many of the following elements:

1. **Project title** should be concise and create a vision for the end result of the project, such as Implement a Customer Relationship Management System, or Install Wind Farm to Support Energy Needs of Bioprocessing Facility in Europe. If there is a concern about confidentiality or proprietary competitive information, a company may give the project a generic title such as Capacity Expansion, or a government military agency may refer to a project as Project 824 for security reasons.

2. **Purpose** summarizes the need and justification for the project. It may reference prior documents regarding the rationale for selecting the project and commits the funding for the project. The project charter also summarizes the key conditions and parameters for the project and establishes the framework for developing a detailed baseline plan for performing the project. The content and format of the charter or authorization is not standard, but varies depending on the company or organization. It usually includes many of the following elements:

3. **Description** provides a high-level description of the project. It may include a description of the major tasks or work elements or phases of the project or even a preliminary work breakdown structure delineating the major work elements. For a project to develop and launch a new food product, the major work elements may be Concept Development, Feasibility Assessment, Ingredients Selection, Preliminary Formulation, Prototype Development, Final Formulation, Produce Sample Lot, Test Market, Final Reformulation, Production, Marketing Support, Training, and Distribution and Logistics. The project charter may reference other more detailed documents that are available regarding key performance requirements, prior studies, and so forth.

4. **Objective** is a statement of what is expected to be accomplished—the end product or deliverable. It can indicate the amount of funds authorized for the project and the expected completion time (either as a specific date or length

---

**Project Charter**

---

**FIGURE 2.1 Project Evaluation and Selection Form**

<table>
<thead>
<tr>
<th>EVALUATION CRITERIA</th>
<th>PROJECT A</th>
<th>PROJECT B</th>
<th>PROJECT C</th>
</tr>
</thead>
<tbody>
<tr>
<td>Investment ($)</td>
<td>$700,000</td>
<td>$2,100,000</td>
<td>$1,200,000</td>
</tr>
<tr>
<td>Return on Investment</td>
<td>9.1%</td>
<td>18.3%</td>
<td>11.5%</td>
</tr>
<tr>
<td>Time to Market</td>
<td>10 months</td>
<td>16 months</td>
<td>12 months</td>
</tr>
<tr>
<td>Increase in Market Share</td>
<td>2%</td>
<td>5%</td>
<td>3%</td>
</tr>
<tr>
<td>Risk</td>
<td>Low</td>
<td>High</td>
<td>Medium</td>
</tr>
<tr>
<td>Chance of Success</td>
<td>High</td>
<td>Medium</td>
<td>High</td>
</tr>
</tbody>
</table>

**Comments**
- **Project A**: Major competitor already has similar product and may reduce price.
- **Project B**: New technology may not work as expected.
- **Project C**: Product features may not be accepted in some international markets.
of time in weeks, months, etc.). An objective might be to launch a new website in eight months for an amount not to exceed $100,000.

5. **Success criteria or expected benefits** indicate the outcomes or expected quantitative benefits that will result from implementation of the project. They describe the sponsor’s expectations regarding measures that will define success for the project. Examples include achieving a sales volume of 500,000 units within 12 months after the launch of a product, reducing the waiting time for patients in the emergency room by 40 percent, reducing annual energy costs by 50 percent after installation of a wind farm, or handling 10,000 cases in a new clinic in the first year after it opens.

6. **Funding** indicates the total amount of funds the sponsor authorizes for the project. Sometimes the funds are released in stages depending on the progress of the project. For example, a project may be authorized for $2,000,000 with $500,000 released for phase 1 up through preliminary design. Funding for subsequent phases will be based on satisfactory progress and results of prior phases.

7. **Major deliverables** are the major end products or items that are expected to be produced during and at the completion of the performance of the project, such as concept sketches for a new zoo, a website, a simulation of the workflow for the production system in a new motorcycle manufacturing plant, the photos or final text for an annual report, an electronic medical records system, or a promotional video.

8. **Acceptance criteria** describe the quantitative criteria for each major deliverable that the sponsor will use to verify that each deliverable meets certain performance specifications and are the basis for the sponsor’s accepting that the deliverable is indeed done correctly and meets the sponsor’s expectations. For example, a new production line will achieve 99 percent uptime during a 30-day acceptance test period, an information system will process up to 10,000 transactions per second without any degradation of response time, or the text for a marketing brochure does not exceed 400 words and is written at a fifth-grade reading and comprehension level.

9. **Milestone schedule** is a list of target dates or times for the achievement of key events in the project timetable. For constructing a new office building, the key milestones and their target completion times might be:

<table>
<thead>
<tr>
<th>Deliverable</th>
<th>Target Completion Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline plan</td>
<td>month 1</td>
</tr>
<tr>
<td>Architectural concepts</td>
<td>month 2</td>
</tr>
<tr>
<td>Preliminary design and specifications</td>
<td>month 4</td>
</tr>
<tr>
<td>Order long lead items</td>
<td>month 5</td>
</tr>
<tr>
<td>Final design specifications</td>
<td>month 8</td>
</tr>
<tr>
<td>Complete excavation and foundation</td>
<td>month 10</td>
</tr>
<tr>
<td>Complete steelwork and concrete work</td>
<td>month 14</td>
</tr>
<tr>
<td>Complete exterior</td>
<td>month 16</td>
</tr>
<tr>
<td>Complete utilities</td>
<td>month 18</td>
</tr>
<tr>
<td>Complete interior</td>
<td>month 20</td>
</tr>
<tr>
<td>Complete landscaping</td>
<td>month 20</td>
</tr>
</tbody>
</table>

Chapter 2  Identifying and Selecting Projects  39
Complete furnishing  month 22
Move in  month 24

Some projects are segmented into phases. For example, a project to develop and build a website might have the following milestone targets for completion of each phase:

<table>
<thead>
<tr>
<th>Phase</th>
<th>End Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phase 1 Preliminary design</td>
<td>March 31</td>
</tr>
<tr>
<td>Phase 2 Detail design</td>
<td>June 30</td>
</tr>
<tr>
<td>Phase 3 Construct website</td>
<td>August 31</td>
</tr>
<tr>
<td>Phase 4 Test and accept</td>
<td>September 15</td>
</tr>
</tbody>
</table>

10. **Key assumptions** include those that the project rationale or justification is based on, such as a new medical device will receive approval from the regulatory agency. Or an assumption could be about resources for the project, such as the company will be able to secure financing for the construction project at an interest rate of 5 percent or lower.

11. **Constraints** could include such things as a requirement to complete the project without disrupting the current workflow, or the necessity to outsource a project because the organization does not have the appropriate expertise or capacity to perform the project with its own staff. Another constraint might be that certain project team members will have to obtain a specific level of government security clearance to work on secret portions of the project.

12. **Major risks** identify any risk that the sponsor thinks has a high likelihood of occurrence or a high degree of potential impact that could affect the successful accomplishment of the project objective. As an example, if a project requires the integration of several technologies in a way that has not been done before, there could be a significant risk that it may not work and cause a delay and additional costs to the project because of redesign, or even result in terminating the project.

13. **Approval requirements** define the limits of authority of the project manager, such as the approval of all purchase orders or subcontracts of more than $25,000 require the approval of the board of directors. Approvals may also be required for a project to move from one phase to the next. As an example, at the completion of phase 1, the external contractor must present the results of phase 1 to the sponsor’s executive committee and obtain the committee’s approval before starting work on phase 2 of the project.

14. **Project manager** is an individual in the organization who has been identified to be the manager for the project. The project manager’s initial work is to organize a core team to do the planning for the project. If the project will be outsourced to an external resource (contractor), then the sponsor’s project manager will prepare a request for proposal. It is also not unusual for the sponsor to identify the project manager early in the initiating phase of the project life cycle; the project manager would participate in preparing the project charter.

15. **Reporting requirements** state the frequency and content of project status reports and reviews. For example, the project manager must provide monthly
written status reports to the sponsor or have quarterly status review meetings with the sponsor.

16. **Sponsor designee** is the person who the sponsor designates to act on behalf of the project sponsor. The designee is the individual with whom the project manager would communicate and to whom the project manager is accountable. The sponsor may also authorize the designee to sign off on the acceptance of the project deliverables. If a corporation’s board of directors sponsors a $10 million project to implement a new financial reporting system, the board may designate the corporation’s chief information officer to be its designee to oversee the project on the board’s behalf; the project manager would be accountable to this person.

17. **Approval signature and date** indicate that the sponsor has officially or formally authorized the project. Depending on the funding amount of the project, level of risk, or organizational reporting structure, the signature might be that of the company president, marketing director, or manager of the information technology department, for example; or it might be that of a not-for-profit organization’s executive director or the deputy secretary of a government agency. The approval date on the project charter is significant because it is considered to be when the clock starts for accomplishing the key milestones by their target dates.

The project charter is an important document. It not only authorizes going forward with a project but also provides the key conditions and parameters that are the framework for the project manager and team to develop a detailed baseline plan for performing the project. Figure 2.2 shows an example of a project charter.

---

**Reinforce Your Learning**

5. List at least eight elements that could be included in a project charter.

---

**FIGURE 2.2 Project Charter**

**Project Charter**

**Project Title:** Create ASTRA Corporation Online University

**Purpose:** Currently ASTRA Corporation offers and provides education and training programs for its employees that are delivered face to face in classroom settings. Online training has been requested by ASTRA employees at the company’s six locations in North America and five locations in Europe. This project is authorized to create ASTRA Corporation Online University, an education and training component that will provide online training programs for employees.

**Description:** ASTRA will issue a request for proposal to select an external contractor to design, develop, deliver, and evaluate the online environment for 20 courses that have been identified as critical information for the majority of ASTRA employees. ASTRA has identified the 20 courses from the current face-to-face course offerings in the corporate training catalog. The language of instruction will be English. Feedback for the initial six courses available online will be evaluated for availability, requirements for synchronous and asynchronous experiences, and effectiveness during the initial three-month pilot. At the conclusion of the six-course pilot, the contractor will provide a written report and a presentation to ASTRA’s Vice President for Human Resources of the results of the evaluation and recommended changes for availability, training experience, and effectiveness. The remaining 14 courses will be available online at the conclusion of the pilot. At six months, nine months, and the conclusion of the first year of training offerings, the contractor will present reports of enrollments and course evaluations.

**Objective:** The objectives of the implementation of the 20 critical courses are twofold:

(continued)
1. To provide a consistent training message for the courses through the online delivery using the ASTRA course management system; and,

2. To reduce costs related to providing training for the courses by incorporating Web 2.0 technologies and other appropriate instructional strategies into the course design and removing the requirement of a face-to-face instructor.

**Success Criteria or Expected Benefits:** The implementation of the courses is expected to reduce the costs of presenting the information for the 20 courses by 26% in the first year and provide training to all new employees within their probation period and re-certification for all other employees once per year.

**Funding:** The total amount of funds authorized for this project is $200,000 for the design and development of the 20 courses and $25 per enrollment for delivery. The projected enrollments are 15,000 (3,000 employees, 5 courses each).

**Major Deliverables:** The contractor is to design, develop, deliver, and evaluate 20 online courses; provide written and presented quarterly reports; and provide technical support at all times during the year after the initial pilot.

**Acceptance Criteria:** The online training environment will meet the ASTRA standards in AOU Publication #7. Training will be in English. The Vice President for Human Resources for ASTRA has the final approval for all courses before they go online.

**Milestone Schedule:** The project timetable for key milestones in calendar months after the contract is signed with the contractor:

1. Baseline project plan prepared month 1
2. Pilot courses designed month 3
3. Pilot courses developed month 7
4. Evaluation designed month 7
5. Start delivery of six pilot courses month 8
6. Remaining 14 courses designed month 10
7. Complete evaluation of six pilot courses month 11
8. Remaining 14 courses developed month 12
9. Start delivery of remaining courses month 12
10. Evaluation of all courses month 15
11. Evaluation of all courses month 18
12. Evaluation of all courses month 21

**Key Assumptions:** The contractor will use the course management system already developed and tested by ASTRA Corporation information systems.

**Constraints:** Courses must present the information within the developed courses selected by ASTRA. Appropriate instructional strategies are to be used for the presentation of the information within the online environments. The ASTRA course management system contains Web 2.0 technologies, quiz mechanisms, calendaring system, video capacity, and participant activity monitoring.

**Major Risks:** The contractor must sign a nondisclosure agreement to not reveal any proprietary information within the 20 courses to avoid disclosure of processes and practices ASTRA Corporation has developed to have a competitive edge.

**Approval Requirements:** All courses are to be approved by the ASTRA Vice President for Human Resources at milestones and before their initial offering activation.

**Project Manager:** Marie Kerba is the assigned ASTRA project manager and is responsible for the project. She is ASTRA’s point of contact with the contractor and will oversee the performance of the contractor.
It should be noted that not all projects use a project charter. Projects that are informal (not done within a formal business environment) or done in response to an unexpected event may not be appropriate for a project charter. Examples are a home remodeling project, a wedding, organizing a community event, or responding to a natural disaster.

Preparing a Request for Proposal

In some cases, an organization does not have the expertise or staff capacity to plan and perform the project or major portions of the project, and therefore it decides to outsource the work to an external resource (contractor). The purpose of preparing a request for proposal is to state, comprehensively and in detail, what is required, from the sponsor’s/customer’s point of view, to address the identified need. A good RFP allows contractors to understand what the customer expects so that they can prepare a thorough proposal that will satisfy the customer’s requirements at a realistic price. For example, an RFP that simply requests contractors to submit a proposal for building a house is not specific enough. Contractors could not even begin to prepare proposals without information about the kind of house that is wanted. An RFP should be comprehensive and provide sufficiently detailed information so that a contractor or project team can prepare an intelligent proposal that is responsive to the customer’s needs.

Following are some guidelines for drafting a formal request for proposal to external contractors:

1. The RFP must state the project objective or purpose, including any rational or background information that may be helpful to contractors so that they can prepare thorough and responsive proposals.

2. An RFP must provide a statement of work (SOW). An SOW deals with the scope of the project, outlining the major tasks or work elements the customer wants the contractor or project team to perform. For example, if the RFP is for a house, the contractor needs to know whether he should design and build the entire house, build it according to the customer’s design, or include finishing the basement and installing the carpeting. If a customer needs a marketing brochure, the RFP must state whether the contractor is just to design the brochure or design, print, and mail it.

3. The RFP must include the customer requirements, which define specifications and attributes. Requirements cover size, quantity, color, weight, speed, and other physical or operational parameters the contractor’s proposed solution must satisfy. For the marketing brochure, the requirements might be for a trifold self-mailer, printed on card stock in two colors, with a print run of 10,000. Requirements for the house might include an overall size of 3,000 square feet with four bedrooms, two baths, a two-car garage, central air conditioning, and a fireplace.

Some requirements address performance. If the RFP is for an automated billing and collection system, performance requirements might include the...
capacity to process 12,000 transactions a day and provisions for special functions such as consolidated multiple invoices for individual customers and automatic generation of second invoices for payments not received within 30 days of the initial invoice.

The requirements may also reference standards and codes that must be used and met.

4. The RFP should state what deliverables the customer expects the contractor to provide. Deliverables are the tangible items that the contractor is to provide. With the brochure example, there might be two deliverables: the concept layout and the 10,000 copies of the brochure. With the billing and collection system, the contractor may be expected to provide the hardware (computers), software, operator manuals (electronic and hardcopies), and training sessions. Deliverables could also include regular progress reports or a final report that the customer requires the contractor to provide.

5. The RFP should state the acceptance criteria the customer will use to determine if the project deliverables are completed according to the customer’s requirements. For example, the project contractor will have to run tests on the automated billing and collection system to verify to the customer that it meets the performance requirements before the customer accepts the system and makes the final payment to the contractor.

6. The RFP should list any customer-supplied items. For example, the RFP might state that the customer will supply a copy of its logo for use on the brochure. If the RFP is for a piece of automated equipment for testing electronic circuit boards, it may state that the customer will provide a certain quantity of the boards for the contractor to use during factory testing of the equipment before it is shipped to the customer.

7. The RFP might state the approvals required by the customer. For example, the housing customer may want to review and approve the plans before construction is started. The brochure customer may want to review and approve the brochure’s layout before printing is started.

8. Some RFPs mention the type of contract the customer intends to use. It could be a fixed-price contract, in which case the customer will pay the contractor a fixed amount, regardless of how much the work actually costs the contractor. (The contractor accepts the risk of taking a loss.) Or the contract might be for time and materials. In this case, the customer will pay the contractor whatever the actual costs are. For example, if the RFP is to remodel a basement, the RFP might state that the contractor will be paid for the hours expended and the cost of materials.

9. An RFP might state the payment terms the customer intends to use. For example, the brochure customer may intend to make one payment at the end of the project. On the other hand, the customer for the house may specify progress payments, based on a percentage of the total price, that are made as certain milestones are accomplished—25 percent when the foundation is complete, another 25 percent when the framing is complete, and so on, until the entire project is finished.

10. The RFP should state the required schedule for completion of the project and key milestones. It might state simply that the house must be completed within six months, or it might include a more detailed schedule. For example, the billing and collection system must be designed and developed and a design review meeting conducted within four months of the start of the project; then, the system must be
installed and tested within four months of the design review; and, finally, the contractor must provide all system documentation and operator training within one month of the system’s installation. In addition to the required project completion date, the RFP may also indicate required dates for key milestones during the project.

11. The RFP should provide instructions for the format and content of the contractor proposals. If the customer is going to compare and evaluate proposals from several contractors, it is important that they be consistent in format and content so that a fair evaluation can be made. Instructions might state a required outline or table of contents, the maximum number of pages, specific requirements to provide a detailed breakdown of cost elements, or even the font size and margins for the proposal.

12. The RFP should indicate the due date by which the customer expects potential contractors to submit proposals. Customers want to receive all proposals by a certain date so that they can compare and evaluate them at the same time. For example, a customer may give potential contractors 30 calendar days from the time the RFP is formally issued to submit a proposal. Customers usually state in the RFP that any proposals submitted after the due date will not be accepted for consideration, because it would be unfair to give some contractors extra time.

13. An RFP may include the evaluation criteria. These are the criteria that the customer will use to evaluate proposals from competing contractors in order to select the one to perform the project. Criteria might include the following:
   a. The contractor’s experience with similar projects. How recently has the contractor completed similar projects? Were they completed within budget and on schedule? Were the customers satisfied?
   b. The technical approach proposed by the contractor. What technology will be used? What type and configuration of computer hardware will be used? What is the design approach for the database? Which software language will be used for developing the management information system?
   c. The schedule. Will the contractor be able to meet or beat the required schedule?
   d. The costs. If the estimate is based on time and materials, are the costs reasonable? Have any items been left out? Does it appear that the contractor has submitted a low cost estimate but will add costs after the project is under way, resulting in final costs that are much higher than the original estimate?

14. In rare cases, an RFP will indicate the funds the customer has available to spend on the project. Usually, the customer expects contractors to submit a proposal that meets the requirements in the RFP at the most reasonable cost. In some situations, however, it may be helpful for the customer to indicate a “ballpark” amount to be spent. For example, stating in the RFP that the cost of building the house should be about $300,000 would be helpful. Contractors can then submit proposals that are appropriate to that level of funding, rather than submitting proposals for houses that cost far more than the customer has available. Otherwise, all the contractors might submit proposals with prices much higher than the available funding, and the disappointed customer will have to ask all the contractors to resubmit proposals for a less expensive house.

A sample RFP is shown in Figure 2.3. Additional examples of requests for proposals can be found by using a search engine to search the Web for “Request for Proposals.”
FIGURE 2.3 Request for Proposal

February 1st
To Whom It May Concern:
AJACKS Information Services Company is seeking proposals from contractors with relevant experience to conduct a market survey of the technical information needs of manufacturing firms nationwide. The objectives of this project are

1. To determine the technical information needs of manufacturing firms nationwide, and
2. To recommend approaches to promote the purchase and utilization of AJACKS Information Services by such firms.

This project must provide adequate information for AJACKS Information Services Company to determine

- Future information products or services, and
- The best methods for delivering these products or services to its customers.

The contents of this request for proposal are to be considered confidential information.

1. Statement of Work
   The contractor will perform the following tasks:
   
   **Task 1: Identify Technical Information Needs of Manufacturing Firms**
   Conduct a survey of manufacturing firms nationwide to determine their specific needs for external (to their firms) technical information. The assessment should determine the various specific types of technical information needed and the frequency with which each type of information is needed.

   **Task 2: Determine the Best Approaches to Promote the Purchase and Utilization of AJACKS Information Services by Businesses**
   The survey should include an identification of the firms’ perceptions of the most effective direct and indirect marketing approaches that influence the firms’ decisions to both purchase and utilize specific services or products, in particular, information services.

2. Requirements
   The survey should determine the various specific types of technical information needed and the frequency with which each type of information is needed.

   The survey should identify the current sources for the various types of technical information that are used by manufacturing firms, their frequency of use, and the firms’ perception of the value (benefit, cost, accuracy, timeliness) of each source. It should determine the various methods the firms currently use to access these sources of information. The survey should determine the average and range of funds (both internal to the firm and external fees) that firms currently expend for obtaining the various types of technical information.

   The assessment must provide sufficient detail to permit demand-driven product planning by AJACKS Information Services Company. Therefore, it must include: (1) the information content most frequently needed by firms; (2) the applications for which the firms use the information; (3) the persons (title, skill level) responsible for both accessing and utilizing the information; and (4) the channels that firms use to access the various types of information.

   AJACKS Information Services Company is interested in developing and delivering products and services that are valued by the users (manufacturing firms). With these interests in mind, the contractor must generate information about which firms (as distinguished by size, sector, location, or other important factors) may benefit most from information products and services or represent the most appropriate markets for such products and services.

   The contractor should determine the size of the market for the various types of technical information and determine market sensitivity to price, timeliness, accuracy, and delivery mechanisms.

(continued)
for such information. The survey methodology should include both focus groups and mail surveys.

The focus groups should be categorized by major manufacturing sectors and by multisector firm size (large, medium, small).

Based on the results from the focus groups, a draft mail survey questionnaire should be developed and pre-tested on representative firms. This survey instrument should be finalized after sufficient pre-testing.

The contractor should provide a sampling design for the mail survey that is stratified by sector and firm size, is representative of the entire population of manufacturing firms, and is sufficiently large to present the survey results for each stratum at the 90% confidence level.

3. Deliverables

a. A detailed report of the results of Task 1 must be prepared that identifies and analyzes the results for all respondents and also provides detailed analyses (1) for each sector and (2) by firm size. The contractor must provide an electronic copy and twenty (20) hardcopies of the report. The database of the survey responses used in the analysis must be delivered in a format suitable for further analysis by AJACKS Information Services Company.

b. Based on the analyses of Tasks 1 and 2, provide a detailed report of recommendations of the most effective approaches, and associated costs, to promoting technical information services to manufacturing firms with the objective of getting such firms to purchase and use such services. Discuss any differences in approaches based on sector or size of business. The contractor must provide an electronic copy and twenty (20) hardcopies of the report.

c. Status reports on project progress must be e-mailed to AJACKS Information Services Company on the 15th and 30th of each month. Reports should be brief and focus on progress compared to the contractor’s original plan and schedule. These reports should cover activities, milestones achieved, plans for the next month, obstacles encountered or anticipated, and hours and dollars expended. For any work items where progress is behind schedule, a plan must be proposed to complete the project within the original schedule and budget.

4. Acceptance Criteria

Reports identified in items A and B of section 3, Deliverables, must contain all the information mentioned in section 2, Requirements, in order to be accepted by AJACKS Information Services Company. Final payment as stated in section 10, Payment Terms, will not be made until AJACKS is satisfied that reports in items A and B of section 3 are inclusive of all the required information and supporting data and in a format suitable to AJACKS.

5. Items Supplied by AJACKS Information Services Company

AJACKS will provide the contractor with detailed information about its current information services and products, as well as statistical information regarding its current customer base.

6. Approvals Required

The contractor must obtain the approval of AJACKS for the final version of the survey instrument before it is implemented.

7. Type of Contract

The contract will be for a fixed price for all of the work the contractor proposes to meet all the requirements of this request for proposal.

(continued)
8. Due Date
   The contractor must submit an electronic copy and five (5) hardcopies of the proposal to AJACKS Information Services Company on or before February 28th.

9. Schedule
   AJACKS Information Services Company expects to select a contractor by March 30th. The required period of performance of this project is six months, from May 1st to October 30th. Report identified in item A of section 3, Deliverables must be provided to AJACKS by September 30th, and the report identified in item B of section 3, Deliverables, must be provided to AJACKS by October 15th.

10. Payment Terms
    AJACKS Information Services Company will make payments to the contractor according to the following schedule:
    • 20% of total amount upon approval by AJACKS of the final survey instrument
    • 35% of the total amount when report identified in item A of section 3, Deliverables, is accepted by AJACKS
    • 35% of total amount when report identified in item B of section 3, Deliverables, is accepted by AJACKS
    • 10% of total amount when AJACKS Information Services Company is satisfied that the project is 100% complete and that the contractor has fulfilled all contractual obligations

11. Proposal Contents
    As a minimum, the contractor's proposal must include the following:
    a. Approach
       A discussion that indicates the contractor clearly understands the request for proposal and what is expected. Also, a detailed discussion of the contractor's approach to conducting the project and a detailed description of each task and how it will be accomplished.
    b. Deliverables
       A description of each deliverable the contractor will provide.
    c. Schedule
       A bar chart or network diagram showing the weekly schedule of the detailed tasks to be performed in order to complete the project by the required project finish date.
    d. Experience
       A discussion of recent similar projects the contractor has performed, including customer names, addresses, and phone numbers.
    e. Staffing
       The names and detailed resumes of the specific individuals who will be assigned to work on the project and highlights of their experience on similar projects.
    f. Costs
       The total fixed price must be stated and supported by a detailed breakdown of hours and an hourly cost rate for each person who will be assigned to the project. Additionally, an itemized list of all direct expenses must be included.

    AJACKS Information Services Company will evaluate all contractor proposals according to the following criteria:
    a. Approach (30%)
       The approach and methodology the contractor proposes to conduct the survey and analyze the results.
Soliciting Proposals

Once the RFP has been prepared, the customer solicits proposals by notifying potential contractors that the RFP is available. One way for customers to do this is by identifying a selected group of contractors in advance and sending each of them a copy of the RFP. For example, a customer who has prepared an RFP for designing and building a customized piece of automated testing equipment might send it to several well-known companies (contractors) that specialize in producing such equipment. Another approach to soliciting potential contractors is for the customer to provide information on certain websites and in relevant business newspapers that the RFP is available and give instructions on how interested contractors can obtain or download a copy. For example, federal government agencies announce their RFPs on the Federal Business Opportunities website.

Business customers and contractors consider the RFP/proposal process to be a competitive situation. Customers should be careful not to provide one or more of the contractors with information that is not provided to all interested contractors. Therefore, during the proposal development phase, customers may not want to answer questions from individual contractors who are preparing proposals for fear of giving those contractors an unfair competitive advantage over other contractors who do not have the same information. Business or government customers may hold a bidders’ meeting to explain the RFP and answer questions from interested contractors.

It must be noted that not all project life cycles include the preparation of a written request for proposal by a customer and subsequent submittal of proposals from contractors. Some endeavors move right from the initiating phase where a project is identified and selected into the planning and performing phases of the life cycle. This process bypasses the RFP and proposal steps. For instance, when a company decides to initiate and implement a project to meet a certain need or solve a particular problem, it may use its own staff and project team rather than external contractors. Or when a group of volunteers decides to put on a countywide week-long arts festival, the volunteers may elect to do all the work themselves. When an accident victim requires a series of reconstructive surgeries, a team of surgeons may determine what needs to be done and then plan and perform a series of operations spanning several years. In all these examples, requests for proposals from contractors would not be appropriate.

There are other projects in which requirements are not written down in a formal RFP, but are communicated to several providers or suppliers (contractors). For example, in planning a wedding, the bride and groom may define their requirements for the reception, dinner, flowers, and other items and then shop around to select the providers that most closely match their requirements and budget.
Although projects can be businesslike or informal, they all start with the identification of a need, problem, or opportunity and then proceed to the sponsor defining (in writing or verbally) the scope, requirements, budget, and schedule for what is to be accomplished.

**REAL WORLD PROJECT MANAGEMENT**

**Spokane Builder and Others Propose Methow Project**

In Spokane, Washington, affordable housing is a problem for some employees of the local businesses. To have an affordable house, they have to make a long commute to work in the Methow Valley. To help with this problem, a development company is proposing to develop and construct a $10 million to $12 million affordable housing project on a seven-acre parcel two blocks from the business district.

In this initiating phase of a project, there is recognition of a problem that a project could solve. Most of the housing in the Methow Valley has been purchased as second homes, leaving very few places that are affordable or for rent. The largest three employers in the region have responded to a need for their employees to have subsidized rental units. Seasonal employees have limited choices for monthly rentals. There is a need for affordable housing.

The housing authority is completing a market survey to determine the need for housing for seniors, farm workers, and other potential renters. The information gathered in the market survey will inform the authority’s board of directors about the need for housing units. The housing authority does have some subsidized housing units adjacent to the Methow Riverwalk site that would be developed.

These market surveys are being used to inform the evaluation criteria for the housing authority to determine if there is a benefit in doing a project to meet the housing need in Methow Valley. The housing authority members do not have the expertise to develop and construct the units; however, they do have the expertise to manage and rent the units after they are completed. They require the assistance of the developer to satisfy the need and complete the project. The Methow Riverwalk project proposal was unsolicited. The housing authority for Methow Valley had not put out a request for proposals for the development.

The project would be to construct 35–40 new units that are rented at subsidized rates or at market rates. Some new tenants may be residents that sell their houses in the Valley and want to downsize. Others may be workers in the region that may or may not require housing assistance. Ultimately, the developer would seek funding from a lender for the project. When construction is complete, the units would be sold to the housing authority to be rented to the new tenants.

The decision maker for this project is the housing authority. Using the information from the market survey and from the Build America Bonds program, the authority’s board of directors is developing the evaluation metrics necessary to determine if this project should go forward and if it will purchase the housing units after development. If the project is approved, the developers will create a project charter to secure funding and begin construction in the spring of next year.

The developers hope, for the workers and residents of the Methow Valley, that this project will move from this initiating phase to the planning and performing phases of the project life cycle.

The initiating phase of the project life cycle starts with recognizing a need, problem, or opportunity for which a project or projects are identified to address the need. Projects are identified in various ways: during an organization’s strategic planning, as part of its normal business operations, in response to unexpected events, or as a result of a group of individuals deciding to organize a project to address a particular need.

Sometimes organizations identify several or many needs but have limited funds and people available to pursue potential projects to address all of those needs. In such cases, the company must go through a decision-making process to prioritize and select those projects that will result in the greatest overall benefit.

Project selection involves evaluating potential projects and then deciding which of these should move forward to be implemented. The steps in the project selection process are developing a set of criteria against which the project will be evaluated, listing assumptions about each project, gathering data and information about each project, and evaluating each project against the criteria. Having a well-understood evaluation and selection process and a well-rounded committee will increase the chances of making the best decision that will result in the greatest overall benefit.

Once a project is selected, it is formally authorized using a document referred to as a project charter, sometimes called a project authorization or project initiation document. In this document, the sponsor provides approval to go forward with the project and commits the funding for the project. The project charter also summarizes the key conditions and parameters for the project and establishes the framework for developing a detailed baseline plan for performing the project.
In some cases, an organization does not have the expertise or staff capacity to plan and perform the project or major portions of the project, and therefore decides to have the project done by an external resource (contractor). The purpose of preparing a request for proposal is to state, comprehensively and in detail, what is required, from the customer’s point of view, to address the identified need. A good RFP allows contractors to understand what the customer expects so that they can prepare a thorough proposal that will satisfy the customer’s requirements at a realistic price.

RFPs may include the project objective or purpose; a statement of work; customer requirements for physical or operational parameters, such as size, quantity, color, weight, and speed; deliverables the customer expects the contractor to provide; acceptance criteria for the deliverables; a list of any customer-supplied items; any approvals the customer requires; the type of contract the customer intends to use; the payment terms; the required schedule for completion of the project; instructions for the format and content of the contractor proposals; the due date by which the customer expects potential contractors to submit proposals; and criteria by which the proposals will be evaluated.

Once the RFP has been prepared, the customer solicits proposals by notifying potential contractors that the RFP is available. Business customers and contractors consider the RFP/proposal process to be a competitive situation. Customers should be careful not to provide one or more contractors with information that is not provided to all interested contractors.

Not all project life cycles include the preparation of a written request for proposal by a customer and subsequent submittal of proposals from contractors. Some endeavors move right from the initiating phase, where a project is identified and selected, into the planning and performing phases of the life cycle.

QUESTIONS

1. Why is it important to do a thorough and detailed job of needs identification?
2. Describe a situation in your life in which you performed needs identification.
3. Why is it important to select the right project before you begin working?
4. Describe how a business selects which projects to work on when there are numerous projects that could be done.
5. Which elements of a project charter would you use to help plan if you have a project that does not require a project charter? Why?
6. Give examples of situations in which a business might develop a request for proposal.
7. Give examples of situations in which an individual might develop a request for proposal.
8. Why is it important for a business to try to quantify the expected benefits of implementing a solution to a problem?
9. What should be contained in a statement of work?
10. What is meant by customer requirements? Why must they be precise?
11. Why would an RFP state the approvals that will be required during the project? Give some examples.
12. Why would a customer give contractors instructions in the RFP to submit their proposals according to a standard format?
13. Develop an RFP for a real-world project such as landscaping the grounds surrounding a nearby business office, building a deck for your house, or holding a big graduation celebration. Be creative in specifying your needs. Feel free to come up with unique ideas for the RFP.

INTERNET EXERCISES

For the website addresses of the organizations mentioned in these exercises, go to “Internet Exercises” at the book’s companion website at www.cengagebrain.com. It is suggested that you save this website in your “Favorites” list for easy access in the future.

In order to answer the following questions, perform a search for “Requests for Proposals,” using your favorite search engine.

1. Based on the results of your search, find an RFP that has been posted on the Web. What company developed the RFP, and what is the company looking to accomplish?
2. Evaluate the effectiveness of this RFP based on information you have studied in this chapter. Discuss the strengths and weaknesses of the RFP. Are there any items missing from the RFP that should have been included?
3. Download the RFP, and based on what you learned in this chapter, revise it. Highlight the areas you revised. What makes your revised RFP better than the original?
4. Locate a website that provides suggestions for developing RFPs. Compare and contrast this with what was presented in the chapter.
5. Perform a Web search for software systems that can help you develop an RFP. Provide the Web address and a brief summary for three of the systems you found. Download a demo copy of at least one, if possible.

CASE STUDY 1

A Midsize Pharmaceutical Company

Jennifer Childs is the owner and chief executive officer of a midsize global pharmaceutical company with sales offices or manufacturing plants in eight countries. At an October staff meeting she tells her managers that company profits for the year are expected to be $2,000,000 more than anticipated. She tells them she would like to reinvest this additional profit by funding projects within the company that will either increase sales or reduce costs. She asks her three key managers to get together to develop a prioritized list of potential projects and then to meet with her to “sell” her on their ideas. She mentions that they should not assume the funds will be divided equally among the three of them. She also mentions that she is willing to put all of the funds into just one project if it seems appropriate.

Julie Chen, manager of product development, has had a team of scientists working on a new prescription drug. This effort has been taking much longer than expected. She is worried that larger firms are working on a similar prescription drug and that these firms might get it to the marketplace first. Her team has not made any major breakthroughs yet, and some tests are not producing the expected results. She knows this is a risky project but feels that she cannot stop it now. Julie believes the company’s long-term growth depends on this new drug, which can be sold worldwide. She has tried to be optimistic at staff meetings about progress on this development project, but she knows that Jennifer is growing impatient and
that her peers believe she should have terminated the project after the initial tests were less than promising. Julie would like to use the additional funds to accelerate the development project. She would hire a highly respected scientist from a larger firm and buy more sophisticated laboratory equipment.

Tyler Ripken, manager of production at the firm’s largest and oldest manufacturing facility, has been with the company only six months. His early observation is that the production flow is very inefficient. He believes this is the result of poor planning when additions were made to the plant over the years as the company grew. Tyler would like to form several employee teams to implement a better layout of the equipment in the plant. He thinks this would increase plant capacity while reducing costs. When Tyler mentions this idea to some of his supervisors, they remind him that when Jennifer’s father ran the business, Jennifer was in charge of production, and she was responsible for the design of the current plant layout. They also remind Tyler that Jennifer is not a fan of using employee teams. She believes production employees are paid to do their jobs, and she expects her managers to be the ones to come up with and implement new ideas.

Jeff Matthews, manager of operations, is responsible for the company’s computers and information systems as well as its accounting operations. Jeff believes that the company’s computer systems are outdated, and as the business has grown with locations worldwide, the older computer equipment has been unable to handle the volume of transactions. He thinks that a new computer system could keep better track of customer orders, reduce customer complaints, and issue more timely invoices, thus improving cash flow. The employees in Jeff’s operation joke about their outdated computer systems and put pressure on Jeff to buy newer equipment. Jennifer has told Jeff in the past that she is not interested in spending money on new computers just for the sake of having the latest equipment, especially if the current system is working all right. She had suggested that Jeff look into hiring an outside service to do the accounting operations and reduce his own staff. Jeff would like to use this year’s excess profits to buy new computers and to hire a computer programmer to upgrade the software to run on the new computers. He feels that this would be cost-effective.

After Jennifer’s October staff meeting, Joe Sanchez, manager of marketing, stops by Jennifer’s office. He says that although he has not been asked to come up with project ideas for the extra profits, his feeling is that she should forget this project nonsense and just give him a larger budget to hire more sales representatives in several additional countries. “That would increase sales faster than anything else,” Joe tells her. “And besides, that’s what your father would have done!” Joe is counting on disagreements among the other three managers in establishing priorities. He hopes that if Jennifer sees a lack of consensus, she might give him funds to hire the additional sales representatives.

CASE QUESTIONS

1. How should Jennifer go about making her decision?
2. What kind of additional data or information should she collect?
3. What exactly should Jennifer require the others to submit in the way of proposals?
4. What do you think Jennifer should do with the $2,000,000? In explaining your answer, address the concerns and positions of Julie, Tyler, Jeff, and Joe.
GROUP ACTIVITY
Select five course participants to play the roles of Jennifer, Julie, Tyler, Jeff, and Joe. While Jennifer and Joe leave the room, have Julie, Tyler, and Jeff role-play (preferably in front of the remaining course participants) a meeting in which they discuss their proposed projects and develop a prioritized list to “sell” to Jennifer.

After Jennifer and Joe reenter the room, have all five participants role-play (preferably in front of the class) a meeting with Jennifer in which Julie, Tyler, and Jeff try to sell her on the prioritized list of projects and Joe promotes his agenda.

Discuss what took place. What positions did the players take? How was the final decision made? What was the final decision?

CASE STUDY 2  Transportation Improvements
Polk County is the largest county in the state, yet it is one of the most sparsely populated. The fairly mountainous terrain is home to a number of lakes and forests, which provide great fishing and hunting for many of its residents as well as for visitors. Winters can be pretty rough. Both the average age of its population and the percentage of people over the age of 65 are substantially higher than the state statistics.

The county seat, Mainville, is located in the eastern side of the county. With a population of 15,000, it is the largest town in the county. Most of the people from Mainville work for the hospital, the town school system, the town government, or the Big John’s superstore just outside the town limits. The largest employer in the county is the state correctional institution for female offenders located in the southwestern part of the county.

A three-member board of commissioners governs the county. The current members are Commissioners Thomas, Richardson, and Harold, all from remote regions of the county. Each receives a minimal stipend for serving on the board and travel to Mainville once a week for the commissioners’ meeting at the county office building. Commissioners Thomas and Harold are retired. Commissioner Richardson lives on the western edge of the county and is a foreman at Ye Olde Saw Mill in the adjacent western county.

JR is the supervisor for the county Transportation Department; he lives in Mainville. Most of the department’s budget is used to clear and salt the roads during the long winters, and for minimal maintenance. Until about five years ago, when Mainville resident and state senator Joe Schmooze passed away, the Transportation Department received a special allocation of state funds. JR worked for Joe, the prior supervisor for the county Transportation Department, and they became friends. Joe, after years of being re-elected and gaining seniority in the Senate, was named the head of the Transportation Committee. With his position, Joe was able to make sure funds were available each year for Polk County. The new state senator representing Polk County is focused on economic development for the county, not on transportation.

Without the special state allocation, county roads have progressively deteriorated. Several critical projects need to be done: the entrance to Big John’s superstore, Elk Mountain Road, and a bridge on County Route 1045. With the budget situation, JR is worried that none of the projects may get done. The commissioners will not be willing to raise taxes, but they may allocate funds from
another department’s budget to pay for such projects. The final decision is to be made by the commissioners at their September 15 budget meeting.

JR is working with his summer intern, Zachary, a resident of Mainville, to pull together information about each of the projects by August 15. Zachary is starting his senior year as a civil engineering major at the state university this fall. JR is worried if he does not present a good case for at least one of the projects, then the commissioners probably will not fund any of them. He is very concerned that all three are disasters waiting to happen.

“Why don’t the commissioners just give you the money for all three projects?” Zachary asked JR.

“I wish it was that simple,” replied JR. “They don’t want to raise taxes, and even if they did, we are a poor county and the people probably wouldn’t have the money to pay any more taxes anyway. They also have other budgets to think about besides just the Transportation Department. I’m sure all the other county departments would like more money, too.

“Zachary, I’m hoping that some of what you learned at that university is going to help you put together what I need—a priority ranking of the three projects and the information on each one to back it up. I know the commissioners are going to ask a lot of questions, and I need to be prepared. If we’re lucky, they’ll approve the project we recommend. If we don’t have a good story to help them with a decision, they may just argue about it and deadlock with no decision. And we won’t get any money for any of the projects. Yep, I think this will give you an opportunity to get a different kind of education than you get at the university. Why don’t we get together next week, and you can give me your ideas about how you’ll tackle this? This may be a bigger job than you think. I want you to work on it full-time for the next two months. This is very important, and I want you to do a thorough job.”

Zachary pulled together the following information for the meeting with JR about the three projects. Zachary realized that he had a personal connection to each.

The first project, the entrance to Big John’s superstore, is off a two-lane highway at the base of the hill. It is difficult for cars traveling in one direction to see cars traveling in the opposite direction until they come over the crest. This makes it difficult for the cars turning left into the store and for those pulling out of the parking lot. A number of accidents have occurred. Just months ago, Peggy Sue Suite, one of Zachary’s best friends from high school, was seriously hurt when a pick-up truck struck her car from behind as she was waiting to turn left into the store’s entrance.

The number of cars traveling on the road has increased over the last three years since the store opened. Several residents have raised concerns at the commissioners’ meetings in the past. The commissioners just said people have to be careful. JR had approached the store manager about helping to pay for the road improvements to widen the road to add a turning lane or install a traffic light. JR is concerned if something is not done, someone will get killed there eventually. The manager replied, “Big John’s superstore has been a good community citizen for the county because it has created jobs, kept its prices low, gave discounts to senior citizens, and donated a percentage of its sales receipts to various charities and fund raisers in the county. We are barely making a profit. If we don’t make a profit, corporate headquarters will close it down, and a lot of people will lose their jobs.” The manager did sympathize with JR about the highway safety issue.
Zachary also learned that many people go to the store because there are no other shopping malls in the county and that Commissioner Thomas’s wife works at the store part-time.

The second project is to widen and repair Elk Mountain Road in the northwest part of the county. The winters have taken their toll on the road and left it with large, deep potholes. The increase in unemployment in the county has led to an increase in independent loggers using the road to bring logs from Elk Mountain to several sawmills, including Ye Olde Saw Mill in the adjacent county. The lack of repair over the years and the heavy trucks are causing the road to deteriorate even faster. Both Commissioners Thomas and Richardson have seen the worsening conditions of the road; they use it frequently to go hunting and fishing on Elk Mountain. Each has received an earful of complaints from friends who use the road.

Zachary knows how bad the road is from personal experience. Last week, he had had to wire his car’s muffler and tailpipe to the frame because the bracket had rusted. While driving up Elk Mountain Road, Zachary was nearly sideswiped by a logging truck that was much bigger than his little car; he was forced off the side of the road. The low-hanging tailpipe and muffler were ripped off Zachary’s car as he hit a large pothole.

The third project, County Road 1045, is the main road to the state correctional institution in the southwestern part of the county. Near the prison is a bridge over Crockett Creek that barely passed the last state inspection four years ago. Each spring during the winter thaw, Crockett Creek threatens to wash out the bridge. If the bridge washes out or is closed, the detour would be nearly 15 miles for most of the people who work at the prison.

Commissioner Thomas suggested at a meeting last year, “Let’s wait until the bridge washes out and then maybe the state will give the county money to build a new bridge. Besides, all those people who work at the prison make a lot of money compared to all the retired people on a fixed income.” Commissioner Harold, whose daughter is a correctional officer at the prison, was quite angry and got into a shouting match at the meeting with Commissioner Thomas.

Zachary’s brother is also a correctional officer at the prison. He has said to Zachary, “It is just a matter of time until Crockett Creek bridge collapses or is washed out. I swear I can feel it shake when I go over it. I just hope that I am not on it or my girlfriend (Commissioner Harold’s daughter) isn’t on it at the moment it happens.”

CASE QUESTIONS

1. What criteria should Zachary use to evaluate the projects?
2. What assumptions should he make?
3. What additional data and information should he gather, and how should he go about gathering the data and information?
4. After he has evaluated each project against the evaluation criteria, how should he decide the priority of the three projects?

GROUP ACTIVITY

Ask each course participant to individually answer the first case question. Then, divide the course participants into groups of three or four to discuss the case questions. Each group must select a spokesperson to present its answers to the entire class.
REFERENCES

CHAPTER 3

Developing Project Proposals

Building Relationships with Customers and Partners
Pre-RFP/Proposal Marketing
Decision to Develop a Proposal
Creating a Winning Proposal
Proposal Preparation
Proposal Contents
  Technical Section
  Management Section
  Cost Section
Pricing Considerations
Simplified Project Proposal
Proposal Submission and Follow-Up
Customer Evaluation of Proposals
Contracts
  Fixed-Price Contracts
  Cost-Reimbursement Contracts
  Contract Terms and Conditions
Measuring Proposal Success
Summary
Questions
Internet Exercises
Case Study 1 Medical Information Systems

Concepts in this chapter support the following Project Management Knowledge Areas of A Guide to the Project Management Body of Knowledge (PMBOK® Guide):

Project Procurement Management
Mortenson Construction Selects Skire Unifier as Enterprise Project Management System

Mortenson Construction was founded in 1954 and has grown to be one of the nation’s top builders, with offices in six major U.S. cities and international offices in Canada and China. Planning, program management, preconstruction, general contracting, construction management, design-build, and turn-key development are some of the services offered to clients.

Mortenson became a customer as it was looking for a system that would work as a key component for its collaboration platform between the key stakeholders on its construction projects and company personnel. Improved quality and timeliness of information was essential to the system Mortenson Construction adopted for its projects.

Six months of evaluation of systems led to a decision to select Skire, a leading provider of capital program, facilities, real estate, and project portfolio management software. One of Skire’s goals is to blend into the client company to help it complete capital projects in a timely manner. The Skire Unifer solution that Mortenson chose integrates schedule files from Microsoft Project with change orders, action items, and other files into a centralized system where document control helps with lowering costs, improving quality, and accelerating schedules of all aspects of a project.

The chief information officer at Mortenson Construction said, “We chose Skire not only because we viewed the technology as robust and best-in-class, but because their people and culture align well with ours. The company’s product development organization impressed us a great deal.”

Skire’s management understands the construction management business from past work experience and from working with the Mortenson Construction team during the evaluation of the systems. The chief executive officer of Skire stated, “Mortenson’s people, knowledge and culture are an excellent fit with Skire’s and this relationship represents a strategic partnership for Skire.”

Mortenson Construction and Skire expect to have a long-term relationship and look ahead to working together to create the next generation of software, making it more efficient, intelligent, and collaborative.

Providing a solution to a customer is more than answering the request for proposals and solving the problem; it is about creating a relationship that goes beyond the solution. Organizations that practice relationship building are viewed as partners. Skire personnel evaluated their own systems and processes to be sure that they could deliver a product that provided the same exceptional experience that Mortenson Construction delivers to its customers. When responding to a request for proposal, make it so that your company and the client organization are commencing a long-term relationship by starting the relationship before the proposal-writing phase and continuing it after the project is concluded, even if your organization is not chosen to provide the solution to the request.

This chapter covers the development of proposals by interested contractors in response to a customer’s request for proposal. When the customer decides which contractor to engage to perform the project, the customer and the contractor sign an agreement (contract).

In many situations, a request for proposal does not involve soliciting competitive proposals from external contractors. For example, suppose company management sees a need to develop new marketing materials (brochures, videos, websites, TV ads, or sample CDs of software) or to reconfigure the office layout. Management may simply ask someone on its own staff or internal team to prepare a proposal that defines what should be done, what company resources would be needed, how much it would cost, and how long it would take. Once the individual or team has prepared the proposal, management can decide whether to go forward with the project, maybe modifying it in the process. Once a decision is made to go forward, the project proceeds directly to the planning and performing phases of the project life cycle: creating a detailed plan for the project and then implementing that plan to accomplish the project objective.

For some projects, there is neither a request for proposal nor an actual proposal; rather, after the need is identified, the project moves right into the planning and performing phases of the project life cycle. Examples include a project that one or two individuals do by themselves, such as remodeling their basement into a family room, or a project carried out by a volunteer group, such as organizing a fundraising event. You will become familiar with

- Building relationships with customers and partners
- Proposal marketing strategies
- Decision making to develop a proposal
- Creating winning proposals
- The proposal preparation process
- Elements that may be included in a proposal
- Pricing considerations
- Customer evaluation of proposals
- Types of contracts between the customer and the contractor
- Measuring success of proposal efforts

**LEARNING OUTCOMES**

After studying this chapter, the learner should be able to:

- Develop relationships with customers and partners
- Decide whether to prepare a proposal in response to a customer’s RFP
- Create a credible proposal
- Determine a fair and reasonable price for a proposal
- Discuss how customers evaluate proposals
- Explain types of contracts and various terms and conditions
- Measure the success of proposal efforts
Building Relationships with Customers and Partners

Customers (clients) and partner organizations prefer to work with people they know and trust.

Relationships establish the foundation for successful funding and contract opportunities. Relationship building requires being proactive and engaged. In many ways, it is a contact sport. It requires getting out of the office and having face to face contact. It cannot be done as effectively through electronic messages or phone conversations. For example, if you were soliciting proposals from several contractors for a house you wanted them to build, would you make a final decision of which contractor to select based solely on exchanges of electronic messages or phone conversations? Probably not. You would want to meet the contractors face to face.

Contractors should get to know people in potential customer organizations on a personal basis. Relationship building necessitates being a good listener and a good learner. When you are with clients, ask questions and listen. Make the discussion about them, not about you. You will learn more from listening than from telling. Try to learn some personal information about them—where they are from, their career and prior work assignments, where they may have gone to college, their hobbies or interests, their family, etc.—without seeming intrusive. Look for things that you may have in common: do you know people from the same city or have common interests (sports, gardening, books, children of similar ages, etc.), or did you attend the same university? You can store this information for later recall in future encounters with them. Start every dialogue by showing a personal interest and making a personal inquiry such as, "How is your daughter’s soccer team doing?" or "How is your mother recovering from her hip surgery?" If you show a genuine interest, they will be impressed or flattered that you remembered. Make clients feel good. Empathize with their issues whether they are business or personal. Look for opportunities to congratulate or console them. If they just got married, had a baby, or had a death in their family, send them a card with a handwritten note. If you know that a client has a particular personal or business interest, such as mountain climbing, collecting antiques, the American Civil War, or a technology such as digital media or biofuels, send her any articles you may come across, along with a handwritten note stating, "I thought this might be of interest to you." The personal touch is special and endearing. Sending an electronic message with a link to an article on a website would also be a nice gesture.

Contacts with potential clients should be frequent and not just when there is a current opportunity for funding or just before they will be issuing a request for proposal (RFP). Whenever you are in the city where a client is located, plan ahead to schedule a lunch, or perhaps just stop by the office to say "Hello." If you stop by for an impromptu visit and the client is not available, make sure you leave your business card and a note to let him know that you stopped by. During these lunches or brief encounters, do not just talk all business, but also discuss personal interests that you have in common, such as specific sports, movies, recent vacations, current news events, etc. However, you may want to avoid some topics, such as politics, that could lead to strong disagreements, unless you get to know the client’s views better.

During contacts, do not focus on discussing potential contract opportunities. If you talk too much business or ask too many questions about upcoming RFPs or funding opportunities, the client will know you are just trying to pry information from her. When business is discussed, try to listen and understand the client’s needs and determine if you or your organization can help the client organization achieve its goals and be successful. After meeting with a client, always express your appreciation and thank her for making the time to meet with you. You may want to follow up with...
a brief electronic message saying thanks. Offer to provide any help or information the client may need, or extend an invitation to visit you and your organization. Leave the door open for continuing the dialogue and developing a stronger relationship.

*Establishing and building trust is key to developing effective and successful relationships with clients and partners.* One way to foster this is to always keep your word; be reliable and responsive. If you tell a client that you will send him particular information by the end of the week, make sure you do it. Deliver on what you promise, but make realistic promises.

Ethical behavior in dealing with clients and partners is also imperative for building trust. Nothing can sour a business relationship faster than doing or saying something that the client may perceive as unethical. In encounters with clients and partners, do not do anything that would give the impression that you are trying to get away with something or acting shady or underhanded. Do not exaggerate or stretch the truth. Be fair and always do the right thing. Do not be nosy or try to pry insider or confidential information from them. For example, do not ask a client about the detailed budget for a recent contract that the client awarded to one of your competitors. Similarly, if the client asks you for information that is confidential, you should tell her that you cannot divulge it; she will respect you for being honest and truthful, and it will build her trust in you. Do not pass along gossip, rumors, or hearsay and then tell the client that she should keep it confidential or not tell anyone else. You are asking her to do something that you yourself could not do—keep a secret—and the client will lose trust in you. Also do not make negative comments about other people or organizations, even if the client does: do not join the feeding frenzy.

The first impression you make on a client is pivotal to developing a continuing and fruitful relationship. It is important to control your emotions and be tactful and not confrontational in discussions with clients. Do not make quick knee-jerk responses that you may regret later. It is better to sleep on a contradictory issue and provide a more thoughtful response the next day. Learn to guide the conversations with the client by knowing when to keep quiet, when not to respond, when to give your opinion (or not to give it prematurely), and when to change the topic of discussion. If you prematurely respond to a client’s comment before he is finished with it, your response can be totally off-base from where he was going with his comments. Also be careful and sensitive to making, or responding to, comments or jokes that may be inappropriate. For example, telling a joke about a person of a certain religious faith or about a person with a certain disability or an off-color remark about the opposite gender may strike a discord with the client and could end the relationship, closing your firm out of future business opportunities with that client. Avoid foul language, slang, and jargon.

Maintain a positive and can-do attitude in your dealings with clients and partners. Do not be negative and dwell on why things will not work or cannot be done. Rather, try to suggest creative approaches of how things can be done. Clients want to work with people who can solve problems, not with those who merely identify them.

Build credibility based on performance. Do not just say you can deliver; prove it. Go the extra mile, make the extra effort, and exceed expectations.

Always put the client first. Clients want to be confident that any projects they do with a contractor will be successful, involve a good working relationship with the contractor, and help the clients achieve their business goals.

It is advisable not to rely on a good relationship with just one individual in a client or partner organization, but rather to build relationships with several key people, since key individuals may leave and others may become more influential.

Building effective and successful relationships takes time and work; it does not happen overnight.
Pre-RFP/Proposal Marketing

Contractors whose livelihood depends on creating winning proposals in response to business or government RFPs should not wait until formal RFP solicitations are announced by customers before starting to develop proposals. Rather, such contractors need to develop relationships with potential customers long before the customers prepare a request for proposal.

Contractors should maintain frequent contacts with past and current customers and initiate contacts with potential customers. During these contacts, contractors should help customers identify areas in which they might benefit from the implementation of projects that address needs, problems, or opportunities. Working closely with a potential customer puts a contractor in a better position to be selected eventually as the winning contractor when the customer does issue an RFP. A contractor who is familiar with a customer’s needs, requirements, and expectations can prepare a more clearly focused proposal in response to the customer’s RFP. These pre-RFP or pre-proposal efforts by a contractor are considered marketing or business development and are performed at no cost to the customer. The payoff to the contractor for these efforts is expected to come later—when the contractor is selected as the winning contractor in response to the customer’s RFP.

During this pre-RFP/proposal activity, the contractor should learn as much as possible about the customer’s needs, problems, and decision-making process. The contractor should ask the customer for information, data, and documentation about the identified need or problem. The contractor may then develop some pre-proposal concepts or approaches and present them to or review them with the customer. By getting the customer’s reactions to such concepts, the contractor can begin to understand and clarify what the customer expects, as well as develop a responsive and favorable image in the eyes of the customer. The contractor may invite the customer to visit another of the contractor’s clients who had a similar need or problem for which the contractor proposed and implemented a successful solution. Such a visit can enhance the contractor’s reputation with the customer.

In some cases, the contractor may prepare an unsolicited proposal and present it to the customer. If the customer is confident that the proposal will address their need or solve their problem at a reasonable cost, the customer may simply negotiate a contract with the contractor to implement the proposed project, thus eliminating the preparation of an RFP and the subsequent competitive proposal process. By doing a good job in pre-RFP/proposal marketing, the contractor may obtain a contract from a customer without having to compete with other contractors.

Whether the goal is winning a competitive RFP or obtaining a noncompetitive contract from a customer, a contractor’s pre-RFP/proposal efforts are crucial to establishing the foundation for eventually winning a contract from the customer.

Decision to Develop a Proposal

Because the development and preparation of a proposal takes time and can be costly, contractors interested in submitting a proposal in response to an RFP must be realistic about the probability of being selected as the winning contractor. Evaluating whether to go forward with the preparation of a proposal is sometimes referred to as the bid/no-bid decision. A contractor might consider the following factors in deciding whether to develop a proposal in response to an RFP:
1. Competition. Which other contractors might also submit a proposal in response to the RFP? Do any of these contractors have a competitive advantage, because of either pre-RFP marketing efforts or their previous work for or reputation with the customer?

2. Risk. Is there a risk that the project will be unsuccessful—technically or financially? For example, are there too many uncertainties regarding the technological feasibility of developing an integrated electronic circuit that will meet the customer’s requirements? Or, does the customer want contractors to submit a proposal based on a fixed-price contract for a project that involves a research and development effort with only a 50 percent chance of technical success?

3. Mission. Is the proposed project consistent with the contractor’s business mission? For example, if a contractor’s business is to develop and implement automated systems for business-oriented applications, such as accounting, order tracking, or financial reporting, developing an automated system for monitoring, testing, and controlling a chemical process for a pharmaceutical company would not be within this contractor’s business mission.

4. Extension of capabilities. Would the proposed project provide the contractor with an opportunity to extend and enhance its capabilities? For example, if a contractor has been providing automated inventory control systems to individual food markets, an RFP to provide an integrated inventory control system for a supermarket chain of 10 stores might provide the contractor with an opportunity to extend its capabilities and expand its business to a larger customer base.

5. Reputation. Has the contractor successfully completed projects for the same customer in the past, or were there problems that left the customer dissatisfied? Has the contractor unsuccessfully bid on RFPs from the customer in the past?

6. Customer funds. Does the customer really have funds available to go forward with the project? Or is the customer on a “fishing expedition”—issuing an RFP although unsure whether the project will ever be funded? A customer may issue an RFP with the best of intentions but do so prematurely, anticipating that the board of directors will approve funding. However, if the company is having financial difficulties, the board may decide to postpone the project indefinitely, even after proposals have been received from interested contractors. Good pre-RFP marketing by the contractor will help to determine the viability of a project. Contractors should not spend time responding to RFPs by developing proposals for projects that probably will not be funded.

7. Proposal resources. Are appropriate resources available to prepare a quality proposal? It is not enough for a contractor to just prepare a proposal. It is imperative that the proposal be of sufficient quality to have a good chance of winning. To prepare a quality proposal, a contractor must have the appropriate people—that is, resources—to work on it. If the contractor’s organization does not have the right resources available to prepare a quality proposal, the contractor should make arrangements to secure other resources to ensure the best possible proposal. A contractor should not use inappropriate resources to prepare a proposal just for the sake of submitting a proposal. Submitting a poor quality proposal can leave the customer with a negative impression, which can hurt the contractor’s chances of winning future contracts from that customer.
8. **Project resources.** Are appropriate resources available to perform the project if the contractor is selected as the winner? Contractors need to be sure that the appropriate individuals within their organization will be available to work on the project. If, after being awarded the contract, the contractor discovers that the team must be made up of individuals other than those originally planned for the project, the chances of successfully completing the project may diminish. The result could be a dissatisfied customer who will not ask the contractor to respond to future RFPs. If a contractor is not sure that it has the resources to perform the project, it must have a plan for securing the resources needed to perform the project successfully (such as hiring new people, outsourcing some work elements to subcontractors, or partnering with other contractors).

Contractors need to be realistic about their ability to prepare proposals and about the probability of winning the contract. The proposal selection process is competitive—the customer will select one winner from among competing proposals. For a contractor, success is winning the contract, not merely submitting a proposal. Submitting a lot of non-winning proposals in response to RFPs can hurt a contractor's reputation. So, although it is often the right thing to do, sometimes the hardest thing for a contractor to do is to decide to no-bid an RFP.

Figure 3.1 is an example of a bid/no-bid checklist that a contractor might use in deciding whether to submit a proposal in response to a request for proposal. Such a checklist might be used by the decision makers in the contractor’s organization to reach a consensus. The checklist in Figure 3.1 illustrates the consensus of key individuals from a training consulting firm. It summarizes their deliberations over whether to bid on an RFP from ACE Manufacturing, Inc., to conduct a substantial supervisory training program for employees at seven plant locations nationwide. Do you think they should submit a proposal to ACE?

### Creating a Winning Proposal

It is important to remember that the proposal process is competitive. A customer uses a request for proposal to solicit competing proposals from contractors. Each contractor, therefore, must keep in mind that its proposal will be competing with other contractors’ proposals to be selected by the customer as the winner. Submitting a proposal that meets the customer’s statement of work and requirements in the RFP is not sufficient to guarantee selection as the winning contractor. Many or all of the proposals will likely meet the requirements. The customer will select the one that it expects will provide the best value.

A proposal is a **selling** document; it is not a technical report. In the proposal, the contractor must convince the customer that the contractor

- Understands what the customer is looking for.
- Can carry out the proposed project.
- Will provide the greatest value to the customer.
- Is the best contractor to address the need or solve the problem.
- Will capitalize on its successful experience with previous, related projects.
- Will do the work professionally.
- Will achieve the intended results.
- Will complete the project within budget and on schedule.
- Will satisfy the customer.
FIGURE 3.1  Bid/No-Bid Checklist

<table>
<thead>
<tr>
<th>Factor</th>
<th>Score</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>Competition</td>
<td>H</td>
<td>Local university has been providing most of the training to ACE in the past</td>
</tr>
<tr>
<td>Risk</td>
<td>L</td>
<td>Requirements in RFP are well defined</td>
</tr>
<tr>
<td>Consistent with our mission</td>
<td>H</td>
<td>Training is our business</td>
</tr>
<tr>
<td>Opportunity to extend our capabilities</td>
<td>H</td>
<td>Some tasks require videoconferencing, which we haven't done before</td>
</tr>
<tr>
<td>Reputation with customer</td>
<td>L</td>
<td>Have not done any training for ACE before</td>
</tr>
<tr>
<td>Availability of funds</td>
<td>H</td>
<td>ACE has funds budgeted to implement the training</td>
</tr>
<tr>
<td>Resources available to prepare quality proposal</td>
<td>M</td>
<td>Lynn will have to reschedule her vacation. Will probably need to work over Memorial Day weekend to finish proposal</td>
</tr>
<tr>
<td>Resources available to perform project</td>
<td>M</td>
<td>Will have to hire subcontractors for several specific training topics</td>
</tr>
</tbody>
</table>

Our advantages, strengths, or distinct capabilities:
• Good track record in supervisory training—we have many repeat customers
• More flexible than local university in meeting ACE’s need for on-site training during 2nd and 3rd shift operations

Our weaknesses:
• Most of our customers have been in the service sector, such as hospitals. ACE is a manufacturer
• President of ACE is a graduate of local university and a large contributor to it
In the proposal, the contractor must highlight the unique factors that differentiate it from competing contractors. The proposal must emphasize the benefits to the customer if the customer selects the contractor to perform the project.

Key partners and subcontractors can complement a contractor’s expertise. Identifying and including appropriate partners or subcontractors to perform specific key tasks on a proposed project can provide a significant competitive advantage, especially if those organizations have specific technical expertise that is crucial to the project, have an excellent reputation, or perhaps already have good credibility with the customer.

Proposals should be written in a simple, concise manner; they should not be wordy or redundant. They should use terminology with which the customer is familiar and avoid abbreviations, acronyms, jargon, and other words that the customer may not know or understand. Simple illustrations and graphics should be used when possible. Overly complex illustrations should be avoided; several simple graphics will likely be easier for the customer to understand than one complicated graphic. When a point is made or an approach or concept proposed, it should be supported with logic, rationale, and/or data. Proposals must specifically address the customer’s requirements as laid out in the RFP. Proposals written in generalities will cause the customer to question whether the contractor really understands what needs to be done and how to do it. For example, suppose one of the requirements in a customer’s RFP is the design of a specialized piece of machinery that will produce 20 parts per minute. A contractor proposal stating that "the machine to be designed will, in fact, produce 20 parts per minute" is more convincing than one stating that "the machinery will be designed to produce the maximum number of parts per minute." The customer will be doubtful about the latter statement because "maximum" could mean something less than 20 parts per minute.

Finally, proposals must be realistic in terms of the proposed scope, cost, and schedule in the eyes of the customer. Proposals that promise too much or are overly optimistic may seem unbelievable and again raise doubt about whether the contractor understands what needs to be done and how to do it.

Proposal Preparation
The preparation of a proposal can be a straightforward task performed by one person, or it can be a resource-intensive effort requiring a team of organizations and individuals with various expertise and skills. In the simple case of designing and printing an annual report, an experienced commercial printer (the contractor), after meeting with the customer regarding the requirements, may be able to prepare a proposal within a short period of time without involving other individuals. However, in the case where a government agency has issued an RFP for a multimillion-dollar project to design and construct a new regional rapid transit system, each interested contractor may have to assemble a team of many individuals, subcontractors, and/or partners to help develop the proposal. In such situations, the contractor may designate a proposal manager who coordinates the efforts of the proposal team to ensure that a consistent, comprehensive proposal is prepared by the due date stated in the RFP.

Developing a comprehensive proposal for a large project should be treated as a project in itself; thus, the proposal manager needs to meet with the proposal team to develop a schedule for completing the proposal by the customer’s due date. The schedule should include the dates by which various individuals will
have drafts of their assigned portions of the proposal, dates for conducting reviews with appropriate people on the proposal team, and the date on which the proposal will be finalized. The proposal schedule must allow time for review and approval by management within the contractor’s organization. Time must also be provided for preparing any graphic illustrations, typing, copying, and delivery of the proposal to the customer, who may be hundreds of miles away from the contractor.

Proposals in response to RFPs for very large technical projects can be multi-volume documents that include engineering drawings and hundreds of pages of text. And, yes, such proposals are often due within 30 calendar days of the RFP’s issuance! Contractors who bid on such large projects usually do pre-RFP marketing, and so they may have a draft proposal prepared before the customer even issues a formal RFP. In such cases, during the 30-day response period, the contractor can first revise the draft proposal to incorporate any unanticipated requirements and then use any remaining time to “package” a first-class professional proposal.

Customers do not pay contractors to prepare proposals. Contractors absorb such costs as normal marketing costs of doing business, in anticipation of winning contracts and making profits on them.

As stated previously, a proposal is a selling document, not a technical report. It may consist of several pages or several volumes, containing hundreds of pages, illustrations, and tabulations. A proposal should contain sufficient detail to convince the customer that the contractor will provide the best value to the customer. Too much detail in a proposal, however, may overwhelm the customer and needlessly increase the proposal preparation costs for the contractor.

**Proposal Contents**

Proposals are often organized into three sections: technical, management, and cost. For large proposals, these sections could comprise three separate volumes. The amount of detail the contractor includes will depend on the complexity of the project and the contents of the RFP. Some RFPs state that contractor proposals that exceed a certain number of pages will not be accepted by the customer. After all, customers are anxious to do an expeditious evaluation of all proposals submitted, and they may not have the time to review a large number of voluminous proposals.

**TECHNICAL SECTION**

The objective of the technical section of the contractor proposal is to convince the customer that the contractor understands the need or problem and can provide the least risky and most beneficial solution. The technical section should contain the following elements:

1. **Understanding of the need.** The contractor should state its understanding of the customer’s problem or need in its own words. The contractor should not merely restate the problem statement that appears in the customer’s RFP. This first part of the technical section must show the customer that the contractor thoroughly understands the problem to be solved or the need to be addressed and establish the basis for the solution proposed later in the technical section. The contractor may want to describe, in narrative or graphic form, the customer’s current condition. For example, if the problem is a high
reject rate from a manufacturing process, the contractor may want to incorporate a flowchart of the customer’s current manufacturing process that indicates where the rejects are occurring and what other problems they may be causing, such as production bottlenecks. Customers will feel more confident working with a contractor who, they believe, really understands their need.

2. **Proposed approach or solution.** Some needs lend themselves to a specific proposed solution—for example, an RFP to reconfigure a large office to accommodate 10 percent more people. Other problems, however, do not. A problem may require that an analysis and development task be conducted as part of the proposed project before a specific solution can be described in detail. In such cases, the contractor proposal must describe the approach or methodology that would be used in developing the solution. For example, if an RFP is for a specialized non-contact inspection system to measure certain characteristics of a complexly shaped product made of an advanced material, it would be unrealistic for the customer to expect the contractors to design such a system as part of the proposal itself; rather, such engineering design and development would be done as part of the proposed project. However, in the proposal, the contractor must convince the customer that the approach proposed for designing, developing, and building such a system is logical and realistic and would lead to the contractor supplying a system that would successfully meet the customer’s requirements. This part of the technical section might contain the following:

a. A description of how the contractor would collect, analyze, and evaluate data and information about the need or problem.

b. A description of the methods that would be used by the contractor to evaluate alternative solutions or further develop the proposed solution to the problem. This portion could include a discussion of various experiments, tests, or physical or computer models the contractor would use or has used on similar projects.

c. The rationale for the proposed approach or solution. This rationale could be based on experiments previously conducted by the contractor, the contractor’s experience in solving similar problems, or a unique patented technology the contractor would use to address the need.

d. Confirmation that the proposed solution or approach would meet each of the physical, operational, and performance requirements stated in the customer’s RFP. For example, if the RFP for the design and construction of a day care center states that certain furnishings must be at a specific height to accommodate children under 48 inches tall, the proposal must state that the contractor will meet that requirement. Not addressing each of the customer’s requirements will raise doubt in the customer’s mind about the proposed solution and could hurt a contractor’s chances of winning the contract, especially if competing contractors’ proposals state that they will meet the requirements.

If the contractor cannot meet a specific customer requirement, that fact should be stated in the contractor proposal. A variation from specified requirements is known as an **exception**. For each exception taken to a customer requirement, the contractor should explain why the requirement will not or cannot be met and propose an alternative. Although contractors should avoid taking exceptions to customer requirements, there may be circumstances where an exception is appropriate. For example, if the
customer requires an electric heating system for an office building, the contractor may take exception and show in the proposal that the initial and operating costs for a natural gas heating system would be less expensive for the customer. However, the customer may have very good reasons beyond cost for requiring an electric heating system and may reject proposals that take exception to that requirement.

3. Benefits to the customer. The contractor should state how the proposed approach or solution would benefit the customer and achieve the project’s success criteria or expected outcomes. Benefits could be quantitative or qualitative and could include cost savings; reduced processing time; reduced inventory; better customer service; less scrap, rejects, or errors; improved safety conditions; more timely information; and reduced maintenance. This portion of the proposal should help convince the customer of the value of the proposed approach compared with proposals the customer may receive from competing contractors.

 MANAGEMENT SECTION

The objective of the management section of the contractor proposal is to convince the customer that the contractor can do the proposed work (the project) and achieve the intended results. The management section should contain the following elements:

1. Description of work tasks. The contractor should define the major tasks that will be performed in carrying out the project and provide a brief description of what each major task includes. It is important that the contractor not merely restate the statement of work that may be included in the customer’s RFP. The proposal need not include a lengthy list of detailed activities; such an activity list would be developed during the detailed planning phase, after the contract has been awarded.

2. Deliverables. The contractor should include a list of all deliverables (tangible products or items) that will be provided during the project, such as reports, drawings, manuals, and equipment.

3. Project schedule. The contractor should provide a schedule for performing the major tasks required to complete the project. The schedule must show that the contractor can complete the project within the time frame stated in the RFP. The task schedule can be given in any one of several formats: a list of tasks with their estimated start and completion dates; a bar chart, often called a Gantt chart, with the estimated duration of each task represented by a bar along a horizontal timeline; or a network diagram in which the tasks are portrayed graphically, showing the sequence of and interdependencies among the tasks. In addition to the major tasks, the schedule might include dates for other key milestone events such as important review meetings, customer approval activities, and completion of deliverable items such as progress reports, concept sketches, drawings, manuals, databases, or equipment.

4. Project organization. The contractor should describe how the work and resources will be organized to perform the project. For large projects involving many people and subcontractors or partners, it may be appropriate to include an organization chart that shows the major project functions along with the
name of the specific individual who will be assigned responsibility for each function. Resumes of the key people who will be assigned to the project should be included to convince the customer that their significant related experience will be brought to bear to ensure the project’s success. In addition to or in place of an organization chart, the contractor may include a responsibility assignment matrix that lists the major project tasks and designates the individual, organization, or subcontractor responsible for the accomplishing each task.

5. Related experience. To help convince the customer that the contractor can do the project, the contractor should provide a list of similar projects it has completed. The contractor should briefly describe each past project and explain how the experience from that project will be helpful in successfully performing the proposed project. The contract dollar value of each project should also be provided to give the customer a sense of the contractor’s ability to manage projects the size of the proposed one. The probability of a contractor winning a contract for a $1,000,000 project is not very high if all its previous related experience is on projects of $20,000 or less. For each previous similar project, the contractor might want to include the name, title, and phone number of an individual the current customer could contact to check on the contractor’s performance. Reference letters from satisfied customers might also be included. This type of information will be particularly helpful if the contractor has a strong performance record.

Additionally, if key tasks are proposed to be outsourced to subcontractors or partners, the relevant experience of those organizations should also be stated, including why they were selected to be part of the proposed project team. Resumes of their key people might also be included.

6. Equipment and facilities. Some projects require the contractor to use or have access to unique equipment or materials, such as high-performance computers, proprietary software, manufacturing equipment, or testing facilities. In these cases, the contractor may want to provide a list of the equipment and special facilities it has, in order to convince the customer that it has the necessary resources.

COST SECTION

The objective of the cost section of the contractor proposal is to convince the customer that the contractor’s price for the proposed project is realistic and reasonable. Often the customer requires the contractor to provide a detailed breakdown of the various cost elements. However in some cases, the customer may want only the bottom line total price of the project. Some customers also want to see the costs of optional items. For example, a couple who is asking several contractors for proposals for building a house may be looking for the total cost plus costs of options such as landscaping, a deck, a finished basement, a built-in swimming pool, and a fence around the backyard.

The cost section usually consists of tabulations of the contractor’s estimated costs of elements such as the following:

1. Labor. This portion gives the estimated costs of the various types or classifications of people who are expected to work on the project. It might include the estimated hours and hourly labor rate for each person or classification, such as senior engineer, graphic designer, machinist, programmer, electrician, or painter. The estimated hours must be realistic.
If they are too high and have too much "fat" in them, the total estimated costs may be higher than what the customer is willing to pay. On the other hand, if the estimated hours are too low, the contractor may lose money on the project. The hourly labor rate is usually based on the annual salary for each person or the average annual salary for each classification plus an additional percentage to cover employee fringe benefits (health insurance, retirement, and so forth). These salaries are then divided by the number of normal work hours in a year (for example, 40 hours a week times 52 weeks equals 2,080 hours) to determine the hourly labor rate for each person or classification.

2. **Materials.** This portion gives the cost of materials the contractor needs to purchase for the project. For example, the cost of materials for a remodeling project might include lumber, new windows, electrical and plumbing supplies, and carpeting.

3. **Equipment.** Some projects require equipment that must be purchased as part of the project. Equipment can include items such as computers and machinery. For example, a project to construct a clinic would include the purchase of various types of medical equipment. Or a project to upgrade a manufacturing facility may include the purchase of new production machinery. Or a new office might include the purchase of new computer systems.

4. **Facilities.** Some projects may require special facilities or additional space for the project team, for security reasons, to store materials, or to build, assemble, and test the project end item (deliverable). If such facilities are required, the estimated cost for renting the space needs to be included.

5. **Subcontractors and consultants.** When contractors do not have the expertise or resources to do certain project tasks, they may outsource some of the work to subcontractors or consultants to perform those tasks. For example, a project to remodel a church basement into a day care center might require that the contractor hire a subcontractor to remove any asbestos and a consultant to provide advice on state regulations and codes for day care facilities. The contractor usually asks the subcontractors and consultants to submit a proposal of work scope and cost for their tasks. The contractor then includes these costs in the overall cost of the project.

6. **Travel.** If travel (other than local travel) is required during the project, the costs of travel such as air fare, lodging, and meals need to be included. The contractor must first estimate the number and duration of trips. For example, if the customer is a government agency in Washington, DC, and the contractor is in California, the costs associated with travel to Washington for review meetings with the customer need to be included.

7. **Documentation.** Some customers want the contractor to show separately the costs associated with the project documentation deliverables. This would be the cost of printing manuals, drawings, or reports or the cost of producing videos or DVDs, for example.

8. **Overhead.** Contractors will add a percentage to costs in items 1 through 7 to cover their normal overhead—the indirect costs of doing business, such as insurance, depreciation, accounting, general management, marketing, and human resources. Of course, in informal projects, such as organization of a town celebration by volunteers, such overhead costs are not applicable.

9. **Escalation.** For large projects that are expected to take several years to complete, the contractor needs to include the costs of escalation in wage rates and materials costs over the duration of the project. For example, for a three-year project, the contractor may want to anticipate a 3 percent wage
increase in each of the final two years of the project. If the same project requires that the contractor purchase most of the materials during the third year, the current materials cost estimates may need to be increased by a certain percentage to cover the expected cost of the materials at the time they will be purchased.

10. Contingency. Contingency, or management reserve, is an amount the contractor may want to include to cover unexpected situations that may come up during the project, such as items that may have been overlooked when the initial project scope was defined, activities that may have to be redone because they may not work the first time (redesigns), or the costs to cover a high probability or high impact risk that may occur.

11. Profit. Items 1 through 10 are costs. The contractor must aggregate the cost elements and then add an amount for its desired profit. The total aggregated cost of items 1 through 10 plus the profit is the contractor’s price for the proposed project.

If possible, it is good practice to have the person who will be responsible for the major work tasks estimate the associated costs. This generates a commitment from that person and avoids any bias that may be introduced by having one person estimate all the costs for the entire project. In other cases, the contractor may designate several experienced individuals to estimate the costs for certain groups or types of tasks. If a contractor has performed similar projects in the past and has kept records of the actual costs for various items, these historical data can be used as a guide in estimating costs for the proposed project.

Cost estimates should be reasonable and realistic. They should not be so heavily “padded” that they include contingency funds for every conceivable thing that might come up or go wrong. If cost estimates are overly conservative, the price for the project may be more than the customer has authorized for the project or higher than that of competing contractors. On the other hand, if the estimated costs are overly optimistic and some unexpected expenditures arise, the contractor is likely to either lose money (on a fixed-price contract) or have to suffer the embarrassment of going back to the customer to request additional funds to cover cost overruns.

**Pricing Considerations**

When contractors prepare a proposal, they are generally competing with other contractors to win a contract. Therefore, they need to be careful not to overprice the proposed project, or the customer may select a lower-priced contractor. However, contractors must be equally careful not to underprice the proposed project; otherwise, they may lose money rather than making a profit or may have to request additional funds from the customer, which could be embarrassing and hurt the contractor’s reputation.

The contractor must consider the following items when determining the price for the proposed project:

1. Reliability of the cost estimates. Does the contractor have confidence that the total cost of the proposed project is complete and accurate? The contractor should take the time to think through the project and estimate costs at a detailed level, rather than making a ballpark estimate. Ideally the costs should be based on a recent similar project or, in the case of materials costs,
on current price lists, catalogues, or quotations. It may be advisable to ask experienced individuals or specialists to help estimate the labor effort. In general, the more detailed the cost estimates, the better.

2. **Risk.** If the proposed project involves an endeavor that has not been undertaken before, such as a research and development project to come up with a drug to control a disease, it may be necessary to include a large amount of contingency, or management reserve, funds.

3. **Value of the project to the contractor.** There may be situations in which the contractor is willing to live with a tight or low price. For example, if the contractor has few other projects, it may need to lay off workers unless new contracts are obtained. In such a case, the contractor may include only a very small fee to increase the chances of winning the contract and avoid having to lay off people. Another example of a project that may be particularly valuable to the contractor is a project that provides an opportunity to extend capabilities or expand into new types of projects. For example, a building contractor who has been doing only remodeling projects may want to get into building complete homes and be willing to make a low profit in order to gain entry into the market and establish a reputation.

4. **Customer’s budget.** A contractor who knows how much money the customer has budgeted for a project should not submit a price that exceeds what the customer has available. This is where good pre-RFP marketing is important. By helping a potential customer identify a need or submitting an unsolicited proposal with estimated costs, a contractor can help the customer determine a budget for the project. Then, if the customer issues a competitive RFP (and does not disclose the amount budgeted for the project), the contractor with the customer budget ‘intelligence’ information may be in a better position to submit a proposal with an acceptable price than are contractors who have not done similar homework.

5. **Competition.** If many contractors are expected to submit proposals in response to a customer RFP or if some competing contractors are hungry for work, it may be necessary to submit a price that includes only a small profit in order to increase the chances of winning the contract.

**Simplified Project Proposal**

Large, complex mega-dollar projects that are outsourced by customers using a request for proposal result in contractors preparing and submitting comprehensive proposals that can be voluminous and detailed and include much of the information discussed in the previous section (Proposal Contents). However, many smaller or less complex projects may not require such extensive proposals. In other cases, contractors may even submit an unsolicited proposal prior to the customer’s preparation of an RFP. In both of these situations, a simplified or basic proposal may be appropriate and sufficient. Such a proposal should include the following elements as a minimum:

1. **Statement of customer’s need.** This should clearly describe the contractor’s understanding of the customer’s need or problem and reference any information or data to support the need. For example, if the customer has a need to expand by building a retail outlet in a certain geographic region, the contractor may reference some data on the emerging trends for such a retail outlet or the demographic data for the region where the store will be located. This will demonstrate to the customer that the contractor has made

**Reinforce Your Learning**

16. What are some items a contractor needs to consider when determining a price for a proposed project?
the effort to gather background data relative to the customer’s need. In this section of the proposal, the contractor should try to quantify the customer’s current condition or opportunity in order to establish a baseline for measuring project success.

2. **Assumptions.** Sometimes the customer may not provide certain information in defining their need, may be unintentionally ambiguous about an item, or perhaps may not even address an issue at all that the contractor thinks is significant and necessary to performing the project successfully. In such instances, it is appropriate for the contractor to state any assumptions that may affect the contractor’s scope, schedule, or price. An example might be that the customer would accept upgrading the user interface of all workstations from the current keypads to touch screen technology. Another case may be an assumption that all work regarding reconfiguring office space would be done on weekends to minimize disruption to workflow during normal work hours. Listing assumptions can also be a way for the contractor to address topics that might make its proposal more competitive than that of another contractor.

3. **Project scope.** This should describe the contractor’s approach to addressing the customer’s need or solving the problem, define specifically what work tasks the contractor proposes to do, and outline how the contractor expects the customer to be involved throughout the project. This is the critical section of the proposal. It should be in sufficient detail to convince the customer that the contractor has a well-thought-out approach that is feasible, is practical, and will be successful. It should highlight the unique features of the contractor’s approach and how they will benefit the customer. An example is the contractor’s stating that it will incorporate a unique design technique or use proprietary materials that will result in significantly lower life cycle costs for the new system. Or it may be the contractor’s mentioning how it will capitalize on its knowledge gained from successfully completing similar projects in the last five years.

4. **Deliverables.** The contractor must list all the tangible products or items it will provide to the customer during the performance of the project. Depending on the project, these can include such items as progress reports, concept designs, prototypes or mock-ups, specifications, reports, workbooks, videos, brochures, a website, a database, hardware, a building, furniture, workshops, equipment, and so on. The contractor needs to assure that all deliverables will be done in accordance with the customer’s specifications, building codes, or industry standards, and so forth, and that they will pass the customer’s acceptance criteria. The more descriptive and quantitative the contractor can be regarding the deliverables, the better it will demonstrate its knowledge and confidence in accomplishing the customer’s project objective.

5. **Resources.** This discusses the types of expertise and skills that the contractor will utilize on the project, including any key subcontractors, consultants, or suppliers. This section provides another opportunity for the contractor to state any unique or competitive advantages, such as by highlighting the well-regarded expertise or experience of specific individuals who will be assigned to the project. Other resources to mention might include the availability of unique equipment such as high-precision production equipment to manufacture components that must meet the customer’s rigorous specifications or a proprietary environmental testing chamber to perform required acceptance tests. This portion of the proposal is very important because it allows the
contractor to persuade the customer that the contractor has the right type of resources available and the project management wherewithal to successfully perform the project, and that an excellent working relationship will be established with the customer that will be based on timely and open communication and avoidance of any unpleasant surprises.

6. Schedule. This should include a list of key milestones with their target dates or cycle time from the start of the project. The more detailed it is, the easier it will be for the customer to see the well-thought-out plan. Providing a graphic depiction of the schedule in the form of a network diagram or bar chart could increase the customer’s confidence in the contractor’s ability to manage the project and provide all the deliverables in accordance with the customer’s requirements.

7. Price. The contractor needs to indicate the bottom line price to perform the project. It is also important to include a discussion to convince the customer that the price is fair and reasonable for the work the contractor is proposing to do. The emphasis should be on the value provided and not on how low, or “cheap,” the price is. For example, the contractor should describe the unique things it brings to the project that add value.

Sometimes the contractor may suggest several alternatives or options to the customer’s basic requirements, and therefore also provide a price for each option or alternative for the customer to consider. An example may be an option to increase the structural strength of a building during construction in order to make it less expensive to add several more floors in the future.

8. Risks. If the contractor has concern about any risks that have a high likelihood of occurrence or a high degree of potential impact, then these risks should be pointed out to the customer. This will show the customer that the contractor has experience and a realistic approach to performing the project and wants to avoid surprises. An example of such a risk is that the location where the customer wants to build a child care center has a high likelihood of large rock formations under the top soil, which may prolong the excavation of the foundation, impact drainage, and affect the cost of the project. Another case may be the customer’s requirement to use its existing software language in a project to upgrade its information system, which may create a risk of the system becoming obsolete; this would make the information system more expensive to maintain, and it might be more expensive to hire people with knowledge of the outdated software.

9. Expected benefits. This is an important section of the proposal because the contractor can pull together information from the preceding sections and make a case to justify the “value” of its proposal in terms of expected quantitative benefits, such as return on investment, payback, cost savings, an increase in productivity, reduced processing times, faster time-to-market, and so on. This is an excellent way to conclude the proposal on a positive note, emphasize the distinguishing features of the contractor’s proposal, and indicate the qualitative and quantitative benefits the customer will obtain if they select the contractor to perform the project.

The focus of the proposal should be on quality of the content—clear, concise, and convincing—rather than quantity or number of pages. Many simplified project proposals range from 4 to 8 pages, and they are usually less than 20 pages. It is appropriate to attach appendices for items such as resumes of key people who will be assigned to the project, back-up details for cost estimates, or a list of past related projects and associated references.
Proposal Submission and Follow-Up

The customer’s RFP will usually provide instructions regarding the due date by which proposals must be submitted and the name and contact information of the person to whom the proposals should be submitted. Some customers want the contractor to provide an electronic copy and/or several hard copies of the proposal because the proposal will be distributed to various individuals within the customer’s organization for review and evaluation. From the customer’s point of view, it is easier and less costly to have the contractor make the necessary copies. This is especially true for large projects, where proposals may be several hundred pages and may include large drawings or color graphics. Government agencies are very strict about having proposals submitted on time; those submitted late will not be accepted—and the contractor’s efforts will have been wasted. Rather than trust the mail, some contractors hand-deliver proposals to ensure that they arrive on time. Other contractors have been known to send two sets of proposals by different express mail services to ensure that at least one set arrives at its destination on time. Such precautions are usually taken for multimillion-dollar projects or when thousands of hours have been spent in pre-RFP marketing and proposal preparation. Customers may request that proposals be submitted only electronically. This approach can save both the customer and bidding contractors time and costs associated with printing, mailing, and distribution.

Contractors must continue to be proactive even after the proposal is submitted. The contractor should call the customer to confirm that the proposal was received. After several days, the contractor should contact the customer again and ask whether the customer has any questions or needs clarification of anything in the proposal. Such follow-up needs to be done in a professional manner in order to make a favorable impression on the customer. If the contractor appears aggressive rather than responsive, the customer may view the contractor as an intrusive element trying to influence the proposal evaluation process. A contractor must always consider whether and how aggressively other competing contractors are following up with the customer after proposals have been submitted.

Industrial and, especially, government customers usually do not respond to attempted follow-up communications from contractors so that no contractor gains an unfair advantage in influencing the proposal evaluation process. Such customers will initiate any needed communication. It will usually be in the form of a list of specific questions that need to be answered or points that need to be clarified about a particular contractor’s proposal, and it requires a written response from the contractor by a specific date.

Customer Evaluation of Proposals

Customers evaluate contractors’ proposals in many different ways. Some customers first look at the prices of the various proposals and select, for example, only the three lowest-priced proposals for further evaluation. Other customers initially screen out those proposals with prices above their budget or those whose technical section does not meet all the requirements stated in the RFP. Other customers, especially on large projects, create a proposal review team that uses a scorecard to determine whether each proposal meets all requirements in the RFP and to rate the proposal against predefined evaluation criteria.
Figure 3.2 illustrates a proposal evaluation scorecard. This scorecard was used by AJACKS Information Services Company to review contractor proposals submitted in response to the request for proposal in Chapter 2 (Figure 2.3). It is an evaluation of a proposal from Galaxy Market Research, Inc., one of five contractors that submitted proposals to AJACKS. Each person on the customer’s proposal evaluation team completes a scorecard for each of the contractor proposals. These scorecards are then used by the proposal evaluation team to reach a consensus on which contractor, if any, to select as the winner. The scorecards are not the sole mechanism for evaluating proposals and selecting the winner. They are usually used as input to the decision-making process.

Sometimes the technical and management proposals are evaluated first, without consideration of cost. Those proposals with the highest points on the technical/management review are then evaluated for their costs. The customer weighs the technical/management merit against the costs to determine which proposal offers the best value.

Some of the criteria that might be used by customers in evaluating contractor proposals include the following:

- Compliance with the customer’s statement of work and requirements in the request for proposal.
- Contractor’s understanding of the customer’s need or problem.
- Soundness and practicality of the contractor’s proposed approach to solving the problem.
- Contractor’s experience and success with similar projects.
- The experience of key individuals who will be assigned to work on the project.
- Management capability, including the contractor’s ability to plan and control the project to ensure that the work scope is completed within budget and on schedule.
- Realism of the contractor’s schedule. Is it realistic, considering the resources the contractor plans to assign to the project? Does it meet the customer’s schedule as stated in the RFP? How detailed is the schedule?
- Price. Customers may evaluate not only the contractor’s total price for the project but also the detailed costs in the cost section of the proposal. Customers are concerned about the reasonableness, realism, and completeness of the contractor’s costs. Did the contractor use sound cost-estimating methodology? Are the labor hours, classifications, and rates appropriate for the type of project? Were any items left out? The customer wants to be sure that a contractor is not "lowballing" the price to win the contract, expecting to come back to the customer for additional funds if the project overruns its proposed cost. It is unethical and may be illegal for contractors to intentionally lowball their price.

In some instances, especially when a large number of proposals are received, the proposal evaluation process will produce a short list of proposals the customer considers to be acceptable and of good value. The customer may then ask each of these contractors to give an oral presentation of its proposal. This provides a final opportunity for each contractor to convince the customer that its proposal will provide the best value. The customer may also ask each of these contractors to submit a best and final offer (BAFO). This gives the contractor one last chance to reduce its price and possibly win the contract. However, the customer usually requires the contractor to provide a written rationale for any cost reductions to make sure that they are reasonable. The contractor, for
FIGURE 3.2 Proposal Evaluation Scorecard

AJACKS Information Services Company
Proposal Evaluation

Project Title: Technical Information Needs of Manufacturers
Contractor: Galaxy Market Research Inc.

Score all criteria on a scale from 1 (low) to 10 (high)

<table>
<thead>
<tr>
<th>Evaluation Criteria</th>
<th>Weight A</th>
<th>Score B</th>
<th>Points A x B</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Approach</td>
<td>30</td>
<td>4</td>
<td>120</td>
<td>Shallow description of methodology</td>
</tr>
<tr>
<td>2. Experience</td>
<td>30</td>
<td>3</td>
<td>90</td>
<td>Little experience with manufacturing firms</td>
</tr>
<tr>
<td>3. Price</td>
<td>30</td>
<td>9</td>
<td>270</td>
<td>Lowest price bid Supported by details</td>
</tr>
<tr>
<td>4. Schedule</td>
<td>10</td>
<td>5</td>
<td>50</td>
<td>Schedule is overly optimistic</td>
</tr>
<tr>
<td>Total</td>
<td>100</td>
<td></td>
<td>530</td>
<td></td>
</tr>
</tbody>
</table>

Advantages of this proposal:
- This is the lowest price proposal received. It appears the salaries of Galaxy’s staff are low compared to those of other proposers.

Concerns about this proposal:
- Galaxy may not fully comprehend the requirements.
- Low salaries in its budget may reflect low levels of experience of the staff Galaxy plans to use.
- Optimistic schedule (3 months) to complete project may indicate Galaxy doesn’t fully comprehend the work scope.
instance, might review the people to be assigned to the project and determine that for some tasks individuals with lower labor cost rates could be used, or the contractor might decide that some travel to meetings could be eliminated by videoconferencing.

Once the customer has selected the winning contractor, the contractor is informed that it is the winner, subject to successful negotiation of a contract.

Contracts

Just because the contractor has been selected as the winner does not mean the contractor can start doing the work. Before the project can proceed, a contract must be signed between the customer and the contractor.

A contract is a vehicle for establishing good customer–contractor communications and arriving at a mutual understanding and clear expectations to ensure project success. It is an agreement between the contractor, who agrees to perform the project and to provide a product or service (deliverables), and the customer, who agrees to pay the contractor a certain amount in return. The contract must clearly spell out the deliverables the contractor is expected to provide. For example, a contract will state that the project result will meet certain specifications or that certain documentation will be provided. The contract must also state the terms by which the customer will make payments to the contractor. There are basically two types of contracts: fixed-price and cost-reimbursement.

**FIXED-PRICE CONTRACTS**

In a fixed-price contract, the customer and the contractor agree on a price for the proposed work. The price remains fixed unless the customer and the contractor agree on changes. This type of contract provides low risk for the customer because the customer will not pay more than the fixed price, regardless of how much the project actually costs the contractor. However, a fixed-price contract is high risk for the contractor because if the cost of completing the project is more than originally planned, the contractor will make a lower profit than anticipated or may even lose money.

A contractor bidding on a fixed-price project must develop accurate and complete cost estimates and include sufficient contingency costs. However, the contractor needs to be careful not to overprice the proposed project, or a competing contractor with a lower price may be selected.

**COST-REIMBURSEMENT CONTRACTS**

In a cost-reimbursement contract, the customer agrees to pay the contractor for all actual costs (labor, materials, and so forth), regardless of amount, plus some agreed-upon profit. This type of contract is high risk for the customer because contractor costs can overrun the proposed price—as when a car repair service provides an estimate for repairing a transmission but presents a final bill that is higher than the original estimate. In cost-reimbursement contracts, the customer
usually requires that, throughout the project, the contractor regularly compares actual expenditures with the proposed budget and reforecasts cost at-completion, comparing it with the original proposed price. This allows the customer to take action if it looks as if the project will overrun the original proposed budget. This type of contract is low risk for the contractor because all costs will be reimbursed by the customer. The contractor cannot lose money on this type of contract. However, if the contractor’s costs do overrun the proposed budget, the contractor’s reputation will be hurt, in turn reducing the contractor’s chances of winning contracts in the future.

Cost-reimbursement contracts are most appropriate for projects that involve risk. Examples include the development of a new robotics device to assist during surgery or the environmental cleanup of a contaminated site.

**CONTRACT TERMS AND CONDITIONS**

The following are some miscellaneous terms and conditions that may be included in project contracts:

1. *Misrepresentation of costs.* States that it is illegal for the contractor to overstate the hours or costs expended on the project.
2. *Notice of cost overruns or schedule delays.* Outlines the circumstances under which the contractor must notify the customer immediately of any actual or anticipated cost overruns or schedule delays, submitting in writing both the reason and a plan for corrective action to get the costs back within budget or the schedule back on track.
3. *Approval of subcontractor.* Indicates when the contractor needs to obtain advance approval from the customer before hiring a subcontractor to perform a project task.
4. *Customer-furnished equipment or information.* Lists the items (such as parts for conducting tests) that the customer will provide to the contractor throughout the project and the dates by which the customer will make these items available. This provision protects the contractor from incurring schedule slippage caused by customer delays in furnishing information, parts, or other items.
5. *Patents.* Covers ownership of patents that may result from performing the project.
6. *Disclosure of proprietary information.* Prohibits one party from disclosing confidential information, technologies, or processes utilized by the other party during the project to anyone else or using it for any purpose other than work on the project.
7. *International considerations.* Specifies accommodations that must be made for customers from other countries. Contracts for projects that are done for a foreign customer or are conducted in part in a foreign country may require the contractor to make certain accommodations, such as
   - Observing certain holidays or work rules
   - Spending a certain percentage of the contract costs for labor or materials within the customer’s country
   - Providing project documentation, such as manuals, specifications, training materials, and reports, in the customer’s language
8. *Termination.* States the conditions under which the customer can terminate the contract, such as nonperformance by the contractor.
9. **Terms of payment.** Addresses the basis on which the customer will make payments to the contractor. Some types of payments are

- Monthly payments, based on actual costs incurred by the contractor
- Equal monthly or quarterly payments, based on the expected overall duration of the project schedule
- Percentages of the total contract amount, paid when the contractor completes predefined milestones or when the customer accepts specific deliverables
- Single payment at completion of the project

In some cases, such as when the contractor needs to purchase a significant amount of materials and supplies during the early stages of the project, the customer provides an initial down payment at the start of the contract.

10. **Bonus/penalty payments.** Some contracts have a bonus clause, whereby the customer will pay the contractor a bonus if the project is completed ahead of schedule or exceeds other customer performance requirements. On the other hand, some contracts include a penalty clause, whereby the customer can reduce the final payment to the contractor if the project is not completed on schedule or if performance requirements are not met. Some of these penalties can be substantial, such as 1 percent of the total contract price for each week the project extends beyond the required project completion date, up to a maximum of 10 percent. A 10-week schedule overrun could wipe out the contractor’s profit and cause a loss.

11. **Changes.** Covers the procedure for proposing, approving, and implementing changes to the project scope, schedule, or budget. Changes can be initiated by the customer or be proposed by the contractor. Some changes may necessitate a change in price (increase or decrease); others may not. All changes must be documented and approved by the customer before they are incorporated into the project. Customers usually want the contractor to provide a price estimate, along with an indication of the schedule impact, for a proposed change before they will allow the contractor to implement the change. If a contractor makes changes without the customer’s approval or with only verbal approval from someone in the customer’s organization who may not be authorized to give it, the contractor runs the risk of being unable to collect payment for the work associated with the changes made.

**Measuring Proposal Success**

Contractors measure the success of their proposal efforts by the number of times their proposals are selected by customers and/or by the total dollar value of their proposals that are selected. A measure that is often used is known as the **win ratio.** This measurement is the percentage of the number of proposals a contractor won out of the total number of proposals the contractor submitted to various customers over a particular time period. An alternative method of determining the win ratio is to base it on the total dollar value of proposals that the contractor won as a percentage of the total dollar value of all the proposals the contractor submitted to various customers during a specific time period. The former approach gives equal weight to all proposals, whereas the later approach gives more weight to proposals with larger dollar amounts. For example, assume that a contractor submits four different proposals to four different customers in a
particular month, for the amounts of $120,000, $50,000, $250,000, and $80,000; however, only one of their proposals, the one valued at $250,000, was selected by a client. The contractor’s win ratio based on the number of proposals submitted is 0.25 or 25 percent (1 of 4), but their win ratio based on dollar value is 50 percent ($250,000 of $500,000).

Some contractors have a strategy of submitting proposals in response to as many RFPs as they can with the hope that they will eventually win their fair share. Their philosophy is that if they do not submit a proposal, then they do not have any chance to win, but by submitting more proposals, they increase their chances of winning more contracts. Other contractors are more selective in submitting proposals; they respond to only those RFPs where they think they have a better-than-average chance of winning the contract. These contractors seriously consider the bid/no-bid decision process in responding to RFPs and submit fewer proposals but attempt to have a high win ratio.

Kings Arena Proposal Gains Support

The National Basketball Association (NBA) worked with consultants to evaluate a development plan for the state fairgrounds in Sacramento, California. Officials prepared to extend a request for proposals to developers for a $1.9 billion redevelopment of the 350-acre fairgrounds site to have offices, stores, and housing in addition to a new arena for the Sacramento Kings.

The Cal Expo officials worked with a group of developers in the pre-request for proposal (RFP) stage to develop a conceptual plan for the project and determine if the project was viable. As the plan evolved, three tracks of land were explored for development: the current ARCO Arena location, the Cal Expo site and home of the state fairgrounds, and the downtown rail-yards location. The RFP was planned to include standards for green commerce and sustainability in addition to environmentally friendly construction techniques that would develop new jobs and tax revenue for the city. It was suggested that the financing of the project exclude tax dollars from the city’s residents. Rather, the development plans would need to describe public-private partnerships to fund the project.

By working with the groups of developers, all three sites were included in the redevelopment plans for the city. The team of developers chosen from seven proposal submissions had a long history of successful development projects in the region. The complex plan called for something different from the original thoughts of the NBA and Cal Expo officials. The new arena would not be on the Cal Expo site; it would be located on the eight acres at the rail yards. The Cal Expo site would be a mixed-use facility, and parts of the property would be sold to other developers to help raise funds for the arena construction. The ARCO Arena was proposed as an expo hall.

The officials took their time and had many meetings with consultants and developers to create an RFP that would help the city and keep the Kings in Sacramento. Discussions with developers helped shape the RFP. The developers worked to build relationships with the NBA and city officials, and together they shaped an RFP to have a solution that was in the best interests of the city.

The winner of the seven submitted proposals included what the other proposals did not include—private investment. The owners of the Kings agreed to sign a 30-year lease at $10 million of rent per year to help fund the project. The developers for the

Reinforce Your Learning

21. A measure used to determine the success of proposal efforts is known as the

REAL WORLD PROJECT MANAGEMENT

Kings Arena Proposal Gains Support

The National Basketball Association (NBA) worked with consultants to evaluate a development plan for the state fairgrounds in Sacramento, California. Officials prepared to extend a request for proposals to developers for a $1.9 billion redevelopment of the 350-acre fairgrounds site to have offices, stores, and housing in addition to a new arena for the Sacramento Kings.

The Cal Expo officials worked with a group of developers in the pre-request for proposal (RFP) stage to develop a conceptual plan for the project and determine if the project was viable. As the plan evolved, three tracks of land were explored for development: the current ARCO Arena location, the Cal Expo site and home of the state fairgrounds, and the downtown rail-yards location. The RFP was planned to include standards for green commerce and sustainability in addition to environmentally friendly construction techniques that would develop new jobs and tax revenue for the city. It was suggested that the financing of the project exclude tax dollars from the city’s residents. Rather, the development plans would need to describe public-private partnerships to fund the project.

By working with the groups of developers, all three sites were included in the redevelopment plans for the city. The team of developers chosen from seven proposal submissions had a long history of successful development projects in the region. The complex plan called for something different from the original thoughts of the NBA and Cal Expo officials. The new arena would not be on the Cal Expo site; it would be located on the eight acres at the rail yards. The Cal Expo site would be a mixed-use facility, and parts of the property would be sold to other developers to help raise funds for the arena construction. The ARCO Arena was proposed as an expo hall.

The officials took their time and had many meetings with consultants and developers to create an RFP that would help the city and keep the Kings in Sacramento. Discussions with developers helped shape the RFP. The developers worked to build relationships with the NBA and city officials, and together they shaped an RFP to have a solution that was in the best interests of the city.

The winner of the seven submitted proposals included what the other proposals did not include—private investment. The owners of the Kings agreed to sign a 30-year lease at $10 million of rent per year to help fund the project. The developers for the
winning proposal listened to the requirements of not raising taxes for the residents and prepared a proposal that reflected that understanding.

Just as the developers worked on establishing relationships during the pre-RFP stages, contractors must listen to the customer and incorporate what was learned into the proposal solution. In this case, the winning developer made sure in the cost section of the proposal to offer a financial plan that met the needs of the customer. The management and technical sections of the proposal demonstrated a strong plan that reflected the efforts of the NBA, the city officials, and the King’s owners. Organizations that forge strong relationships and develop quality proposals have a higher probability of success!

*Based on information from T. Bizjak, “Kings Arena Proposal Gains Support,” The Modesto Bee, January 16, 2010.*

**CRITICAL SUCCESS FACTORS**

- Customers and partner organizations prefer to work with people they know and trust. Relationships establish the foundation for successful funding and contract opportunities.
- Establishing and building trust is key to developing effective and successful relationships with clients and partners.
- The first impression one makes on a client is pivotal to developing a continuing and fruitful relationship.
- Pre-RFP/proposal efforts are crucial to establishing the foundation for eventually winning a contract from the customer.
- Do not wait until formal RFP solicitations are announced by customers before starting to develop proposals. Rather, develop relationships with potential customers long before they prepare their RFPs.
- Working closely with a potential customer puts a contractor in a better position to be selected as the winning contractor. Learn as much as possible about the customer’s needs, problems, and decision-making process during the pre-RFP/proposal marketing.
- Becoming familiar with the customer’s needs, requirements, and expectations will help in preparing a more clearly focused proposal.
- Be realistic about the ability to prepare a quality proposal and about the probability of winning the contract. It is not enough just to prepare a proposal; rather, the proposal must be of sufficient quality to have a chance of winning.
- A proposal is a selling document, not a technical report. It should be written in a simple, concise manner and should use terminology with which the customer is familiar.
- In a proposal, it is important to highlight the unique factors that differentiate it from competitors’ proposals.
- Proposals must be realistic. Proposals that promise too much or are overly optimistic may be unbelievable to customers, and may raise doubt about whether the contractor understands what needs to be done or how to do it.
- When bidding on a fixed-price project, the contractor must develop accurate and complete cost estimates and include sufficient contingency costs.

**SUMMARY**

Interested contractors develop proposals in response to a customer’s request for proposal. When the customer decides which contractor to engage to perform the project, an agreement (contract) is signed by the customer and contractor.

Customers (clients) and partner organizations prefer to work with people they know and trust. Relationships establish the foundation for successful funding and
contract opportunities. Relationship building requires being proactive and engaged. Establishing and building trust is key to developing effective and successful relationships with clients and partners. Ethical behavior in dealing with clients and partners is also imperative for building trust. The first impression one makes on a client is pivotal to developing a continuing and fruitful relationship. Building effective and successful relationships takes time and work.

Contractors should develop relationships with potential customers long before customers prepare a request for proposal. Contractors should maintain frequent contacts with past and current customers and initiate contacts with potential customers. During these contacts, contractors should help customers identify areas in which the customers might benefit from the implementation of projects that address needs, problems, or opportunities. These pre-RFP/proposal efforts are crucial to establishing the foundation for eventually winning a contract from the customer.

Because the development and preparation of a proposal take time and money, contractors interested in submitting a proposal in response to an RFP must be realistic about the probability of being selected as the winning contractor. Evaluating whether to go forward with the preparation of a proposal is sometimes referred to as the bid/no-bid decision. Some factors that a contractor might consider in making a bid/no-bid decision are the competition, the risk, its business mission, the ability to extend its capabilities, its reputation with the customer, the availability of customer funds, and the availability of resources for the proposal and the project.

It is important to remember that the proposal process is competitive and that the proposal is a selling document that should be written in a simple, concise manner. In the proposal, the contractor must highlight the unique factors that differentiate it from competing contractors. The contractor proposal must also emphasize the benefits to the customer if the customer selects the contractor to perform the project. The customer will select the contractor that it expects will provide the best value.

Proposals are often organized into three sections: technical, management, and cost. The objective of the technical section of the contractor proposal is to convince the customer that the contractor understands the need or problem and can provide the least risky and most beneficial solution. The technical section should show an understanding of the need, a proposed approach or solution, and the benefits to the customer. The objective of the management section of the contractor proposal is to convince the customer that the contractor can do the proposed work and achieve the intended results. The management section should contain a description of work tasks, a list of deliverables, a project schedule, a description of the organization of the project, a synopsis of related experience, and a list of any special equipment and facilities the contractor has. The objective of the cost section of the contractor proposal is to convince the customer that the contractor’s price for the proposed project is realistic and reasonable. The cost section usually consists of tabulations of the contractor’s estimated costs of such elements as labor, materials, equipment, facilities, subcontractors and consultants, travel, documentation, overhead, escalation, contingency, and a profit.

When contractors prepare proposals, they are generally competing with other contractors to win a contract. Therefore, they must consider the reliability of the cost estimates, the risk, the value of the project to the contractor, the customer’s budget, and the competition when determining the price for the proposed project.
Many projects that are small or not complex may not require an extensive proposal. In other cases, contractors may even submit an unsolicited proposal prior to the customer preparing an RFP. In both of these situations, a simplified or basic proposal may be appropriate and sufficient. Such a proposal should include the following elements: statement of the customer’s need, assumptions, project scope, deliverables, resources, schedule, price, risks, and expected benefits. The focus of the proposal should be on quality of the content—clear, concise, and convincing—rather than quantity or number of pages.

Customers evaluate contractors’ proposals in many different ways. Sometimes the technical and management proposals are evaluated first, without consideration of cost. Those proposals with the highest points on the technical-management review are then evaluated for their costs. The customer weighs the technical/management merit against the costs to determine which proposal offers the best value. Some of the criteria that might be used by customers in evaluating contractor proposals include compliance with the customer’s statement of work, the contractor’s understanding of the customer’s need or problem, the soundness and practicality of the contractor’s proposed solution to the project, the contractor’s experience and success with similar projects, the experience of key individuals who will be assigned to work on the project, the contractor’s ability to plan and control the project, the realism of the contractor’s schedule, and the price.

Once the customer has selected the winning contractor, the contractor is informed that it is the winner, subject to successful negotiation of a contract. A contract is an agreement between the contractor, who agrees to perform the project and to provide a product or service (deliverables), and the customer, who agrees to pay the contractor a certain amount in return.

There are basically two types of contracts: fixed price and cost reimbursement. In a fixed-price contract, the customer and the contractor agree on a price for the proposed work. The price remains fixed unless the customer and the contractor agree on changes. This type of contract provides low risk for the customer and high risk for the contractor. In a cost-reimbursement contract, the customer agrees to pay the contractor for all actual costs (labor, materials, and so forth), regardless of amount, plus some agreed-upon profit. This type of contract provides low risk for the contractor and high risk for the customer, because contractor costs can overrun the proposed price.

A contract may include miscellaneous terms and conditions covering misrepresentation of costs, notice of cost overruns or schedule delays, approvals for any subcontractors, customer-furnished equipment or information, patent ownership, disclosure of proprietary information, international considerations, termination, terms of payment, bonuses or penalties, and procedures for making changes.

Contractors measure the success of their proposal efforts by the number of times their proposals are selected by customers and/or by the total dollar value of their proposals that are selected. A measure that is often used is known as the win ratio.

QUESTIONS

1. Describe why building relationships with customers and partners is important. How is this accomplished?
2. Describe what is meant by pre-RFP/proposal marketing. Why should contractors do it?
3. Discuss why contractors must make bid/no-bid decisions and the factors involved in making these decisions. Give an example of when a contractor should bid and when a contractor should not bid.

4. Define proposal and describe the purpose of a proposal. In addition, list the three major sections of a proposal and the purpose and elements of each.

5. What factors must be considered when a contractor develops the proposal price? Why is this not an easy task?

6. Should a contractor try to contact a customer after a proposal has been submitted? Why or why not?

7. How do customers evaluate proposals? What factors might they consider?

8. Should the lowest-priced proposal always be selected as the winner? Why or why not? Give examples.

9. Describe two different types of contracts, when each should be used, and the risks associated with each.

10. Give examples of some miscellaneous provisions that might be found in a contract.

11. Describe two methods for measuring the effectiveness of your proposal efforts.

12. Develop a complete proposal in response to the RFP you created for question 13 at the end of Chapter 2.

INTERNET EXERCISES

For the website addresses of the organizations mentioned in these exercises, go to "Internet Exercises" at the book’s companion website at www.cengagebrain.com. It is suggested that you save this website in your "Favorites" list for easy access in the future.

To answer the following questions, perform a Web search for sample proposals, using your favorite search engine.

1. Based on the results of your search, find a sample proposal that has been posted on the Web. What company or organization developed the proposal, and what objective was it trying to accomplish?

2. Evaluate the effectiveness of this proposal based on information you have studied in this chapter. Discuss the strengths and weaknesses of the proposal. Are there any items missing from the proposal that should have been included?

3. Based on what you have learned in this chapter, download the proposal and revise it. Highlight the areas you revised. What makes your revised proposal better than the original?

4. Locate a website that provides suggestions for developing effective proposals. Compare and contrast this information with what was presented in the chapter.

5. Explore and describe at least three software packages that can help you write effective proposals. What features do these packages provide? Download a demo copy of at least one, if possible.

CASE STUDY 1  Medical Information Systems

Maggie Pressman, Paul Goldberg, and Steve Youngblood are equal partners in their own consulting business, which specializes in designing and installing computer-based information systems for physicians. These systems usually include
patient records, prescriptions, billings, and medical insurance processing. In some cases, the physician customers have a manual system and want to computerize it; in other situations, they have an existing computer system that needs to be upgraded and enhanced.

In most cases, the consulting firm purchases the necessary hardware as well as some packaged software. They add some of their own customized software to meet the specific requirements of the physician, and they install the complete, integrated system. They also provide training for the employees in the physician’s office. The cost of most of these projects ranges from $10,000 to $40,000, depending on the amount of hardware needed. Most physicians are willing to spend such amounts rather than hire an additional office person to keep up with the ever-increasing paperwork.

Dr. Houser, one of the physicians for whom Paul had done a project in the past, left her private practice to join a large regional medical practice. This organization has six offices throughout the region, with an average of eight physicians in each office. Two of the offices also include a pharmacy. The organization employs a total of 200 people. Dr. Houser contacted Paul and asked if his consulting firm would be interested in submitting a proposal to upgrade the information system for the entire regional medical practice. The project will include integrating the six offices and two pharmacies into one system; the physicians will eventually hire an information systems person to oversee the operation of the system. Presently, each office has its own system.

Paul learns from Dr. Houser that some of the other physicians have patients who work for large consulting firms that they think could also do the job. She says that a team of representatives from the six offices and two pharmacies, with the help of the organization’s purchasing manager, has prepared a request for proposal. The proposals are due in two weeks. The RFP was issued two weeks ago to the larger consulting firms, which are already working on their proposals. The purchasing manager was not familiar with Paul’s consulting firm, and that is why he did not receive a copy of the RFP.

Dr. Houser tells Paul that she is sorry she cannot talk to him more about this, but she has not been involved like some of the other physicians, who discussed ideas with their patients who work at the larger consulting firms before the RFP was issued. Dr. Houser says that she will have the purchasing manager send Paul the RFP if he is interested and will be able to submit a proposal within two weeks.

“Sure,” Paul says. “I’ll drive over this afternoon and pick it up!” He asks if she knows how much money the medical practice has allocated for the project, but she does not. Paul picks up the RFP and makes copies for Maggie and Steve. Paul is enthusiastic about the opportunity when he meets with them. “This is the big break we’ve been waiting for!” he shouts.

Maggie moans, “This couldn’t have come at a worse time. I’m working on three projects for other physicians, and they’re all hounding me to finish up. In fact, one of them is not very satisfied. He said that if I don’t finish his project in two weeks, he doesn’t want it and won’t recommend us to other physicians. I’m working 16 hours a day to keep up. I’m just overcommitted. I agree with you, Paul, it is a great opportunity, but I’m afraid I won’t be able to spend any time helping with the proposal.”

Steve wonders out loud, “Preparing the proposal is one thing, but can we do the project? I think we have the expertise among the three of us to do such a project, but this is a really big one, and we have other customers, too.”
Paul replies, "We can hire more people. I have a few friends who would probably want some part-time work. We can do it! If we don't go after projects like this, we'll always be a small firm, each of us working 12-hour days for peanuts. And these small jobs for individual offices aren't going to last forever. Someday they'll all be computerized, and we'll be out of business. What do we have to lose by submitting a proposal? We can't win if we don't submit one!"

**CASE QUESTIONS**

1. Why did this team not receive the RFP at the same time the larger consulting firms did?
2. Why is this team being considered as a candidate to submit a proposal?
3. Develop a bid/no bid checklist to help determine if they should submit a proposal.
4. What should Maggie, Paul, and Steve do? In explaining your answer, address the concerns of each of the three team members.

**GROUP ACTIVITY**

Divide the course participants into teams of three or four to discuss the case and decide whether the consulting firm should submit a proposal. Each team must provide reasons for its decision. Have each team choose a spokesperson to present its decision and reasons for that decision to the entire class.

---

**CASE STUDY 2**

**New Manufacturing Facility in China**

At its January 15 meeting, the board of directors of Omega Consolidated Industries made a decision to build a new manufacturing facility in China and approved funding up to $180 million for construction and start-up activities. It wants the new facility completed within two years from the date that a contractor is selected to design and build the facility. Omega is a worldwide corporation with its headquarters in London.

The board asked I. M. Uno, Omega’s president, to assign a team to develop a request for proposal (RFP) and solicit proposals from contractors to design and build the facility, including installation of all production equipment, offices, and an integrated information system. The team would also be responsible for monitoring the performance of the selected contractor to ensure the contractor fulfills all contractual requirements and performance specifications.

Ms. Uno selected four members of her management team:

- Alysha Robinson, who will be the plant manager of the new facility
- Jim Stewart, Chief Financial Officer
- Olga Frederick, Vice President of Engineering
- Willie Hackett, Procurement Manager

The team chose Alysha as their team leader. By April 30, they developed a comprehensive RFP that included:

- A statement of work describing the major tasks that the contractor must complete, as well as the performance specifications for the production capacity of the facility
- A requirement that the contractor complete the project within 24 months after a contract is signed
Criteria by which the team would evaluate proposals:

- Related experience: 30 points
- Cost: 30 points
- Schedule: 15 points
- Innovative design: 25 points

That the contract would be a fixed-price contract.

The RFP did not state how much funding Omega had available for the project.

On May 15, the team announced the RFP in various trade publications and websites and required that interested contractors submit a proposal no later than June 30.

On June 30, the Omega team received three proposals:

1. J&J, Inc., an American firm, submitted a proposal for $150 million. However, the proposal stated that they would require 30 months to complete the project.

2. ROBETH Construction Company of Ireland submitted a proposal for $175 million. They had built several other facilities for Omega in the past, and its officers felt they had a good relationship with Ms. Uno, Jim Stewart, and Olga Frederick’s predecessor, who recently left Omega to become president of one of Omega’s competitors, which is also considering building a facility in China.

3. Kangaroo Architects and Engineers of Australia submitted a proposal for $200 million. Although Kangaroo has never done a project for Omega, they are one of the largest contractors in the world, have designed and built many and various types of facilities, and have a great reputation for innovative concepts, such as "green" environmentally friendly designs, and for building award-winning showcase facilities. They had built facilities for several of Omega’s competitors.

The team was disappointed that they received only three proposals; they had expected at least eight.

On July 5, a fourth proposal was received from Asia General Contractors, a company based in China. The proposal was for $160 million. They had built many facilities in China for other global corporations and stated that they have good knowledge of many credible trade subcontractors in China that would be needed to build the facility. The proposal also stated that they could complete the project in 20 months.

The team scheduled a meeting for July 15 to discuss the proposals and, as a team, to score each of the proposals with respect to the evaluation criteria. That provided the team members with two weeks to individually read the proposals and develop their individual comments about each proposal, but they agreed not to individually score the proposals prior to the July 15 meeting.

At the July 15 meeting, Alysha opened the meeting and stated, "I like the proposal from Kangaroo because it would provide a showcase state-of-the-art facility."

Jim interrupted her, saying, "Their proposal is for more than the board has allocated for this project, I don’t think we should consider them any further. In my mind, they are out."

Alysha responded, "Even though it would require some additional funding beyond what the board originally approved, I feel confident that I can persuade I. M. and the board to approve the additional amount required."
Jim said, "I like the proposal from ROBETH. We have worked with them in the past during my 30 years here at Omega, and their proposal cost is just about what the board has allocated. I know a lot of the people at ROBETH."

Olga mentioned, "I have only been here at Omega for less than a year, but I took it upon myself to review the final reports of the previous projects that ROBETH did for Omega and found that ROBETH missed their proposed schedules on most of the projects or that some of the production systems never met all the performance specifications." She continued, "I am also concerned about ROBETH’s continuing relationship with my predecessor who is now president at one of our major competitors and the potential conflict of interest if they would also be the contractor selected by our competitor to build the plant they are considering in China. They might use some of our proprietary processes in their design for our competitor’s facility. I think it would be too risky to use them."

She continued, "I think the proposal from Asia General Contractors should be seriously considered, even though it arrived a few days after the required due date."

Willie spoke up. "I strongly disagree. It would be unfair to the other three contractors."

Olga replied, "I think it is our job to select the contractor that will provide the best value and not be concerned about some silly rules about being a few days late; who cares? Besides, they state that they can complete the project in 20 months, which means we will get the facility fully operational sooner than with any of the other contractors. And that means more products out the door sooner, more revenues and cash flow earlier, and a better return on our investment."

After everyone’s initial comments, Alysha stated, "Okay, I guess we have to score these four proposals against the evaluation criteria."

Jim interrupted, "You mean three proposals."

Olga spoke up loudly, "I think she said the four proposals, not three. Let’s not get bogged down in bureaucratic games; we have an important decision to make."

I. M. Uno is expecting the team to recommend a contractor to her by July 31 so that she can review it and present it to the board of directors at their August 15 meeting.

CASE QUESTIONS
1. Is there anything the team should have done when they received only three proposals by June 30?
2. Should the team consider the proposal from Asia General Contractors? Why or why not?
3. After sharing their individual comments at the start of the July 15 meeting, how should the team proceed with the rest of the meeting and any follow-up?
4. How could the selection process have been improved? Is there anything the board, I. M. Uno, Alysha, or the team could have done differently?

GROUP ACTIVITY
Divide the course participants into teams of three or four to discuss this case and decide which contractor should be selected to design and build the new manufacturing facility in China. Each team must provide reasons for its decision. Have each team select a spokesperson to present its decision and reasons for that decision to the entire class.
REFERENCES


Define Project Scope
Plan for Quality
Create Work
Breakdown Structure
Assign Responsibility
Define Activities
Sequence Activities
Network Principles
Create Network
Diagram
Planning for Information Systems Development
An IS Example: Internet Applications Development for ABC Office Designs
Project Management Information Systems
Summary
Questions
Internet Exercises
Case Study 1 A Not-for-Profit Medical Research Center
Case Questions
Group Activity

“Real World Project Management
Plan of Attack
“If you start out on the wrong foot with a program, it likely will get worse,” cautions Chuck Allen, vice president for integrated defense systems at Boeing.

Boeing was the builder of the FA-18E/F Super Hornet for the United States Navy, a combat-proven strike fighter. The stakeholders included navy officials and prime contractor program managers. Chuck Allen gathered the 150 stakeholders for a meeting that lasted two weeks to review the proposal line by line to determine the deliverables for each work package. The initial costs of the plan exceeded the project budget. The planning meeting trimmed the deliverables to those that were requirements and necessary for operational capacity.
Case Study 2 The Wedding

Case Questions
Group Activity
References
Appendix Microsoft Project

This chapter discusses the project scope document, quality, how to define what activities need to be done, who will be responsible for them, and in what sequence they will be performed. It describes techniques and tools used to plan the work elements and activities that need to be performed in order to accomplish the project objective successfully. The project scope defines what work needs to be done and what deliverables need to be produced. Then, specific activities are defined and arranged in a sequence of dependent relationships to determine how the work will be performed. You will become familiar with

- Clearly defining the project objective
- Preparing a project scope document
- Understanding the importance of planning for quality
- Creating a work breakdown structure
- Assigning responsibility for work elements
Defining specific activities
Creating a network diagram
Utilizing a project management methodology called the systems development life cycle for information systems development projects

LEARNING OUTCOMES

After studying this chapter, the learner should be able to:

- Establish a clear project objective
- Prepare a project scope document
- Discuss the importance and elements of a project quality plan
- Develop a work breakdown structure
- Prepare a responsibility assignment matrix
- Describe how to define specific activities
- Create a network diagram

Establish Project Objective

The planning process is based on the project objective, which establishes what is to be accomplished. Often the project objective is stated in the project charter or request for proposal. The objective is the tangible end product that the project team or contractor must produce and deliver in order for the sponsor or customer to achieve the expected benefits from implementing the project. The project objective is usually defined in terms of the end product or deliverable, schedule, and budget. It requires completing the project work scope and producing all the deliverables by a certain time and within budget. It should also include the expected benefits that will result from implementing the project and define the success of the project. The project objective must be clearly defined and agreed upon by the sponsor or customer and the project team or contractor that will perform the project. The project objective must be clear, attainable, specific, and measurable. The project objective should include the following elements:

- Expected benefits that will result from implementation of the project and define success. This element establishes why the project is being done. It may include verbs, such as to increase, to expand, to reduce, to save, to establish, and so on. This element should also include a quantified measure if appropriate, such as a percent, dollar amount, or absolute number. Examples include: to increase sales volume by 5,000 units annually, to expand customer base in European markets by 60 percent, to reduce the number of patients that contract postsurgical infections by 50 percent, to double the number of donors, or to reduce annual overhead costs by $150,000.
- Primary project end product or deliverable, such as an online shopping capability, a nationwide marketing campaign, a dormitory complex, or a noninvasive medical monitoring device.
- Date by which the project is required to be completed, such as by June 30, 2012, or in 18 months.
- Budget within which the project must be completed.
Some examples of project objectives are:

- To increase emergency room capacity by 20 percent and reduce average patient waiting time by 50 percent through a reconfiguration and process improvement project to be completed in 12 months and within a budget of $400,000.
- To reduce outstanding accounts payable by $20 million by implementing a new billing, collection, and receiving system by May 31 with a budget not to exceed $220,000.
- To raise $40,000 for hunger relief by organizing a community festival for the last weekend in September within a budget of $3,000.
- To double annual sales revenue by creating an online shopping and fulfillment capability by April 30 with a budget not to exceed $40,000.
- To expand market share by 3 percent by introducing a new portable food preparation appliance within 10 months with a budget of $2 million.
- To increase August sales revenue by 10 percent above that of last August by producing and distributing a back-to-school catalog by July 15 with a budget not to exceed $40,000.
- To meet new environmental regulatory requirements by installing a new filtration system within 15 months and a budget of $3.2 million.
- To obtain information about consumer preferences by conducting a consumer market study to be completed in 26 weeks with a budget of $40,000.

A project objective such as “complete the house” is too ambiguous because the customer and the contractor may have different views of what is meant by “complete.” A better objective is to “complete the house by May 31 in accordance with the floor plans and specifications dated October 15 and within a budget of $200,000.” The specifications and floor plans provide the details as to the scope of the work that the contractor agreed to perform. Therefore, no arguments should arise about whether the landscaping and carpeting were to be included or about the size of the entrance door, the color of paint in the bedrooms, or the style of lighting fixtures. All of these should have been spelled out in the specifications.

The project objective should be clear and concise at the beginning of the project. However, there can be situations where the project objective needs to be modified as the project proceeds because of extenuating circumstances or new information. The project manager and the customer must agree on all changes to the project objective. Any such changes might affect the remaining work scope, deliverables, completion date, and final cost.

**Define Project Scope**

The project scope defines what needs to be done. It is all the work that must be done to produce all the project deliverables, satisfy the sponsor or customer that all the work and deliverables meet the requirements or acceptance criteria, and accomplish the project objective. The project charter or request for proposal establishes the framework for further elaboration of the project scope.

The project team or contractor prepares a project scope document that includes many of the items contained in the project charter, RFP, or contractor’s proposal, but in much greater detail. The document is valuable for establishing a
common understanding among project stakeholders regarding the scope of the project.

The project scope document usually contains the following sections:

1. **Customer requirements** define the functional or performance specifications for the project’s end product and other project deliverables. The requirements can include specifications regarding size, color, weight, or performance parameters, such as speed, uptime, throughput, processing time, or operating temperature range, that the project result must satisfy. Some of a customer’s requirements for a new house might include five bedrooms, a two-car attached garage, a fireplace, and a geothermal system. One of the requirements for a commercial security system might be eight hours of battery backup power in case of an outage of the primary power source.

In many cases, the customer states high-level requirements in the project charter or RFP, but the project team or the contractor may need to collect more information from the customer or end users to further refine the requirements. This information can be obtained or collected using interviews, surveys, or focus groups. It is typical in process improvement projects or information systems projects to obtain input for requirements from the end users who are most familiar with and knowledgeable about the existing process or system and may have specific requirements or suggestions for improving the process or enhancing the current system. These requirements could include items such as consolidation of documents, data elements to include or exclude from databases, formats or contents of reports, or human factors such as the design or location of workstations. For product development projects, such as a new food product or vehicle, focus groups are often used to help determine customer preferences and requirements.

This requirements section should also include or reference applicable technical specifications, standards, and codes that must be used and met regarding quality and performance of the project work and deliverables. As an example, for a project to construct a child care center, the requirements might state that the design must meet government specifications for certain physical parameters (square feet of space per child, number of restrooms, etc.), and also must meet local building codes (use of fire retardant materials for interior walls, floor height for electric outlets, etc.). Or if an internal project team is developing a new website for a company that was acquired by a parent corporation, they may be required to design the website in accordance with the corporation’s technical specifications for websites to assure consistency, compatibility, and integration with the parent corporation’s other websites.

It is important to document the detailed requirements in the project scope document in order to establish a clear understanding with the sponsor or customer.

2. **Statement of Work (SOW)** defines the major tasks or work elements that will need to be performed to accomplish the work that needs to be done and produce all the project deliverables. The SOW defines what the project team or contractor will do. If something is not included in the statement of work, then it should be assumed that it will not be done or provided. Having the contractor or project team review the statement of work with the sponsor or customer provides an opportu-
nity to make sure everything that the customer expects is included. For example, if training users how to operate or maintain a new system was not stated in the project charter or request for proposal, or was ambiguous, then including it in the SOW provides an opportunity to clarify or determine if the contractor should or should not provide training. Similarly, if landscaping was not stated in the homeowner’s requirements and therefore not included in the contractor’s SOW, it will not be provided, even though the homeowner may assume that it will be included. The statement of work section of the project scope document is where the contractor or project team can state and clarify exactly what is included in the work scope and provide an opportunity to reconsider items that are not stated but that the customer may have forgotten to include in her requirements or RFP.

For a project of designing, building, and installing a specialized automated high-speed packaging machine in the customer’s factory, the SOW might include the following major work elements:

a. Develop preliminary and detailed designs, including preparation of specifications, drawings, flowcharts, and a list of materials.
b. Prepare plans for testing of the components, subsystems, and system by the contractor, before shipping the equipment to the customer’s plant and after it has been installed at the customer’s plant, to ensure that the equipment meets the customer’s acceptance criteria. The customer may want to review and approve the test plans before the start of testing.
c. Conduct design review meetings, both internally and with the customer. Based on these design review meetings, the customer may initiate or approve changes to the original plan. These changes could have an impact on the scope, schedule, and price. The customer may need to amend the contract, and the contractor may have to do some replanning of the project to incorporate any changes and establish a new baseline plan for the remainder of the project work.
d. Order materials and parts.
e. Fabricate components and parts.
f. Develop and test software.
g. Assemble and test hardware, including testing components, assembling components into subassemblies, testing subassemblies, assembling subassemblies into the system, and testing the entire hardware system.
h. Integrate hardware and software and test the system. The customer may want to witness and document the test results to ensure that they meet the customer’s specifications.
i. Prepare installation requirements, such as floor plans and utility requirements (electrical, plumbing, and so forth), and identify which items the customer will be responsible for during installation.
j. Develop training materials (workbooks, videos, computer simulations) to train the customer to operate and maintain the new equipment.
k. Ship the equipment to the customer’s factory and install it.
l. Conduct training for the customer’s employees who will operate and maintain the new equipment.
m. Conduct final acceptance tests to demonstrate that the equipment meets the customer’s specified requirements and acceptance criteria.
For a project to put on a community festival, the major work elements might include the following:

a. Prepare promotions—newspaper advertisements, posters, tickets, and so forth.
b. Solicit volunteers.
c. Organize games, including constructing booths and acquiring prizes.
d. Contract for amusement rides and obtain the necessary permits.
e. Obtain performers to entertain and workers to construct the grandstand stage.
f. Arrange for food, including making or purchasing the food and building concession stands.
g. Organize all the support services, such as parking, cleanup, security, and restroom and first aid facilities.

3. **Deliverables** are the products or outputs that the project team or contractor will produce and provide to the customer during and at the completion of the performance of the project. Although major or key deliverables may be stated in the project charter or request for proposal, they need to be expanded on in greater detail in the project scope document. A detailed description of each deliverable should be stated to provide a basis for agreement between the project team or contractor and the customer of exactly what will be provided. This will help to manage stakeholder expectations. It would be embarrassing if a customer is expecting the contractor to provide a concept of a new office building as a three-dimensional physical model, but the contractor provides a pencil sketch on paper. Not only would the customer not accept the sketch, but the contractor would also have to spend additional time and money to construct the three-dimensional model, and would probably delay the project schedule. It would also be a setback to developing a good working relationship with the customer.

4. **Acceptance criteria** for all project deliverables must be described in greater detail than what is stated in the project charter or request for proposal. For each deliverable, the quantitative measures or references to specifications, standards, or codes that will be used should be stated, as the criteria will be the basis for the customer agreeing that a deliverable is acceptable. The inclusion of specifications or standards will help assure quality of the deliverable. In some cases, the acceptance criteria may need to describe certain inspection techniques (such as sampling), testing procedures (length of testing period, use of external laboratory), or specific testing equipment or facilities that must be used (calibrated to industry standards, environmental chamber). A clear description of the acceptance criteria with quantitative measures will help to avoid misunderstandings. For example, if the acceptance criteria for testing a prototype of a new product are not clear and only state that the prototype must be tested for a sufficient period of time without failing, the development team may test the prototype for 2 days and expect the sponsor to approve and accept the prototype design and specifications; however, the sponsor may have expected the test period to be 10 days. In this case, the acceptance criteria should have stated that the prototype must be tested to show that it operates continuously over a 10-day period without failing, rather than merely stating “for a sufficient period of time.”

For some projects, the terms of payment may be tied to the customer’s acceptance of certain deliverables, such as 20 percent of the total project
amount is paid to the contractor upon customer approval and acceptance of the detail design specifications for the customer relationship management system.

Clear, unambiguous acceptance criteria for all deliverables are important because they are the basis for verifying that the project scope has been completed in accordance with the customer’s requirements and expectations.

5. Work Breakdown Structure (WBS). The major work elements defined in the statement of work section along with the detailed list of deliverables provide the basis for creating a work breakdown structure, which is a hierarchical decomposition of the project work scope into work packages that produce the project deliverables. It is a technique for organizing and subdividing all the project work and deliverables into more manageable components. The WBS establishes the framework for further planning to create a baseline plan for performing the project work. The project scope document may include a high-level WBS in a graphic chart format or as an indentured list of the work elements and associated deliverables. This work breakdown structure will be used as the basis for creating a more detailed WBS in the next step of the planning process.

It should be noted that at the beginning of the project it might not be possible to define all of the requirements, work elements, and deliverables at a detailed level. This is especially the case for a project with a long duration, such as a multiyear project, or a project that has several phases. It is easier to define the details for the near-term efforts, but as the project progresses or moves from phase to phase, the project team or contractor can progressively elaborate the details as more information is known or becomes clear.

The project scope document is valuable for establishing a common understanding among project stakeholders regarding the scope of the project. The contractor or project team needs to gain agreement from the sponsor or customer on the project scope document. If the scope seems much greater than originally anticipated by the customer, it may affect the budget and schedule for performing the work and jeopardize accomplishing the project objective. In such a case, the customer and contractor would have to agree on increasing the budget, extending the schedule, reducing the scope, or some combination thereof.

The agreed-upon project scope document establishes the baseline for any changes that may be made to the scope during the performance of the project. A change control system needs to be established to define how changes will be documented, approved, and communicated. The project team or contractor must avoid scope creep, which is informally making changes to the project scope without appropriate approval. Many projects overspend their budget or are not completed on time because of scope creep caused by additional work that was not documented or approved, or was not communicated and in turn caused errors or rework for other elements of the project. See the section on managing changes in Chapter 10, and the section on track document changes in Chapter 12 for further information.

Plan for Quality

It is important to plan for quality in performing the project to assure that the work is done according to specifications and applicable standards and that deliverables meet acceptance criteria. Planning for quality is a necessary, yet often
forgotten or dismissed, function on a project. It is essential to have a plan for assuring the quality of project deliverables and results rather than waiting until the end of the project to check if the sponsor/customer requirements and expectations have been met regarding the quality of the project deliverables. For example, if a new homeowner required the contractor to paint the interior walls of all the rooms, but the work was done in a sloppy manner and the paint showed streaks, the rooms were painted, but the quality was below customer expectations. If 20,000 merchandise catalogues were printed but the photo images were fuzzy or blurred, the quantity of deliverables was accomplished, but the quality was not.

In order to prevent poor quality and avoid quality problems, there needs to be a **project quality plan**. The quality plan must include or reference the specifications, industry or government standards (for design, testing, safety, construction, etc.), and codes that must be used and met during the performance of the project work. For example, in construction projects, appropriate industry standards should be used for building design and for materials, along with local building codes. Similarly, on projects that involve developing electrical-based products, industry standards regarding safety should be used and the product tested in accordance with specified testing procedures to assure it meets these safety standards. Quality standards that will be used should also be stated and referenced in other appropriate project documents, such as technical specifications and acceptance criteria, and communicated to members of the project team at the outset of the project before the work begins. The quality plan may also state that suppliers must provide documentation certifying that the materials they supply meet certain required specifications.

To help assure quality, the project quality plan should contain written procedures for using various quality tools and techniques, such as audits, inspections, testing, checklists, and so on. The plan should also state which tools and techniques to use and when. Techniques such as audits and inspections are often used. For military contracts that use contractors to develop or build weapon systems for example, it is normal for the government agency to have a quality representative reside at the contractor’s facility for the duration of the project to regularly review and inspect the contractor’s work. In the case of building a house, the contractor is required to have a local building inspector check certain types of work (foundation, framing, plumbing, electrical) at different times throughout the construction. If the work does not comply with the codes or meet required specifications, then the contractor has to redo the work until it passes inspection. For some projects, the customer may hire an independent third party or laboratory to be its representative or perform tests rather than relying on the contractor’s inspecting and testing its own work. In other situations, the customer may make unannounced visits to the contractor’s facility or work site and randomly select certain work elements to review in order to determine whether they are being done in conformance with quality standards and requirements.

With the quality plan in place including procedures for the application of appropriate quality tools and techniques, quality can then be controlled. The key to **quality control** is to monitor the quality of the work early and regularly throughout the performance of the project, compare results with quality standards, and make any necessary corrective actions immediately, rather than waiting until all the work is completed before checking or inspecting for quality. If, in the house painting example, there had been written quality procedures that stated the project manager must inspect the paint work after the first room is painted and before painting is started in the remaining rooms, it might have
minimized the impact of the shoddy paint job by making sure the painting of the remaining rooms would be done correctly—only the first room would have had to be repainted, rather than all the rooms.

Having a written quality plan at the outset of a project is extremely beneficial because it helps prevent incurring additional costs and schedule extensions due to rework caused by work and deliverables that fail to meet quality requirements and customer expectations. The focus must be on doing it right the first time by doing the work in accordance with quality standards, and therefore preventing quality problems, rather than relying on after-the-fact inspections or testing and then having to do additional work to correct quality problems.

It is often said that some people think they never have enough time to do the work right the first time, but then must take the time later to redo it correctly—haste makes waste!

**Create Work Breakdown Structure**

Once the project scope document has been prepared and agreed on, the next step in the planning phase is to create a detailed work breakdown structure (WBS), which is a deliverable-oriented hierarchical decomposition of the project work scope into work packages that produce the project deliverables. Having a comprehensive project scope document is important because it is the foundation for creating the work breakdown structure. The project scope document defined what needs to be done in terms of the statement of work and deliverables, and the WBS establishes the framework for how the work will get done to produce the project deliverables.

Creating a WBS is a structured approach for organizing all the project work and deliverables into logical groupings and subdividing them into more manageable components to help ensure that all the work and deliverables to complete the project are identified and included in the baseline project plan. It is a hierarchical tree of deliverables or end items that will be accomplished or produced by the project team or contractor during the project. The work breakdown structure subdivides the project into smaller pieces called work items. The lowest-level work item of any one branch is called a work package. The work package includes all of the specific work activities that need to be performed to produce the deliverable associated with that work package. The WBS should be decomposed to a level that identifies individual work packages for each specific deliverable listed in the project scope document. Often the WBS includes a separate work package labeled “project management” that is for all the work associated with managing the project such as preparing progress reports; conducting review meetings; planning, monitoring, and tracking schedules and budgets, and so on. The accomplishment or production of all of these lowest-level work packages in the work breakdown structure constitutes completion of the project work scope.

The WBS can be created using a graphic chart format or as an indentured list. Figure 4.1 shows a work breakdown structure in a graphic chart format for a community festival project. Not all branches of the WBS have to be broken down to the same level. Most work packages shown in Figure 4.1 are at the second level, but four work items are further divided into a more detailed third level; one work item (Volunteers) is not broken down beyond the first level.
Another example of a work breakdown structure for a consumer market study project is illustrated in Figure 4.2.

**FIGURE 4.1 Work Breakdown Structure for Festival Project**
Guidelines for deciding how much detail or how many levels to include in the work breakdown structure are:
The level at which a specific deliverable is produced as the output or end product of the work associated with a work package. For example, a WBS for remodeling an office might have one of the lowest level work packages labeled as “Furnishings,” with the deliverable being the installation of all new office furniture and accessories. The work package would include all of the specific work activities to determine what types and quantities of furniture are needed, prepare specifications, prepare requests for proposals, review vendor proposals for various layouts and prices, select vendor(s), and have the furniture and accessories delivered, assembled, and set up.

The level at which there is a high degree of confidence that all the activities that need to be performed to produce the deliverable can be defined, the types and quantities of resources can be determined, and the associated activity durations and costs can be reasonably estimated.

The level at which a single organization (marketing communications, materials engineering, human resources, a subcontractor, etc.) or individual can be assigned responsibility and accountability for accomplishing the work package.

The level at which the project manager wants to monitor and control the budget, and can collect data on actual costs and the value of the work completed during the performance of the project.

The other format for creating a WBS is an indentured list, as shown in Figure 4.3 for the consumer market study project. This format may be appropriate for larger projects where a chart may become too large and unwieldy. Notice on the indented list that it also states the specific deliverable that is expected to be completed from the work activities associated with each lowest level-work package. For example, the deliverable for the work package 1.1 (Design) is Questionnaire approved; for 1.2 (Responses), the deliverable is All completed responses received; for 2.1 (Software), the deliverable is Application software working; and for 2.2 (Report), the deliverable is Final report.

For large or complex projects, it may be difficult for one individual to determine all the work elements to include in the work breakdown structure. Therefore, the project manager should involve key team members in developing the
WBS. They may have special expertise, knowledge, or experience that will help develop a more comprehensive and complete WBS. Having other project team members participate in developing the project scope statement and work breakdown structure will also build teamwork, commitment to the project plan, and commitment to completing the project successfully.

The WBS usually indicates the organization or individual assigned responsibility for performance and completion of each work item. However, the work breakdown structure is not the same thing as the project organization chart or structure. In some cases, it could be—but not usually. See Chapter 13, Project Management Organizational Structures, for more discussion on this topic.

The work breakdown structure establishes the framework for further planning to create a baseline plan for performing the project work. There is not a single ideal WBS for any project. Different project teams might create somewhat different work breakdown structures for the same project.

**Assign Responsibility**

A **responsibility assignment matrix (RAM)** defines who will be responsible for the work. It is a tool used to designate the individuals responsible for accomplishing the work items in the work breakdown structure. It is a useful tool because it emphasizes who is responsible for each work item and shows each individual’s role in supporting the overall project. Figure 4.4 shows the responsibility assignment matrix associated with the WBS in Figure 4.1 for the community festival project.

The responsibility assignment matrix may use a P to designate primary responsibility and an S to indicate support responsibility for a specific work item. The RAM shows all the individuals associated with each work item in the work breakdown structure, as well as all the work items associated with each individual. For example, Figure 4.4 indicates that Jim has primary responsibility for the game booths, with Chris and Joe supporting this effort. The figure also shows all the work items with which Joe is involved, for example. Only one individual should be designated as the lead, or primary, person responsible for each work item. Designating two or more individuals as having primary responsibility can cause confusion and increase the risk that some work will "fall through the cracks," because each person may assume that the other person is going to do it.
Figure 4.4 Responsibility Assignment Matrix for Festival Project

<table>
<thead>
<tr>
<th>WBS Item</th>
<th>Work Item</th>
<th>Andrea</th>
<th>Beth</th>
<th>Bill</th>
<th>Chris</th>
<th>Damian</th>
<th>Jack</th>
<th>Jeff</th>
<th>Jim</th>
<th>Joe</th>
<th>Keith</th>
<th>Lynn</th>
<th>Neil</th>
<th>Pat</th>
<th>Rose</th>
<th>Steve</th>
<th>Tyler</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Festival</td>
<td></td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Promotion</td>
<td></td>
<td>S</td>
<td></td>
<td>S</td>
<td>P</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Newspaper Ads</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Posters</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Tickets</td>
<td></td>
<td>P</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Volunteers</td>
<td></td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Games</td>
<td></td>
<td>S</td>
<td>S</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Booths</td>
<td></td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Games</td>
<td></td>
<td>S</td>
<td>S</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Prizes</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Rides</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Amusement Contractor</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Permits</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Entertainment</td>
<td></td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Performers</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Grandstand</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2.1</td>
<td>Stage</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2.2</td>
<td>Audio &amp; Lighting</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2.3</td>
<td>Seating</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Food</td>
<td></td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Food</td>
<td></td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>Facilities</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.1</td>
<td>Food Booths</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.2</td>
<td>Cooking Equipment</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2.3</td>
<td>Eating Areas</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Services</td>
<td></td>
<td>P</td>
<td></td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1</td>
<td>Parking</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2</td>
<td>Clean-up</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2.1</td>
<td>Containers</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2.2</td>
<td>Contractor</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3</td>
<td>Restroom Facilities</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3.1</td>
<td>Restrooms</td>
<td></td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.3.2</td>
<td>First Aid Stations</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.4</td>
<td>Security</td>
<td></td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**  
- **P** = Primary responsibility;  
- **S** = Support responsibility.
Define Activities

Using the work breakdown structure, the individual or team responsible for each work package must next define all the specific activities that need to be performed to produce the end item or deliverable for the work package. Activities define more specifically how the work will get done. An activity, also referred to as a task, is a defined piece of work that consumes time. It does not necessarily require the expenditure of effort by people—for example, waiting for concrete to harden can take several days but does not require any human effort.

For work package 3.1 in Figure 4.1, game booths, the following eight specific activities may be defined:

- Design booths
- Specify materials
- Buy materials
- Construct booths
- Paint booths
- Dismantle booths
- Move booths to festival site and reassemble
- Dismantle booths and move to storage

In Figure 4.5, the work breakdown structure for a consumer market study project, the specific activities that need to be performed for each work package are defined.

**FIGURE 4.5 Work Breakdown Structure for Consumer Market Study Project**
When all the specific activities have been defined for all of the work packages, they should be consolidated into a comprehensive activity list. The next step is to create a network diagram that shows their appropriate sequence and defines the dependent relationships indicating how the activities need to be performed to accomplish the overall project work scope and produce the deliverables.

It should be noted that at the beginning of the project it might not be possible to define all of the specific activities. This is especially the case for a project with a long duration. It is easier to define the specific activities for near-term work; but as more information is known or becomes clear, the project team can progressively elaborate the specific activities.

**Sequence Activities**

A network diagram defines the sequence of how the activities will get done. It is a tool for arranging the specific activities in the appropriate sequence and defining their dependent relationships.

Two network planning techniques, program evaluation and review technique (PERT) and the critical path method (CPM), were developed in the 1950s. Since that time, other forms of network planning, such as the precedence diagramming method (PDM), have been developed. All of these fall under the general category of network planning techniques, because they all make use of a network diagram to show the sequential flow and interrelationships of activities. In the past, there were distinguishable methodological differences between PERT and CPM. Today, however, when most people refer to a CPM diagram or PERT chart, they mean a generic network diagram. See Figures 4.9 and 4.13 for examples of network diagrams for a project to conduct a consumer market study and for a project to develop a Web-based reporting system.

**NETWORK PRINCIPLES**

There are a few basic principles that must be understood and followed in creating a network diagram. Each activity is represented by a box in the network diagram, and the description of the activity is written within the box, as shown below.

Activities consume time, and their description usually starts with a verb. Each activity is represented by one and only one box. In addition, each box is assigned a unique activity number. In the above example, the activity "Get Volunteers" has been given activity number 7.

Activities have a dependent relationship—that is, they are linked in a logical sequence to show which activities must be finished before others can start. Arrows linking the activity boxes show the direction of the dependent relationship. An activity cannot start until all of the preceding activities that are linked to it by arrows are finished.

Certain activities have to be done in serial sequence. For example, as shown below, only after "Wash Car" is finished can "Dry Car" start.
Some activities may be done concurrently. For example, as shown below, “Get Volunteers” and “Buy Materials” can be performed concurrently; when they are both finished, “Construct Booth” can start. Similarly, when “Paint Booth” is finished, both “Dismantle Booth” and “Clean Up” can start and be performed concurrently.

Shown below is an illogical relationship among activities known as a loop. In preparing a network diagram, drawing activities in a loop is not acceptable because it portrays a path of activities that perpetually repeats itself.

Some projects have a set of activities that are repeated several times. For example, consider a project involving the painting of three rooms. Painting each room requires: (1) preparing the room to be painted, (2) painting the ceiling and walls, and (3) painting the trim. Assume that three experts will be available—one to do the preparation, one to paint the ceilings and walls, and one to do the trim.

It may seem logical to draw a network diagram for the project like the one shown in Figure 4.6 or 4.7. However, Figure 4.6 indicates that all the activities must be done in serial sequence, which means that at any one time only one person is working while two other people are waiting. Figure 4.7, on the other hand, indicates that all three rooms can be done concurrently, which is not possible because only one expert is available for each type of activity.

Figure 4.8 shows a technique known as laddering, which can be used to diagram this painting project. It indicates that each expert, after finishing one room, can start working on the next room. This approach will allow the project to be completed in the shortest possible time while making the best use of available resources (the experts).
CREATE NETWORK DIAGRAM

With the list of specific activities and knowledge of network principles, a network diagram can now be created. Start by drawing the activities in boxes in their logical sequence and connecting them with arrows to show the required dependent relationships, as the project should be performed from start to completion. When deciding on the sequence in which the activities should be drawn to show their dependent relationships to one another, ask the following three questions regarding each individual activity:

1. Which activities must be finished immediately before this activity can be started?
2. Which activities can be done concurrently with this activity?
3. Which activities cannot be started until immediately after this activity is finished?

By answering these questions for each activity, you should be able to draw a network diagram that portrays the sequence and dependent relationships of activities needed to accomplish the project work scope.
The entire network diagram should flow from left to right, although some arrows may flow from right to left to prevent the overall diagram from becoming too long or unwieldy. It is easier to visualize the entire project if the network diagram can be drawn to fit on a large sheet of paper. If the network is very large, however, it may require multiple sheets. In such cases, it may be necessary to create a reference system or set of symbols to show the linkages between activities on different sheets.

When initially drawing the network diagram for a project, do not be too concerned about drawing it neatly. It is better to sketch out a rough draft of the diagram and make sure the sequence and dependent relationships among the activities are correct. Then, go back later and draw it more neatly (or preferably generate the diagram on the computer if you are using project management software).

The following guidelines should be considered in deciding how detailed (in terms of number of activities) a network diagram for a project should be:

1. Based on the work breakdown structure for a project, specific activities should be defined for each work package. For example, Figure 4.5 shows a WBS for a project involving a consumer market study and the specific activities that have been defined for each work package.

2. It may be preferable to draw a summary-level network first and then expand it to a more detailed network. A summary network contains a small number of higher-level activities rather than a large number of detailed activities. In some cases, a summary network may suffice for use throughout a project.

3. The level of detail may be determined by certain obvious interface or transfer points:
   - If there is a change in responsibility—that is, a different person or organization takes over responsibility for continuing the work—it should define the end of one activity and the start of other activities. For example, if one person is responsible for building an item and another person is responsible for packaging it, these should be two separate activities.
   - If there is a tangible output or product or deliverable as a result of an activity, it should define the end of one activity and the start of other activities. Some examples of outputs include a report, a drawing, the shipment of a piece of equipment, and the costumes for a theatrical production. In the case of a brochure, the production of a draft brochure should be defined as the end of one activity; another activity, perhaps “Approve Draft Brochure,” would follow.

4. Activities should not be longer in estimated duration than the time intervals at which actual project progress will be reviewed and compared to planned progress. For example, if the project is a three-year endeavor and the project team plans to review project progress monthly, then the network diagram should contain no activities with estimated durations greater than one month. If there are activities with estimated durations longer than one month, they should be broken into more detailed activities with durations of one month or less.

Whatever the level of detail of the initial network diagram, some activities may be broken down further as the project progresses. It is always easier to identify activities that need to be done in the near term (the next several weeks or months) than to identify activities that are a year in the future. It is not unusual
progressively elaborate the network diagram as the project progresses and more information is known or becomes clear.

In some cases, an organization may do similar projects for different customers, and certain portions of these projects may include the same types of activities in the same sequence and dependent relationships. If so, it may be worthwhile to develop standard subnetworks for these portions of the projects. Having standard subnetworks can save effort and time when a network diagram is developed for an overall project. Standard subnetworks should be developed for those portions of projects for which the logical relationships among the activities have been well established through historical practice. These subnetworks may, of course, be modified as necessary for a particular project.

Finally, when the entire network diagram has been drawn, it is necessary to assign a unique activity number to each activity (box).

Reinforce Your Learning
15. Refer to Figure 4.9.
   a. When “Prepare Mailing Labels” and “Print Questionnaire” are finished, what activity can be started?
   b. In order to start “Input Response Data,” which activities must have been finished immediately beforehand?

The network diagram is a roadmap that displays how all the specific activities fit together to accomplish the project work scope. It also is a communication tool for the project team because it shows who is responsible for each activity and how each person’s work fits into the overall project.
What Went Wrong?—Learning from Past Postmortems

Analysis of a project during and after completion is used to provide lessons learned for future projects. Planning is a good time to look at these past postmortems and incorporate the lessons into the next project.

*Game Developer* magazine has published a number of articles about the problems associated with game development because hearing about project wrecks has an appeal for its readers. Review of the past has revealed a number of errors that projects seem doomed to repeat even though they are part of the lessons learned and should be part of the planning.

Alyssa Finley of 2K Boston, developer of BioShock, described the root of many problems: “Competing demands for time and resources meant that, unfortunately, some of the important narrative details of the game weren’t created until the final rewrite, that therefore required quite a bit of work to retrofit into an existing game.” The content was being added too late during the development, and the scheduling of the project was in question, as was the approval process. Requiring too much approval had made the process too slow and actually resulted in the design studio
for Titan Quest going out of business. Riley Cooper, Tomb Raider: Legend, stated after his company had planning problems with features of their game, “You need to do them 100 percent or not at all.”

Brandon Sheffield points out that “schedules aren’t always determined by developers, but they agreed upon them. Keeping the schedule and the scope of your game within reasonable limits while still doing the best you can is not easy. But it’s absolutely critical.” The popular game, Guitar Hero, fell victim to improper planning of project scope when long hours were spent to include a freestyle mode into the game that had to be cut from the product due to improper planning of time necessary to make the feature sound good and integrate properly into the game play. Management at Harmonix did not want to take the chance of a bad product because their scope and scale of the projects failed to be balanced.

Harmonix also failed at having enough resources with responsibility for completing the necessary tasks. Rock Band, a product of Harmonix, failed to have adequate numbers of team members to complete the tasks necessary. Partway through Alpha, they moved the entire team into a larger space to provide work space for new employees. Rob Kay reported, “Despite all this, we still didn’t hire aggressively enough. Many years of making small, tightly focused games had ingrained an efficiency bias and ‘smaller is better’ mentality that were hard to shake.”

Age of Booty, developed by Certain Affinity, suffered because the project management team took on three additional projects and split up the programmers to work on multiple projects. The additional projects served as distractions and limited the team members’ time to pay attention to the progress being made on each of the games’ or to get a feel for the game. Brian Reynolds from Big Huge Games summarized the need to have a project manager set the responsibility matrix for tasks: “Not having a solid management structure meant that things tended to fall through the cracks. There was no one to set goals for the programming team or art group. There was no one to assert what needed to be done day-to-day, or week-to-week, or month-to-month. The employees sometimes drifted, unsure of what they should work on next, spending too much time on assets that were unimportant, neglecting elements of the game that were actually critical.”

Joseph Triangle from 5th Cell, developer of Drawn to Life, described their project: “Playing catch up from day one is the key phrase here, and proper schedule and project management are the solution. Easier said than done!”

As you work on developing your project management skills, consider what these developers did wrong and how they let the same problems persist in their development projects. You can be the judge as to whether defining the project scope, quality, responsibility, and sequence is easier said than done or easier done than said!

Based on information from B. Sheffield, “What Went Wrong?—Learning from Past Postmortems,” Game Developer 15, no. 11 (December 2008), 7.

**Planning for Information Systems Development**

Because of the rapidly increasing number of information technology–related projects that are being undertaken, it seems appropriate to include a section in each of the next few chapters on project management practices in information systems
development. An **information system (IS)** is a computer-based system that accepts data as input, processes the data, and produces useful information for users. Information systems include computerized order entry systems, e-commerce systems, automatic teller machines, and billing, payroll, and inventory systems. The development of an IS is a challenging process that requires extensive planning and control to ensure that the system meets user requirements and is finished on time and within budget.

A project management planning tool, or methodology, called the **systems development life cycle (SDLC)** is often used to help plan, execute, and control IS development projects. The SDLC consists of a set of phases or steps that need to be completed over the course of a development project. Many people view the SDLC as a classic problem-solving approach. It consists of the following steps:

1. **Problem definition.** Data are gathered and analyzed, and problems and opportunities are clearly defined. Technical, economic, operational, and other feasibility factors are defined and studied to determine, at least initially, whether the IS can be successfully developed and used.

2. **System analysis.** The development team defines the scope of the system to be developed, interviews potential users, studies the existing system (which might be manual), and defines user requirements.

3. **System design.** Several alternative conceptual designs are produced that describe input, processing, output, hardware, software, and the database at a high level. Each of these alternatives is then evaluated, and the best one is selected for further design and development.

4. **System development.** The actual system is brought into existence. Hardware is purchased, and software is purchased, customized, or developed. Databases, input screens, system reports, telecommunication networks, security controls, and other features are also developed.

5. **System testing.** After individual modules within the system have been developed, testing can begin. Testing involves looking for logical errors, database errors, errors of omission, security errors, and other problems that might prevent the system from being successful. After the individual modules are tested and problems are corrected, the entire system is tested. Once the users and the developers are convinced that the system is error-free, the system can be implemented.

6. **System implementation.** The existing system is replaced with the new, improved system, and users are trained. Several methodologies exist for converting from the existing system to the new system with minimal interruption to the users.

The SDLC concludes with implementation of the system. The system life cycle itself continues with a formal review of the development process after the system is up and running, and then continues with maintenance, modifications, and enhancements to the system.

**AN IS EXAMPLE: INTERNET APPLICATIONS DEVELOPMENT FOR ABC OFFICE DESIGNS**

A corporation called ABC Office Designs has a large number of sales representatives who sell office furniture to major corporations. Each sales representative is assigned to a specific state, and each state is part of one of four regions in
the country. To enable management to monitor the number and amount of sales for each representative, for each state, and for each region, ABC has decided to build a Web-based information system that will track prices, inventory, and the competition.

The IS department within the corporation has assigned Beth Smith to be the project manager of the Web-based reporting system development project. With the help of her staff, Beth identified all of the major tasks that need to be accomplished and developed the work breakdown structure shown in Figure 4.10. Notice that the WBS follows the steps of the SDLC. At level 1, the major tasks are problem definition, analysis, design, development, testing, and implementation. Each of these tasks is further broken down into level 2 tasks, and a few are broken down further into level 3 tasks.
After the project team created the WBS, the responsibility assignment matrix shown in Figure 4.11 was developed. Notice that this table reflects all of the activities shown in the WBS. In addition, it shows who has primary and secondary responsibilities for each task.

Next, Beth wanted to develop a network diagram to show the interdependencies that exist among tasks. Before Beth did this, however, she and the project team created a list of all tasks to be done, with the immediate predecessor for each task listed to the right of the task, as shown in Figure 4.12. Notice that before “Prepare (Problem Definition) Report” can start, both “Gather Data” and “Study Feasibility” must be finished. Similarly, before “Prepare (System Analysis) Report” can start, both “Study Existing System” and “Determine User Requirements” must be completed.
### FIGURE 4.11  Responsibility Assignment Matrix for Web-based Reporting System Project

<table>
<thead>
<tr>
<th>WBS Item</th>
<th>Work Item</th>
<th>Beth</th>
<th>Jim</th>
<th>Jack</th>
<th>Rose</th>
<th>Steve</th>
<th>Jeff</th>
<th>Tyler</th>
<th>Cathy</th>
<th>Sharon</th>
<th>Hannah</th>
<th>Joe</th>
<th>Gerri</th>
<th>Maggie</th>
<th>Gene</th>
<th>Greg</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Web-based Reporting System</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Problem Definition</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.1</td>
<td>Gather Data</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.2</td>
<td>Study Feasibility</td>
<td>P</td>
<td></td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1.3</td>
<td>Prepare Report</td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>System Analysis</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.1</td>
<td>Interview Users</td>
<td>P</td>
<td>S</td>
<td>P</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.2</td>
<td>Study Existing System</td>
<td>P</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.3</td>
<td>Define User Requirements</td>
<td>P</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2.4</td>
<td>Prepare Report</td>
<td>P</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>System Design</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1</td>
<td>Input &amp; Output</td>
<td>P</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.1</td>
<td>Menus</td>
<td>S</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.2</td>
<td>Data Entry Screens</td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.3</td>
<td>Periodic Reports</td>
<td>P</td>
<td>S</td>
<td>P</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.1.4</td>
<td>Ad Hoc Queries</td>
<td>S</td>
<td>P</td>
<td>P</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.2</td>
<td>Processing &amp; Database</td>
<td>P</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.3</td>
<td>Evaluation</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3.4</td>
<td>Prepare Report</td>
<td>P</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>System Development</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1</td>
<td>Software</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.1</td>
<td>Packaged Software</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.1.2</td>
<td>Customized Software</td>
<td>S</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.2</td>
<td>Hardware</td>
<td>S</td>
<td></td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.3</td>
<td>Network</td>
<td>S</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4.4</td>
<td>Prepare Report</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Testing</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.1</td>
<td>Software</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.2</td>
<td>Hardware</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.3</td>
<td>Network</td>
<td>S</td>
<td></td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5.4</td>
<td>Prepare Report</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>Implementation</td>
<td>P</td>
<td>S</td>
<td>S</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.1</td>
<td>Training</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2</td>
<td>System Conversion</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3</td>
<td>Prepare Report</td>
<td>S</td>
<td>S</td>
<td>P</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**KEY:**  
- **P** = Primary responsibility;  
- **S** = Support responsibility.
With this list, Beth then created the network diagram shown in Figure 4.13.

### Project Management Information Systems

A wide variety of affordable project management information systems are available for purchase. These systems allow the project manager and the project team to plan and control projects in a completely interactive mode.

Common features of project management information systems allow the user to:

- Create lists of tasks with their estimated durations
- Establish dependencies among tasks
- Work with a variety of time scales, including hours, days, weeks, months, and years
- Handle certain constraints—for example, a task cannot start before a certain date, a task must be started by a certain date, labor unions allow no more than two people to work on the weekends
• Track team members, including their pay rates, hours worked thus far on a project, and upcoming vacation dates
• Incorporate company holidays, weekends, and team member vacation days into calendaring systems
• Handle shifts of workers (day, evening, night)
• Monitor and forecast budgets
• Look for conflicts—for example, over-allocated resources and time conflicts
• Generate a wide variety of reports
• Interface with other software applications such as spreadsheets and databases
• Sort information in a variety of ways—for example, by project, by team member, or by work package
• Handle multiple projects
• Work online and respond quickly to changes in schedule, budget, or team task assignments
• Compare actual costs with budgeted costs
• Display data in a variety of ways, including both network diagrams and Gantt or bar charts

See Appendix A in the back of the book for a thorough discussion of project management information systems.
CRITICAL SUCCESS FACTORS

- Plan the work and then work the plan. It is important to develop a plan before starting to perform the project. Taking the time to develop a well-thought-out plan is critical to the successful accomplishment of any project.

- Participation builds commitment. By participating in the planning of the work, individuals will become committed to accomplishing it according to the plan.

- The project must have a clear objective of what is to be accomplished and defined in terms of end product or deliverable, schedule, and budget, and it must be agreed upon by the customer and the project team that will perform the project.

- The project scope document is valuable for establishing a common understanding and agreement among project stakeholders regarding the scope of the project.

- Having a quality plan at the outset of the project is extremely beneficial because it will help prevent incurring additional costs and schedule extensions due to rework caused by work and deliverables that fail to meet quality requirements and customer expectations.

- The key to quality control is to monitor the quality of the work early and regularly throughout the performance of the project, rather than waiting until all the work is completed before checking or inspecting for quality.

- The network diagram is also a communication tool for the project team because it shows who is responsible for each activity and how each person’s work fits into the overall project.
The planning process is based on the project objective, which establishes what is to be accomplished. The project objective is usually defined in terms of the end product or deliverable, schedule, and budget. It requires completing the work and producing all the deliverables by a certain time and within budget. It should also include the expected benefits that will result from implementing the project and that will define the success of the project.

The project scope defines what needs to be done. It is all the work that must be done to produce all the project deliverables, satisfy the sponsor or customer that all the work and deliverables meet the requirements or acceptance criteria, and accomplish the project objective. The project scope document usually contains the customer requirements, statement of work, deliverables, acceptance criteria, and a work breakdown structure. The project scope document is valuable for establishing a common understanding among project stakeholders regarding the scope of the project. The contractor or project team needs to gain agreement from the sponsor or customer on the project scope document.

It is important to plan for quality in performing the project to assure that the work is done according to specifications and applicable standards and that deliverables meet acceptance criteria. The quality plan must include or reference the specifications, industry or government standards, and codes that must be used and met during the performance of the project work. To help assure quality, the project quality plan should contain written procedures for using various quality tools and techniques. The key to quality control is to monitor the quality of the work early and regularly throughout the performance of the project, rather than waiting until all the work is completed before checking or inspecting for quality. Having a written quality plan at the outset of the project is extremely beneficial because it will help prevent incurring additional costs and schedule extensions due to rework caused by work and deliverables that fail to meet quality requirements and customer expectations.

A work breakdown structure is a deliverable-oriented hierarchical decomposition of the project work scope into work packages that produce the project deliverables. The work breakdown structure establishes the framework for how the work will get done to produce the project deliverables. A WBS is a structured approach for organizing all the project work and deliverables into logical groupings and subdividing them into more manageable components to help ensure that all the work and deliverables to complete the project are identified and included in the baseline project plan.

A responsibility assignment matrix defines who will be responsible for the work. It shows all the individuals associated with each work item in the work breakdown structure, as well as all the work items associated with each individual.

Using the work breakdown structure, the individual or team responsible for each work package must define all the specific activities that need to be performed to produce the end item or deliverable for the work package. Activities define more specifically how the work will get done.

A network diagram defines the sequence of how the activities will get done. It is a tool for arranging the specific activities in the appropriate sequence and defining their dependent relationships. The network diagram is a roadmap that displays how all the specific activities fit together to accomplish the project work.
scope. It also is a communication tool for the project team because it shows who is responsible for each activity and how each person's work fits into the overall project.

Project planning is a critical activity in developing an information system (IS). A project management planning tool, or methodology, called the systems development life cycle (SDLC) is often used to help plan, execute, and control IS development projects. The SDLC consists of a set of phases or steps: problem definition, system analysis, system design, system development, system testing, and system implementation. All of these steps need to be completed over the course of a development project.

Numerous project management information systems are available to help project managers plan, track, and control projects in a completely interactive way.

QUESTIONS

1. What is meant by planning a project? What does this encompass? Who should be involved in planning the work?
2. What is meant by the term project objective? What might happen if a project objective is not clearly written? Give three examples of clearly written project objectives.
3. Describe a project scope document. Why is it important to clearly define the project scope?
4. What is a work breakdown structure? What is a responsibility assignment matrix? How are they related?
5. Why is creating a plan for quality important? From your experience, give an example of how having and controlling a quality plan could have prevented (or did prevent) quality problems in a project.
6. What is an activity? Does it always require human effort? Refer to Figure 4.1. Provide a detailed list of activities needed to accomplish work package 3.3. Do the same for work package 4.2.
7. Refer to Figure 4.9. What activities must be accomplished before "Input Response Data" can start? What activities can start after "Review Comments & Finalize Questionnaire" has finished? List two activities that can be done concurrently.
8. When would you use laddering in a network diagram? Give an example, different from the one provided in the chapter, and draw the corresponding network diagram.
9. Why would you recommend project management software to someone involved in project management? What features and benefits does it provide?
10. Draw a network diagram representing the following logic: as the project starts, activities A and B can be performed concurrently. When activity A is finished, activities C and D can start. When activity B is finished, activities E and F can start. When activities D and E are finished, activity G can start. The project is complete when activities C, F, and G are finished.
11. Draw a network diagram representing the following information: the project starts with three activities—A, B, and C—which can be done concurrently. When A is finished, D can start; when B is finished, F can start; when B and D are finished, E can start. The project is complete when C, E, and F are finished.
12. Draw a network diagram that represents the following IS development task list.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Immediate Predecessor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Problem Definition</td>
<td>—</td>
</tr>
<tr>
<td>2. Study Current System</td>
<td>1</td>
</tr>
<tr>
<td>3. Define User Requirements</td>
<td>1</td>
</tr>
<tr>
<td>4. Logical System Design</td>
<td>3</td>
</tr>
<tr>
<td>5. Physical System Design</td>
<td>2</td>
</tr>
<tr>
<td>6. System Development</td>
<td>4, 5</td>
</tr>
<tr>
<td>7. System Testing</td>
<td>6</td>
</tr>
<tr>
<td>8. Convert Database</td>
<td>4, 5</td>
</tr>
<tr>
<td>9. System Conversion</td>
<td>7, 8</td>
</tr>
</tbody>
</table>

**INTERNET EXERCISES**

For the website addresses of the organizations mentioned in these exercises, make an Internet connection and go to www.cengagebrain.com. At the Cengagebrain.com home page, search for the ISBN of your title (from the back cover of your book), using the search box at the top of the page.

1. Search the Web for project planning tools and describe at least three sites that you find.
2. Visit the website of the International Project Management Association (IPMA). Explore the site to learn more about certifications, memberships, publications, awards, events, and educational opportunities.
3. Look at the IPMA link called “Young Crew.” Young Crew is a key component of IPMA’s strategy for nurturing the project management leaders of tomorrow. Describe what you found.
4. The *International Journal of Project Management* is an IPMA publication. Go to the journal’s home page or go to the website of Elsevier Science Direct and search for the journal. Click on the “Free Tables of Contents and Abstracts” link. Print out a list of articles from the current edition.
5. Within the “Free Tables of Contents and Abstracts” link, perform a quick search using the keyword “Planning.” Provide a list of what you found. Next, click on “View Related Articles” and describe what you found.

**CASE STUDY 1**  
**A Not-for-Profit Medical Research Center**

You are Alexis, the director of external affairs for a national not-for-profit medical research center that does research on diseases related to aging. The center’s work depends on funding from multiple sources, including the general public, individual estates, and grants from corporations, foundations, and the federal government.

Your department prepares an annual report of the center’s accomplishments and financial status for the board of directors. It is mostly text with a few charts and tables, all black and white, with a simple cover. It is voluminous and pretty
dry reading. It is inexpensive to produce other than the effort to pull together the content, which requires time to request and expedite information from the center’s other departments.

At the last board meeting, the board members suggested the annual report be “upscaled” into a document that could be used for marketing and promotional purposes. They want you to mail the next annual report to the center’s various stakeholders, past donors, and targeted high-potential future donors. The board feels that such a document is needed to get the center “in the same league” with other large not-for-profit organizations with which it feels it competes for donations and funds. The board feels that the annual report could be used to inform these stakeholders about the advances the center is making in its research efforts and its strong fiscal management for effectively using the funding and donations it receives.

You will need to produce a shorter, simpler, easy-to-read annual report that shows the benefits of the center’s research and the impact on people’s lives. You will include pictures from various hospitals, clinics, and long-term care facilities that are using the results of the center’s research. You also will include testimonials from patients and families who have benefited from the center’s research. The report must be “eye-catching.” It needs to be multicolor, contain a lot of pictures and easy-to-understand graphics, and be written in a style that can be understood by the average adult potential donor.

This is a significant undertaking for your department, which includes three other staff members. You will have to contract out some of the activities and may have to travel to several medical facilities around the country to take photos and get testimonials. You will also need to put the design, printing, and distribution out to bid to various contractors to submit proposals and prices to you. You estimate that approximately five million copies need to be printed and mailed.

It is now April 1. The board asks you to come to its next meeting on May 15 to present a detailed plan, schedule, and budget for how you will complete the project. The board wants the annual report “in the mail” by November 15, so potential donors will receive it around the holiday season when they may be in a “giving mood.” The center’s fiscal year ends September 30, and its financial statements should be available by October 15. However, the nonfinancial information for the report can start to be pulled together right after the May 15 board meeting.

Fortunately, you are taking a project management course in the evenings at the local university and see this as an opportunity to apply what you have been learning. You know that this is a big project and that the board has high expectations. You want to be sure you meet their expectations, and get them to approve the budget that you will need for this project. However, they will only do that if they are confident that you have a detailed plan for how you will get it all done. You and your staff have six weeks to prepare a plan to present to the board on May 15. If approved, you will have six months, from May 15 to November 15, to implement the plan and complete the project.

Your staff consists of Grace, a marketing specialist; Levi, a writer/editor; and Lakysha, a staff assistant whose hobby is photography (she is going to college part-time in the evenings to earn a degree in photojournalism, and has won several local photography contests).
CASE QUESTIONS
You and your team need to prepare a plan to present to the board. You must:

1. Establish the project objective, and make a list of your assumptions about the project
2. Develop a work breakdown structure
3. Prepare a list of the specific activities that need to be performed to accomplish the project objective
4. For each activity, assign the person who will be responsible
5. Create a network diagram that shows the sequence and dependent relationships of all the activities.

Note: This case study will continue in Chapters 5 through 8, so save the results of your work.

GROUP ACTIVITY
Divide the course participants into groups of four, with the people in each group assuming the role of Alexis, Grace, Levi, or Lakysha. Then address each of the steps listed above.

CASE STUDY 2 The Wedding
Tony and Peggy Sue graduated from a university in Texas last May. She received a degree in elementary education, and he graduated from the culinary school. They both now work in the Dallas area. Peggy Sue teaches, and Tony is a chef at a resort hotel restaurant.

It is Christmas Day and Tony asks Peggy Sue to get marry him. She excitedly accepts. They set a wedding date of June 30.

Tony is from New York City. He is the only son of “Big Tony” and Carmella. He is known as “Little Tony” to his family. He has three younger sisters, none of whom are yet married. The family owns a restaurant called Big Tony’s, and all four children have worked in the restaurant since they were young. They have a large extended family with many relatives, most of whom live in New York City. They also have many friends in the neighborhood.

Peggy Sue is from Cornfield, Nebraska. She is the youngest of four sisters. She and her sisters worked on the family farm when they were young. Her mother, Mildred, now lives alone in the family farmhouse and leases the farmland to a neighboring farmer. Peggy Sue’s sisters all married local men and all live in Cornfield. All of their weddings were small (about 50 people), simple, and pretty much the same. Mildred has the wedding plans down to almost a standard operating procedure—9:00 A.M. ceremony at the small church, followed by a buffet brunch in the church hall, and that is about it. They really could not afford much more elaborate weddings because the income from the farm had been pretty meager. Peggy Sue’s sisters did not go to college, and she had to take out loans to pay for her college expenses.

Tony and Peggy Sue decide to call home and announce the good news about their engagement and the forthcoming wedding.

Tony calls home and tells his mom, Carmella, the news. She replies, “That’s great, honey! I’ve been waiting for this day. I can’t believe my little baby is getting married. I’m so excited. We’re going to have the biggest, best wedding ever. All our friends
and family will come to celebrate. We’ll probably have 300 people. And, of course, we’ll have the reception at our restaurant; the banquet room should be big enough. I’ll tell your cousin Vinnie that you want him to be best man. You grew up together, although you haven’t seen much of each other since you went off to college in Texas. I’ll call Aunt Lucy as soon as we’re done talking and tell her that we want her little Maria and Teresa to be flower girls and little Nicky to be ring bearer. And, oh, I almost forgot the most important thing—your sisters, they’ll all be bridesmaids. I already know what color their gowns will be—a deep rose; they’ll be gorgeous. And sweetie, I didn’t ask your papa yet, but I know he’ll agree with me—on Monday, I’m going to call my friend Francine, the travel agent, and get two tickets for you for a two-week honeymoon in Italy. You’ve never been there, and you must go. It will be a gift from your papa and me. And tell Peggy Lee or Peggy Susie or whatever congratulations. We are so happy for both of you. It’s your wedding, and I don’t want to interfere. I’ll just be here to help. You know what I’m saying. So, my little Tony, whatever you want me to do, you just tell me. And one more thing, I’ll see Father Frank after Mass on Sunday and tell him to mark his calendar already for a two o’clock ceremony on June 30. Goodbye, my big boy. I’ll tell Papa you called. And I can’t wait to start telling everybody to get ready to party on June 30."

Peggy Sue also calls her mom to tell her the news about the upcoming wedding. Mildred responds, “That’s wonderful, dear. I’m glad you’re finally getting married. You waited so long with going off to college and everything. I’ll start getting everything ready. I know how to do this in my sleep by now. I’ll mention it to Reverend Johnson after Sunday service. I’ll tell your sisters to expect to be bridesmaids again in keeping with the family tradition. I guess Holley will be the matron of honor; it’s her turn. By the way, she’s expecting her third child probably right around the same time as your wedding, but I don’t think that will matter. Well, I guess pretty soon you’ll be having babies of your own, like all your sisters. I’m glad you are finally settling down. You should really be thinking about moving back home, now that you are done with college. I saw Emma Miller, your second-grade teacher, at the grocery store the other day. She told me she is retiring. I told her you would be excited to hear that and probably want to apply for her job.”

“She said she didn’t think they would have too many people applying so you would have a good chance. You could move in with me. The house is so big and lonely. There is plenty of room, and I can help you watch your babies. And your boyfriend, Tony—isn’t he a cook or something? I’m sure he could probably get a job at the diner in town. Oh dear, I’m so happy. I’ve been praying that you would come back ever since you left. I’ll tell all your sisters the news when they all come over for family dinner tonight. It won’t be long before we’re all together again. Goodbye, my dear, and you be careful in that big city.”

Tony and Peggy Sue start discussing their wedding. They decide they want a big wedding—with their families and friends, including a lot of their college friends. They want an outdoor ceremony and outdoor reception, including plenty of food, music, and dancing into the night. They are not sure how much it will cost, though, and realize Peggy Sue’s mother cannot afford to pay for the wedding, so they will have to pay for it themselves. Both Tony and Peggy Sue have college loans to pay back, but they hope that the money gifts they get from the wedding guests will be enough to pay for the wedding expenses and maybe have some left over for a honeymoon.

It is now New Year’s Day, and Tony and Peggy Sue decide to sit down and start laying out the detailed plan of all the things they need to do to get ready for their wedding.
CASE QUESTIONS

1. Make a list of assumptions that will be used as the basis for planning the wedding. And no, it is not acceptable to assume that Tony and Peggy Sue will just elope, no matter how tempting that may be!
2. Develop a work breakdown structure.
3. Make a list of the specific activities that need to be done between now and the wedding day.
4. For each activity, identify the person (Tony, Peggy Sue, etc.) who will be responsible for seeing that the activity is accomplished.
5. Create a network diagram that shows the sequence and dependent relationships of all the activities.

Note: This case study will continue in Chapters 5 through 8, so save the results of your work.

GROUP ACTIVITY

Divide the course participants into groups of three or four, then address each of the steps listed above.

REFERENCES

Microsoft Project

Microsoft Project is the most widely used project management software system in the business environment today. It is powerful, easy to use, and available at a very reasonable price. A free trial version is included with new copies of this text. In this appendix, we will briefly discuss how Microsoft Project can be used to support the techniques discussed in this chapter, based on the consumer market study example.

Becoming oriented with the Microsoft Project 2010 environment: Open Microsoft Project 2010. Notice the Gantt Chart View and the Task ribbon in the main workspace. If you do not see Gantt Chart Tools above Format in the Menu or the Task ribbon, click on Task to open the Task ribbon, then in the Tasks View group, click Gantt Chart. Above the main workspace are the ribbons for Task, Resource, View, and Format. To view any of the ribbons, click on the tab with the ribbon’s name. To the left of the ribbon titles is the File tab, which contains links to Microsoft Office Online in the Help link, a list of the previously opened Microsoft Project files, and options to save or print the current project or to begin a New Project.

A quick link to Microsoft Online is available in the upper right corner of the project window as a Question Mark button. The Format ribbon changes to include groups related to the view selected. The Gantt Chart Tools Format ribbon contains Format, Columns, Bar Styles, Gantt Chart Style, Show/Hide, and Drawings groups with selections that format the Gantt Chart. The Resource Usage Tools Format ribbon contains Format and Columns groups that format the Resource Usage chart.

Visit Microsoft Office Online for online tutorials and more: If you have not already explored Microsoft Office Online, set aside some time to do so. There you will find tutorials, tips, templates, news, and other valuable information about Microsoft Project 2010. The link to Microsoft Office Online is provided in the Help link on the File tab or as the quick link on the project window as a Question Mark button.

Let’s begin building the Consumer Market Study Project:

The Consumer Market Study project will continue through Chapter 7. In this appendix, you will enter the work breakdown structure in a hierarchical indented list format, determine predecessors for tasks, assign responsibility for each activity, and create the network diagram.

On the File tab, click New to begin a new project. Then, from the available templates, select Blank Project and click on Create. Save the file as Consumer Market Study by clicking on the File tab and the Save As link.
First, set some properties to describe the project file. On the File tab, click on the Info link. On the right side of the page will be the name Project Information with a drop-down arrow. Click on Project Information. Two choices will appear in a pop-up window: Advanced Properties and Project Statistics. Click on Advanced Properties. In the Advanced Properties window, click on the Summary tab and enter “Consumer Market Study” as the title, as shown in Figure 4A.1. You can enter other information, such as Subject, Author, Manager, Company, and other related comments. Click on OK to save, and close the Advanced Properties window.

You also need to enter time-related information so that the software can automatically build project schedules and calculate costs.

On the Project ribbon, click on the Project Information link in the Properties group to view the Project Information window, and enter the Start date: Mon 1/9/12, as in Figure 4A.2. Click on OK to close the Project Information window.

Click on the Task ribbon to display the Task ribbon tools. You should see the Gantt Chart View with the Entry Table on your screen. Here you will enter the project title and the names for the work packages and their activities into the Task Name column on the level at which you want to monitor and control the budget, and can collect data on actual costs and the value of the work completed during the performance of the project. Please refer to Figure 4A.3 for the title and names to enter.
After you enter a name, notice the Task Mode column has questions about the type of Task Mode automatically entered. Leave these as the default values for now.

You can easily create subsets of the work packages and their activities. In the Task ribbon in the Schedule group, you should see two green arrows. You can use these arrows to create subtasks and to bring a task to a higher level of organization. Highlight the row you want to indent. Click the green arrow to the right once to indent the work packages. Notice that all the highlighted row’s subtasks will indent, too. Clicking the left green arrow will move the entry and the entry’s subtasks to a higher level. Adjust the entries with the arrows to show the work breakdown structure, as shown in Figure 4A.3.
Next, you will enter the predecessor data directly into the Predecessor column to show dependencies among the activities for the work packages. Please see Figure 4A.4 for this data. Each row has a task number along the left column. You will use this number to identify the task for the dependencies. For example, Task 4 is the predecessor for Task 5 or, in other words, Task 5 is dependent on the completion of Task 4. If a task has more than one predecessor, use a comma to separate the task number entries.

The Consumer Market Study project team consists of Susan, Steve, Andy, and Jim. You can show who will perform each activity by entering the name in the Resource Name column for the activity in the Entry Table. Please refer to Figure 4A.5 for name–activity assignments in this exercise. Names are assigned to the activities to monitor and control the project’s budget and collect data for the actual costs and performance. Names assigned to a work package will cue Microsoft Project to assign costs and time to the work package in addition to its activities and
are likely to result in incorrect reports for the project’s costs and workers’ performance.

To view the network diagram shown in Figure 4A.6, on the Task ribbon, click on the View group down arrow and select Network Diagram.

Saving a project with a baseline plan before the project starts is highly recommended so that you can compare actual progress versus planned progress once the project has started. To set a baseline, click on the Project ribbon and select Set Baseline in the Schedule group, as shown in Figure 4A.7. Click OK after making your choice in the Set Baseline window. You can also use this tool to clear a baseline. It is helpful to save your project as you work. To save your project information, on the File tab, click on Save.
FIGURE 4A.5 Resources

FIGURE 4A.6 Network Diagram
FIGURE 4A.7  Set Baseline for Project
Developing the Schedule

Concepts in this chapter support the following Project Management Knowledge Areas of A Guide to the Project Management Body of Knowledge (PMBOK® Guide):

- Project Integration Management
- Project Time Management

REAL WORLD PROJECT MANAGEMENT

**Cost Contingencies, Development Basis, and Project Application**

Large or major transit projects involve capital investment in three primary types of projects: new and replacement buses and facilities, modernization of existing rail systems, and new fixed guideway systems. The cost contingencies on these projects
vary by the type and the level of information available at the start of the planning phase for the projects. The presence of a cost contingency is not a rationale for not having accurate planning, schedule development, and cost estimates for the project.

Cost contingencies are used for estimation and accounting of the probable costs and changes to scope of the project due to uncertainties. Each cost item and major schedule task is assigned an estimation of the contingency. Schedule delays and schedule risks are identified and assigned a time value in the project schedule. Stakeholder input helps refine the project definition to reduce the uncertainty in the schedule estimates. At the beginning of the project, the contingencies are at their largest; they decrease as the project moves forward.

The Federal Transit Authority staff examined the project scope and budgets for 28 transit projects. They measured the schedule delays using a cost method and found an average cost increase of 7.9 percent due to schedule delays. Six of the projects had no or minor project delays and had little or no cost impacts from their delays. Nearly half of the projects had less than 10 percent of their budgets in increased costs due to schedule delays. Only two projects had large cost impacts due to delays, each close to a 20 percent increase.

Project management teams used historical experience to estimate the planning and the phases of the projects and to develop the work breakdown structure. The historical results provided guidelines for potential delays and their resulting costs. The key reasons identified for the 28 transit projects’ development delays were third-party reviews of the project, unanticipated mitigation requirements, stakeholder and public input, and transitions between the project phases. Management of the critical path sequence and the functional operation of the scheduling process were not very often found to be causes for project schedule delays.

The $4.6 billion Los Angeles Redline transit projects experienced $385 million in cost increases due to schedule delays. The increased costs were caused by inflation. Imagine the transit work that could be completed with the funds associated with these schedule delays. Eleven of the 28 projects evaluated cost less than the increased costs on these three projects.

As the project teams continue to use historical information to help guide their planning and schedule development, the Federal Transit Authority is mapping project risks to project schedules, work breakdown structures, and cost accounts to help supply quantitative and qualitative analysis to the estimation of scheduling contingencies. The consistent overrun of large-scale transit projects is not an acceptable method of business. Control and management of schedules are far better alternatives to manage these cost contingencies.

People and businesses that use these transit project outcomes may never know who the project managers were that made it all possible. If the project managers can work to accomplish no or few delays, the people and businesses can use the routes sooner!


The previous chapter discussed what work needs to be done in terms of scope and deliverables. It also discussed how that work will get done by defining specific activities and arranging them in a sequence of dependent relationships to create a network plan. This network plan is a roadmap for how all the activities fit together to accomplish the project work scope and objective. When network planning techniques are used, the scheduling function depends on the planning function. A schedule is a timetable for the plan and, therefore, cannot
be established until the network-based plan has been created. In this chapter, we will develop a schedule for that plan. This chapter deals with estimating the resources and durations for all the specific activities, and developing a detailed project schedule that determines when each activity should start and finish.

This chapter also discusses monitoring and controlling the progress of the project, replanning, and updating the project schedule. Once a project actually starts, it is necessary to monitor progress to ensure that everything is going according to schedule. This involves measuring actual progress and comparing it to the schedule. If at any time during the project it is determined that the project is behind schedule, corrective action must be taken to get back on schedule, which may be very difficult if a project gets too far behind.

The key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis and taking any needed corrective action immediately. A project manager cannot simply hope that a problem will go away without corrective intervention—it will not. Based on actual progress and on consideration of other changes that may occur, an updated project schedule can be generated regularly that forecasts whether the project will finish ahead of or behind its required completion time. You will become familiar with

- Estimating the resources required for each activity
- Estimating the duration for each activity
- Establishing the estimated start time and required completion time for the overall project
- Calculating the earliest times at which each activity can start and finish, based on the project estimated start time
- Calculating the latest times by which each activity must start and finish in order to complete the project by its required completion time
- Determining the amount of positive or negative slack between the time each activity can start or finish and the time it must start or finish
- Identifying the critical (longest) path of activities
- Performing the steps in the project control process
- Determining the effects of actual schedule performance on the project schedule
- Incorporating changes into the schedule
- Developing an updated project schedule
- Determining approaches to controlling the project schedule

**LEARNING OUTCOMES**

After studying this chapter, the learner should be able to:

- Estimate the resources required for activities
- Estimate the duration for an activity
- Determine the earliest start and finish times for activities
- Determine the latest start and finish times for activities
- Explain and determine total slack
- Prepare a project schedule
- Identify and explain the critical path
- Discuss the project control process
- Develop updated schedules based on actual progress and changes
- Discuss and apply approaches to control the project schedule
Estimate Activity Resources

It is necessary to estimate the types and quantities of resources that will be required to perform each specific activity in order to subsequently estimate how long it will take to perform the activity. Resources include people, materials, equipment, facilities, and so forth. The estimated resources required for an activity will influence the estimated duration to perform the activity.

When estimating resources for activities, the availability of each resource has to be taken into account. It is important to know what types of resources are available, in what quantities, and during what time periods to determine if the right types of resources will be available in sufficient quantities during the time periods that the project requires. For example, a project for a new building requires architects and engineers during the design phase at the front end of the project, and then requires crafts- and tradespeople during the construction phase. So the architect-engineering firm needs to have architects and engineers available when they will be needed to design the new office building. If they will not be available because they are assigned to work on other projects, it could delay the design of the office building or may require outsourcing the design activities to a subcontractor. When considering the availability of resources, it may be necessary to make some assumptions, such as the ability to hire additional individuals with the appropriate expertise in time for when they will be required to work on a project. For example, a project to develop a new information system to track product recalls may require more software developers than are currently available on staff. So when resources are estimated for specific software development activities, it may be determined that a certain quantity of software developers are required, along with the assumption that additional developers will be hired and available by the time they are required.

With an understanding of the availability of the types and quantities of various resources during the periods the project will be performed, it is necessary to estimate the types and quantities of resources required to perform each specific activity. In many cases, especially for smaller projects, most activities involve people resources—that is, the members of the project team who may be utilized full time or part time during the project. For example, it is estimated that four painters are needed to paint the interior of a new house. If four painters are not available during the period they will be needed, then some of the painters may have to work extra hours or some of the work may have to be subcontracted. On the other hand, if too many painters are estimated, it would cause a problem of inefficiency because they would be bumping into each other, or they might have an excessive amount of idle time. In addition to people resources, specific activities may also require an estimate of equipment resources, such as the types and quantities of earth-moving equipment required to clear the land for an expansion of a school building. Similarly, there may be specific activities that require an estimate of materials or supplies needed for performing an activity, such as the lumber needed to frame a house, or the shingles needed to install a roof, or the furniture needed to be installed at a new day care center. Sometimes, estimating the types and quantities of materials that will be required for a specific activity provides an opportunity or reminder to include some related activities that may have been unintentionally forgotten when the specific activities were defined for a work package. In the case of the furniture, maybe the materials estimate was for the activity to install furniture, but then it was realized that several other preceding activities associated with the furniture had been left out,
including requesting bids or quotes for the furniture, reviewing proposals, and ordering the furniture, as well as the supplier’s task of making and/or delivering the furniture.

The estimated types and quantities of resources required for an activity together with the availability of those resources will influence the estimated duration for how long it will take to perform the activity.

When estimating the types and quantities of resources required for each specific activity, it is valuable to involve a person who has expertise or experience with the activity to help make the estimate. The estimated activity resources will also be used later for estimating activity costs and determining the project budget. See the section on estimating activity costs in Chapter 7 for further information.

See Chapter 6, Resource Utilization, for further discussion of this topic.

### Estimate Activity Durations

Once the types and quantities of resources are estimated for each activity, estimates can be made for how long it will take to perform each activity. The estimated duration for each activity must be the total elapsed time—the time for the work to be done plus any associated waiting time. In Figure 5.1, for example, the estimated duration for activity 1, “Varnish Floors,” is five days, which includes both the time to varnish the floors and the waiting time for the varnish to dry.

The activity’s estimated duration is shown in the lower right-hand corner of the box.

It is a good practice to have the person who will be responsible for performing a specific activity estimate the duration for that activity. This generates a commitment from that person and avoids any bias that may be introduced by having one person estimate the durations for all of the activities. In some cases, though—such as for large projects that involve several hundred people performing various activities over several years—it may not be practical to have each person estimate activity durations at the beginning of the project. Rather, each organization or subcontractor responsible for a group or type of activities may designate an experienced individual to estimate the durations for all the activities for which the organization or subcontractor is responsible. If an organization or subcontractor has performed similar projects in the past and has kept records of how long specific activities actually took, these historical data can be used as a guide in estimating the durations of similar activities for future projects.

**Reinforce Your Learning**

3. It is necessary to estimate the __________ and __________ of resources required for each activity.

4. True or false: The duration estimate for an activity should include the time required to perform the work plus any associated waiting time.
The estimated duration for an activity must be based on the estimated quantity of resources required to perform the activity. The estimated duration should be aggressive, yet realistic. It should not include time for a lot of things that could possibly go wrong. Nor should it be too optimistically short. It is generally better to be somewhat aggressive and estimate a duration for an activity at five days, say, and then actually finish it in six days, than to be overly conservative and estimate a duration at 10 days and then actually take 10 days. People sometimes perform to expectations—if an activity is estimated to take 10 days, their effort will expand to fill the whole 10 days allotted, even if the activity could have been performed in a shorter time.

Playing the game of inflating estimated durations in anticipation of the project manager negotiating shorter durations is not a good practice. Nor is padding estimates with the vision of becoming a hero when the activities are completed in less time than estimated.

Throughout the performance of the project, some activities will take longer than their estimated duration, others will be done in less time than their estimated duration, and a few may conform to the estimated duration exactly. Over the life of a project that involves many activities, such delays and accelerations will tend to cancel one another out. For example, one activity may take two weeks longer than originally estimated, but this delay may be offset by two other activities that each takes a week less than originally estimated.

It should be noted that at the beginning of the project, it may not be possible to estimate the durations for all activities with a level of confidence regarding their accuracy. This is especially true for longer-term projects. It may be easier to estimate the durations for near-term activities, but as the project progresses, the project team can progressively elaborate the estimated durations as more information is known or becomes clear to allow for more accurate estimated durations.

Figures 5.2 shows the network diagram for a consumer market study, with the estimated durations in days for each activity. A consistent time base, such as hours or days or weeks, should be used for all the estimated durations of activities in a network diagram.

With projects for which there is a high degree of uncertainty about the estimated durations for activities, it is possible to use three time estimates: an optimistic estimate, a pessimistic estimate, and a most likely estimate. For a discussion of this probabilistic technique, see Appendix 1 at the end of this chapter.

Establish Project Start and Finish Times

In order to establish a basis from which to calculate a schedule using the estimated durations for the activities, it is necessary to select an estimated start time and a required completion time for the overall project. These two times (or dates) define the overall window, or envelope, of time in which the project must be completed.

The sponsor or customer often states the project required completion time in the project charter, RFP, or contract—for example, the project must be finished by June 30, the feasibility study must be completed in time for the board meeting on September 30, or the annual reports must be in the mail by January 15.

The contractor, however, may not want to commit to completing the project by a specific date until the customer has approved the contract. In such cases, the contract may state, “The project will be completed within 90 days after signing
of the contract.” Here, the overall project time is stated in terms of a cycle time (90 days) rather than in terms of specific calendar dates.

Assume that the consumer market study project shown in Figure 5.2 must be completed in 130 working days. If we establish the project estimated start time as 0, then its required completion time is day 130.

**Develop Project Schedule**

Once you have an estimated duration for each activity in the network and have established an overall window of time in which the project must be completed, you must determine (based on durations and sequence) whether the project can be done by the required completion time. To determine this, you can develop a project schedule that provides a timetable for each activity and shows:

1. The earliest times (or dates) at which each activity can start and finish, based on the project estimated start time (or date)
2. The latest times (or dates) by which each activity must start and finish in order to complete the project by its required completion time (or date)

**EARLIEST START AND FINISH TIMES**

Given an estimated duration for each activity in the network and using the project estimated start time as a reference, you can calculate the following two times for each activity:
1. Earliest start time (ES) is the earliest time at which a specific activity can begin, calculated on the basis of the project estimated start time and the estimated durations of preceding activities.

2. Earliest finish time (EF) is the earliest time by which a specific activity can be completed, calculated by adding the activity’s estimated duration to the activity’s earliest start time:

\[ \text{EF} = \text{ES} + \text{Estimated Duration} \]

The ES and EF times are determined by calculating forward—that is, by working through the network diagram from the beginning of the project to the end of the project. There is one rule that must be followed in making these forward calculations:

**Rule 1:** The earliest start time for a specific activity must be the same as or later than the latest of all the earliest finish times of all the activities leading directly into that specific activity.

Figure 5.3 shows three activities leading directly into “Dress Rehearsal.” “Practice Skit” has an EF of day 5, “Make Costumes” has an EF of day 10, and “Make Props” has an EF of day 4. “Dress Rehearsal” cannot start until all three of these activities are finished, so the latest of the EFs for these three activities determines the ES for “Dress Rehearsal.” The latest of the three EFs is day 10—the earliest finish time for “Make Costumes.” Therefore, “Dress Rehearsal” cannot start any earlier than day 10. That is, its ES must be day 10 or later. Even though “Practice Skit” and “Make Props” may finish sooner than “Make Costumes,” “Dress Rehearsal” cannot start because the network dependent relationships indicate that all three activities must be finished before “Dress Rehearsal” can start.
Figure 5.4 shows the forward calculations for the consumer market study project. The project estimated start time is 0. Therefore, the earliest “Identify Target Consumers” can start is time 0, and the earliest it can finish is 3 days later (because its estimated duration is 3 days). When “Identify Target Consumers” is finished on day 3, “Develop Draft Questionnaire” starts on day 3 and finishes on day 6. The next activity, “Pilot-Test Questionnaire,” starts on day 6 and finishes on day 10. Since “Develop Draft Questionnaire” and “Pilot-Test Questionnaire” are happening simultaneously, the next activity, “Review Comments & Finalize Questionnaire,” cannot start until day 10. This activity finishes on day 13, allowing “Prepare Mailing Labels” to start on day 13 and finish on day 15. The next activity, “Print Questionnaire,” starts on day 15 and finishes on day 20. Since “Prepare Mailing Labels” and “Print Questionnaire” are happening simultaneously, the next activity, “Develop Data Analysis Software,” cannot start until day 20. This activity finishes on day 32, allowing “Review Comments & Finalize Questionnaire” to be completed. The next activity, “Develop Software Test Data,” starts on day 32 and finishes on day 40.
Draft Questionnaire” can start. It has an estimated duration of 10 days, so its ES is day 3 and its EF is day 13. The calculations of ES and EF for subsequent activities are done similarly, continuing forward through the network diagram.

Look for a moment at “Test Software.” It has an ES of day 50 because, according to Rule 1, it cannot start until the two activities leading directly into it are finished. “Develop Data Analysis Software” does not finish until day 50, and “Develop Software Test Data” does not finish until day 40. Because “Test Software” cannot start until both of these are finished, “Test Software” cannot start until day 50.

As a further illustration of Rule 1, refer once more to Figure 5.4. In order to start “Mail Questionnaire & Get Responses,” the two activities immediately preceding it, “Prepare Mailing Labels” and “Print Questionnaire,” must be finished. The EF of “Prepare Mailing Labels” is day 40, and the EF of “Print Questionnaire” is day 48. According to Rule 1, it is the later of the two EFs, which is day 48, that determines the ES of “Mail Questionnaire & Get Responses.”

If you continue calculating the ES and the EF for each remaining activity in the network diagram in Figure 5.4, you will see that the very last activity, “Prepare Report,” has an EF of day 138. That is 8 days beyond the project required completion time of 130 days. At this point, we know there is a problem.

It should be noted that although the ES and EF times for each activity are shown on the network diagram in Figure 5.4, this is not normally the case. Rather, the ES and EF times (and the LS and LF times, which are explained in the following section)
are listed in a separate schedule table, like the one in Figure 5.5. Separating the schedule table from the network logic diagram makes it easier to generate revised and updated schedules (perhaps using project management software), without continually making changes to the ES, EF, LS, and LF times on the network diagram itself.

**LATEST START AND FINISH TIMES**

Given an estimated duration for each activity in the network and using the project required completion time as a reference, you can calculate the following two times for each activity:

1. **Latest finish time (LF)** is the latest time by which a specific activity must be completed in order for the entire project to be finished by its required completion time. It is calculated on the basis of the project required completion time and the estimated durations of succeeding activities.

2. **Latest start time (LS)** is the latest time by which a specific activity must be started in order for the entire project to be finished by its required completion time. It is calculated by subtracting the activity’s estimated duration from the activity’s latest finish time:

   \[ LS = LF - \text{Estimated Duration} \]
The LF and LS times are determined by calculating backward—that is, by working through the network diagram from the end of the project to its beginning. There is one rule that must be followed in making these backward calculations:

**Rule 2:** The latest finish time for a specific activity must be the same as or earlier than the earliest of all the latest start times of all the activities emerging directly from that specific activity.

Figure 5.6 shows two activities emerging directly from “Print Posters & Brochures.” This project is required to be completed by day 30. Therefore, “Distribute Posters” must be started by day 20 because it has an estimated duration of 10 days, and “Mail Brochures” must be started by day 25 because it has an estimated duration of 5 days. The earlier of these two LSs is day 20. Therefore, the latest that “Print Posters & Brochures” can finish is day 20, so that “Distribute Posters” can start by day 20. Even though “Mail Brochures” does not have to start until day 25, “Print Posters & Brochures” must finish by day 20 or else the whole project will be delayed. If “Print Posters & Brochures” does not finish until day 25, then “Distribute Brochures” will not be able to start until day 25. Because “Distribute Brochures” has an estimated duration of 10 days, it will not finish until day 35, which is 5 days beyond the project required completion time.

Figure 5.7 shows the backward calculations for the consumer market study project. The required completion time for the project is 130 working days. Therefore, “Prepare Report,” the last activity, can finish is day 130, and the latest that it can start is day 120 because its estimated duration is 10 days. In order for “Prepare Report” to start on day 120, the latest that “Analyze Results” can finish is day 120. If the LF for “Analyze Results” is day 120, then its LS is day 112 because its estimated duration is 8 days. The calculations of LF and LS for prior activities are done similarly, continuing backward through the network diagram.

Look at “Review Comments & Finalize Questionnaire.” In order for the four activities emerging from this activity to start by their LS times (so that the project can finish by its required completion time of 130 days), “Review Comments & Finalize Questionnaire” must be finished by the earliest LS of all four activities, according to Rule 2. The earliest of the four LSs is day 30, the latest time by which “Print Questionnaire” must start. Therefore, the latest that “Review Comments & Finalize Questionnaire” can finish is day 30.

If you continue calculating the LF and the LS for each activity in the network diagram in Figure 5.7, you will see that the very first activity, “Identify Target

---

**Reinforce Your Learning**

12. The latest finish and latest start times are determined by calculating backward through the network diagram.

13. Refer to Figure 5.7. What are the latest finish and latest start times for “Input Response Data”?

14. What determines a particular activity’s latest finish time?
Consumers,” has an LS of −8! This means that in order to complete the entire project by its required completion time of 130 days, the project must start 8 days earlier than it is estimated to start. Note that this difference of 8 days is equal to the difference we got when calculating forward through the network diagram to obtain the ES and EF times. In essence, what we have found is that this project may take 138 days to complete, even though its required completion time is 130 days.

Like the earliest start and earliest finish times, the latest start and latest finish times are usually not shown on the network diagram itself, but rather in a separate schedule table as shown in Figure 5.8.

**TOTAL SLACK**

In the consumer market study project, there is a difference of eight days between the calculated earliest finish time of the very last activity (“Prepare Report”) and the project required completion time. This difference is the total slack (TS), sometimes called float. When the total slack is a negative number, as in this example, it indicates a lack of slack over the entire project.

If total slack is positive, it represents the maximum amount of time that the activities on a particular path can be delayed without jeopardizing completion of the project by its required completion time. On the other hand, if total slack is negative, it represents the amount of time that the activities on a particular path...
must be accelerated in order to complete the project by its required completion time. If total slack is zero, the activities on the path do not need to be accelerated but cannot be delayed.

The total slack for a particular path of activities is common to and shared among all the activities on that path. Consider the example below.

The earliest the project can finish is day 15 (the sum of the estimated durations of the three activities, $7 + 5 + 3$). However, the required completion time for the project is 20 days. The three activities on this path can therefore be delayed up to 5 days without jeopardizing completion of the project by the required time. This does not mean that each activity on the path can be delayed 5 days (because this would create a total delay of 15 days); rather, it means that all the activities that make up the path can have a total delay of 5 days.

Reinforce Your Learning
15. When a project has a positive total slack, some activities can be ______________ without jeopardizing completion of the project by its required completion time. When a project has negative total slack, some activities need to be ______________ in order to complete the project by its required completion time.

The total slack for a particular path of activities is common to and shared among all the activities on that path. Consider the example below.
delay of 5 days among them. For example, if “Remove Old Wallpaper” actually takes 10 days (3 days longer than the estimated duration of 7 days), then it will use up 3 of the 5 days of total slack, and only 2 days of total slack will remain.

Total slack is calculated by subtracting the activity’s earliest finish (or start) time from its latest finish (or start) time. That is, the slack is equal to either the latest finish time (LF) minus the earliest finish time (EF) for the activity, or the latest start time (LS) minus the earliest start time (ES) for that activity. The two calculations are equivalent.

\[
\text{Total Slack} = \text{LF} - \text{EF}, \text{ or } \text{Total Slack} = \text{LS} - \text{ES}
\]

**CRITICAL PATH**

Not all networks are as simple as the one just used to illustrate total slack. In large network diagrams, there may be many paths of activities from the project start to the project completion, just as there are many routes you can choose from to get from New York City to Los Angeles. If 20 friends were going to leave at the same time from New York City and each was going to drive a different route to Los Angeles, they could not get together for a party in Los Angeles until the last person had arrived—the one who took the longest (most time-consuming) route. Similarly, a project cannot be completed until the longest
The longest path of activities is finished. This longest path in the overall network diagram is called the **critical path**.

One way to determine which activities make up the critical path is to find which ones have the least slack. Subtract the earliest finish time from the latest finish time for each activity (or subtract the earliest start time from the latest start time—both calculations will result in the same value), and then look for all the activities that have the lowest value (either least positive or most negative). All the activities with this value are on the critical path of activities.

The values of total slack for the consumer market study project are shown in Figure 5.9. The lowest value is –8 days. The activities that have this same value of total slack make up the path 1–2–3–4–6–9–11–12–13. These nine activities comprise the critical, or most time consuming, path. The estimated durations of the activities on this path add up to 138 days (3 + 10 + 20 + 5 + 10 + 65 + 7 + 8 + 10). Among them, these activities need to be accelerated 8 days in order to complete the project by its required completion time of 130 days. Figure 5.10 highlights the activities that make up the critical path.

To eliminate the –8 days of slack, the estimated durations of one or more activities on this critical path need to be reduced. Suppose we reduce the estimated duration of “Mail Questionnaire & Get Responses” from 65 days to 55 days by reducing the time respondents are given to return the questionnaire.

---

**FIGURE 5.9** Schedule for Consumer Market Study Project, Showing Total Slack Values

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Identify Target Consumers</td>
<td>Susan</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>–8</td>
<td>–8</td>
</tr>
<tr>
<td>2 Develop Draft Questionnaire</td>
<td>Susan</td>
<td>10</td>
<td>3</td>
<td>13</td>
<td>–5</td>
<td>–8</td>
</tr>
<tr>
<td>3 Pilot-Test Questionnaire</td>
<td>Susan</td>
<td>20</td>
<td>13</td>
<td>33</td>
<td>5</td>
<td>–8</td>
</tr>
<tr>
<td>4 Review Comments &amp; Finalize Questionnaire</td>
<td>Susan</td>
<td>5</td>
<td>33</td>
<td>38</td>
<td>25</td>
<td>30</td>
</tr>
<tr>
<td>5 Prepare Mailing Labels</td>
<td>Steve</td>
<td>2</td>
<td>38</td>
<td>40</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>6 Print Questionnaire</td>
<td>Steve</td>
<td>10</td>
<td>38</td>
<td>48</td>
<td>30</td>
<td>–8</td>
</tr>
<tr>
<td>7 Develop Data Analysis Software</td>
<td>Andy</td>
<td>12</td>
<td>38</td>
<td>50</td>
<td>88</td>
<td>100</td>
</tr>
<tr>
<td>8 Develop Software Test Data</td>
<td>Susan</td>
<td>2</td>
<td>38</td>
<td>40</td>
<td>98</td>
<td>60</td>
</tr>
<tr>
<td>9 Mail Questionnaire &amp; Get Responses</td>
<td>Steve</td>
<td>65</td>
<td>48</td>
<td>113</td>
<td>40</td>
<td>105</td>
</tr>
<tr>
<td>10 Test Software</td>
<td>Andy</td>
<td>5</td>
<td>50</td>
<td>55</td>
<td>100</td>
<td>105</td>
</tr>
<tr>
<td>11 Input Response Data</td>
<td>Jim</td>
<td>7</td>
<td>113</td>
<td>120</td>
<td>105</td>
<td>112</td>
</tr>
<tr>
<td>12 Analyze Results</td>
<td>Jim</td>
<td>8</td>
<td>120</td>
<td>128</td>
<td>112</td>
<td>120</td>
</tr>
<tr>
<td>13 Prepare Report</td>
<td>Jim</td>
<td>10</td>
<td>128</td>
<td>138</td>
<td>120</td>
<td>130</td>
</tr>
</tbody>
</table>

Reinforce Your Learning

17. The longest path of activities from the beginning to the end of a project is called the __________ path.
Because the estimated duration of an activity on the critical path is being reduced by 10 days, the total slack changes from −8 days to +2 days. The revised estimated duration of 55 days can be used to prepare a revised project schedule, as shown in Figure 5.11. This schedule shows that the critical path now has a total slack of +2 days, and the project is now estimated to finish in 128 days, which is 2 days earlier than the required completion time of 130 days.

As stated earlier, a large network diagram can have many paths or routes from its beginning to its end. Some of the paths may have positive values of total slack; others may have negative values of total slack. Those paths with positive values of total slack are sometimes referred to as noncritical paths, whereas those paths with zero or negative values of total slack are referred to as critical paths. The longest path is often referred to as the most critical path.

It is not unusual that the initial project schedule that is developed may have negative total slack, and it may then take several iterations of revising the estimated resources and estimated durations of specific activities and/or changing the sequence or dependent relationships among activities to arrive at an acceptable baseline schedule.

Sometimes the project team or contractor reacts to the project required completion date by force-fitting the schedule to meet the project required end date by arbitrarily reducing the estimated durations of specific activities and convincing themselves that somehow (by luck) the activities will get done in the reduced amount of time. Then, when the project does not get completed on time, they seem astonished! Instead, they should develop a realistic schedule, then deter-
mine how much negative total slack there is based on the customer’s required completion date. At that point, they can rationally determine how to reduce the negative slack to come up with an acceptable schedule that meets the project required completion date. This is done by making decisions about how to reduce the estimated durations of specific activities on the paths with negative slack. This may mean making trade-off decisions to add more resources; working overtime; subcontracting certain tasks; reducing scope/specifications; replacing some resources with higher-cost, more experienced resources; etc. As a last resort, it may mean going back to the sponsor or customer and asking for an extension of the project required completion date, for more money for the extra resources to accelerate the schedule, or for approval to reduce scope. It is better to inform the customer early in the project rather than surprising him or her later. It is important to manage the customer’s expectations.

**FREE SLACK**

Another type of slack that is sometimes calculated is **free slack (FS)**, which is the amount of time a specific activity can be postponed without delaying the earliest start time of its immediately succeeding activities. It is the relative difference between the amounts of total slack for activities entering into the same activity. Free slack is calculated by finding the lowest of the values of total slack for all the activities entering into a specific activity and then subtracting it from the values of total slack for the other activities also entering into that same activity. Because free slack is the relative difference between values of total slack for activities
entering into the same activity, it will exist only when two or more activities enter into the same activity. Also, because free slack is a relative difference between values of total slack, it is always a positive value.

For an illustration of free slack, consider Figures 5.9 and 5.10. In the network diagram in Figure 5.10, there are three instances where a particular activity has more than one activity entering into it:

- Activity 9, “Mail Questionnaire & Get Responses,” has activities 5 and 6 entering into it.
- Activity 10, “Test Software,” has activities 7 and 8 entering into it.
- Activity 11, “Input Response Data,” has activities 9 and 10 entering into it.

In the schedule in Figure 5.9, the values of total slack for activities 5 and 6 are 0 and −8 days, respectively. The lesser of these two values is −8 days for activity 6. The free slack for activity 5 is the relative difference between its total slack, 0, and −8. This relative difference is 8 days: 0 − (−8) = 8 days. This means that activity 5, “Prepare Mailing Labels,” already has a free slack of 8 days and can slip by up to that amount without delaying the earliest start time of activity 9, “Mail Questionnaire & Get Responses.”

Similarly, the values of total slack for activities 7 and 8 are 50 and 60 days, respectively. The lesser of these two values is 50 days. Therefore, activity 8, “Develop Software Test Data,” has a free slack of 10 days (60 − 50 = 10) and can slip by up to that amount without delaying the earliest start time of activity 10, “Test Software.”

**FIGURE 5.11 Revised Schedule for Consumer Market Study Project**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Start Finish</td>
<td>Start Finish</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Identify Target Consumers</td>
<td>Susan</td>
<td>3 0 3</td>
<td>2 5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Develop Draft Questionnaire</td>
<td>Susan</td>
<td>10 3 13</td>
<td>5 15</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Pilot-Test Questionnaire</td>
<td>Susan</td>
<td>20 13 33</td>
<td>15 35</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Review Comments &amp; Finalize Questionnaire</td>
<td>Susan</td>
<td>5 33 38</td>
<td>35 40</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Prepare Mailing Labels</td>
<td>Steve</td>
<td>2 38 40</td>
<td>48 50</td>
<td>10</td>
<td></td>
</tr>
<tr>
<td>Print Questionnaire</td>
<td>Steve</td>
<td>10 38 48</td>
<td>40 50</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Develop Data Analysis Software</td>
<td>Andy</td>
<td>12 38 50</td>
<td>88 100</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Develop Software Test Data</td>
<td>Susan</td>
<td>2 38 40</td>
<td>98 100</td>
<td>60</td>
<td></td>
</tr>
<tr>
<td>Mail Questionnaire &amp; Get Responses</td>
<td>Steve</td>
<td>55 48 103</td>
<td>50 105</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Test Software</td>
<td>Andy</td>
<td>5 50 55</td>
<td>100 105</td>
<td>50</td>
<td></td>
</tr>
<tr>
<td>Input Response Data</td>
<td>Jim</td>
<td>7 103 110</td>
<td>105 112</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Analyze Results</td>
<td>Jim</td>
<td>8 110 118</td>
<td>112 120</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>Prepare Report</td>
<td>Jim</td>
<td>10 118 128</td>
<td>120 130</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>
BAR CHART FORMAT

Network-based planning and scheduling techniques are often compared to another somewhat familiar tool known as a bar chart, sometimes referred to as a Gantt chart. This is an older planning and scheduling tool; however, it remains popular because of its simplicity.

Figure 5.12 shows a bar chart for the consumer market study. Activities are listed on the left-hand side, and a time scale is shown along the bottom. The estimated duration for each activity is indicated by a bar spanning the period during which the activity is expected to be accomplished. A column that indicates who is responsible for each task can be added to the chart.

Project management software can automatically generate a time-scaled bar chart from the schedule table that is based on the network diagram. These bar charts can display arrows that connect the bars to show the dependent relationships among the activities. The bar chart can be based on the earliest start and finish times or on the latest start and finish times. Figure 5.12 is a bar chart based on the ES and EF times in Figure 5.9.

However, bar charts are sometimes used instead of a network-based schedule. This has a shortcoming. When using only a bar chart for scheduling, without first creating a network-based schedule, the planning and scheduling of activities

**FIGURE 5.12  Bar Chart for Consumer Market Study Project**
is done simultaneously. The person draws the activity bars proportionate to the estimated durations for each activity and must be aware of the dependent relationships among the activities—that is, which activities must be finished before others can start and which activities can be performed concurrently. A major drawback of using only a traditional bar chart is that it does not graphically display those dependent relationships of activities. Therefore, it is not obvious which activities will be affected when a given activity is delayed.

Project Control Process

Figure 5.13 illustrates the steps in the project control process. It starts with establishing a baseline plan that shows how the project scope will be accomplished on schedule and within budget. Once this baseline plan is agreed upon by the customer and the contractor or project team, the project work can be performed. Then it is necessary to monitor the progress to ensure that everything is going according to the plan. The project control process involves regularly gathering data on project performance, comparing actual performance to planned performance, and taking corrective action immediately if actual performance is behind planned performance. This process must occur regularly throughout the project.

A regular reporting period should be established for comparing actual progress with planned progress. Reporting may be daily, weekly, biweekly, or monthly, depending on the complexity or overall duration of the project. If a project is expected to have an overall duration of a month, the reporting period might be as short as a day. On the other hand, if a project is expected to run five years, the reporting period might be a month.

During each reporting period, two kinds of data or information need to be collected:

1. Data on actual performance. This includes:
   - The actual time that activities were started and/or finished
   - The actual costs expended and committed
   - The earned value of the work completed

2. Information on any changes to the project scope, schedule, and budget. These changes could be initiated by the customer or the project team, or they could be the result of an unanticipated occurrence.

It should be noted that once changes are incorporated into the plan and agreed upon by the sponsor or customer, a new baseline plan has to be established. The scope, schedule, and budget of the new baseline plan may be different from those of the original baseline plan.

It is crucial that the data and information discussed above be collected in a timely manner and used to calculate an updated project schedule and budget. For example, if project reporting is done monthly, data and information should be obtained as late as possible in that monthly period so that when an updated schedule and budget are calculated, they are based on the latest possible information. In other words, a project manager should not gather data at the beginning of the month and then wait until the end of the month to use it to calculate an updated schedule and budget because the data will be outdated and may cause incorrect decisions to be made about the project status and corrective actions.
Once an updated schedule and budget have been calculated, they need to be compared to the baseline schedule and budget and analyzed for variances to determine whether a project is ahead of or behind schedule and under or over budget. If the project status is okay, no corrective actions are needed; the status will be analyzed again for the next reporting period.

The key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis and taking any needed corrective action immediately.

If it is determined that corrective actions are necessary, however, decisions must be made regarding how to revise the scope, schedule, or the budget. These decisions
often involve a trade-off of scope, time, and cost. For example, reducing the estimated duration of an activity may require either increasing costs to pay for more resources or reducing the scope of the task (and possibly not meeting the customer’s technical requirements). Similarly, reducing project costs may require using materials of a lower quality than originally planned. Once a decision is made on which corrective actions to take, they must be incorporated into the schedule and budget. It is then necessary to calculate a revised schedule and budget to determine whether the planned corrective measures result in an acceptable schedule and budget. If not, further revisions will be needed.

The project control process continues throughout the project. In general, the shorter the reporting period, the better the chances of identifying problems early and taking effective corrective actions. If a project gets too far out of control, it may be difficult to accomplish the project objective without sacrificing the scope, quality, schedule, or budget. There may be situations in which it is wise to increase the frequency of reporting until the project is back on track. For example, if a five-year project with monthly reporting is endangered by a slipping schedule or an increasing budget overrun, it may be prudent to reduce the reporting period to one week in order to monitor the project and the impact of corrective actions more closely.

The project control process is an important and necessary part of project management. Just establishing a sound baseline plan is not sufficient because even the best-laid plans do not always work out. Project management is a proactive approach to controlling a project to ensure that the project objective is accomplished, even when things do not go according to plan.

Effects of Actual Schedule Performance

Throughout a project, some activities will be completed on time, some will be finished ahead of schedule, and others will be finished later than scheduled. Actual progress—whether faster or slower than planned—will have an effect on the schedule of the remaining, uncompleted activities of the project. Specifically, the actual finish times (AFs) of completed activities will determine the earliest start and earliest finish times for the remaining activities in the network diagram, as well as the total slack.

Part (a) of Figure 5.14 is a network diagram for a simple project. It shows that the earliest the project can finish is day 15 (the sum of the estimated durations of the three activities, 7 + 5 + 3). Since the required completion time is day 20, the project has a total slack of +5 days.

Suppose that activity 1, “Remove Old Wallpaper,” is actually finished on day 10, rather than on day 7 as planned, because it turns out to be more difficult than anticipated. See part (b) of Figure 5.14. This means that the earliest start and finish times for activities 2 and 3 will be 3 days later than on the original schedule. Because “Remove Old Wallpaper” is actually finished on day 10, the ES for “Patch Walls” will be day 10 and its EF will be day 15. Following through with the forward calculations, we find that “Put Up New Wallpaper” will have an ES of day 15 and an EF of day 18. Comparing this new EF of the last activity to the required completion time of day 20, we find a difference of 2 days. The total slack got worse—it changed in a negative direction, from +5 days to +2 days. This example illustrates how the actual finish times of activities have a ripple effect, altering the remaining activities’ earliest start and finish times and the total slack.
It is helpful to indicate on the network diagram, in some manner, which activities have been completed. One method is to shade or crosshatch the activity box, as was done in part (b) of Figure 5.14.

**Incorporate Changes into Schedule**

Throughout a project, changes may occur that have an impact on the schedule. As was noted earlier, these changes might be initiated by the customer or the project team, or they might be the result of an unanticipated occurrence. Here are some examples of changes initiated by the customer:

- A home buyer tells the builder that the family room should be larger and the bedroom windows should be relocated.
- A customer tells the project team developing an information system that the system must have the capability to produce a previously unmentioned set of reports and graphics, which requires additional new elements in the database.

These types of changes represent revisions to the original project scope and will have an impact on the schedule and budget. The degree of impact, however, may depend on when the changes are requested. If they are requested early in the project, they may have less impact on schedule and budget than if they are requested later in the project. For example, changing the size of the family room and relocating the bedroom windows would be relatively easy if the house was still being designed and the drawings being prepared. However, if the changes are requested after the framing is put up and the windows are installed, the impact on schedule and budget will be much greater.

When the customer requests a change, the contractor or project team should estimate the impact on the project schedule and budget and then obtain customer approval before proceeding. If the customer approves the proposed revisions to the project schedule and budget, then any additional activities, revised estimated durations, and revised estimated resources and associated costs should be incorporated into the project schedule and budget.

![Figure 5.14 Effect of Actual Finish Times](attachment:figure_5_14.png)
An example of a change initiated by a project team is the decision by a team that is planning a community festival to eliminate all amusement rides for adults because of space limitations and insurance costs. The project plan would then have to be revised to delete or modify all those activities involving adult rides. An example of a change initiated by a project manager would be for a project to develop an automated invoicing system for a customer, who suggests that, rather than develop customized software, the system use standard available software in order to reduce costs and accelerate the schedule.

Some changes involve the addition of activities that may have been overlooked when the original plan was developed. For example, the project team may have forgotten to include activities associated with developing training materials and conducting training for a new information system. Or the customer or contractor may have failed to include the installation of gutters and downspouts in the work scope for the construction of a restaurant.

Other changes become necessary because of unanticipated occurrences, such as a snowstorm that slows down construction of a building, the failure of a new product to pass quality tests, or the untimely resignation of a key member of a project team. These events will have an impact on the schedule and/or budget and will require that the project plan be modified.

Still other changes can result from progressive elaboration of adding more detail as the project moves forward. No matter what level of detail is used in the initial network diagram, there will be activities that can be broken down into greater detail as the project progresses.

Any type of change—whether initiated by the customer, the contractor, the project manager, a team member, or an unanticipated event—will require a modification to the plan in terms of scope, schedule, and/or budget. When such changes are agreed upon, a new baseline plan is established and used as the benchmark against which actual project performance will be compared.

With respect to the project schedule, changes can result in the addition or deletion of activities, resequencing of activities, changes to estimated durations for specific activities, or a new required completion time for the project.

See the section on managing changes in Chapter 10, and the section on track document changes in Chapter 12 for further discussion of managing and controlling changes.

**Update Project Schedule**

Based on actual progress and on consideration of other changes that may occur, an updated project schedule can be generated regularly that forecasts whether the project will finish ahead of or behind its required completion time. Once data have been collected on the actual finish times of completed activities and the effects of any project changes, an updated project schedule can be calculated. These calculations are based on the methodology explained in this chapter:

- The earliest start and finish times for the remaining, uncompleted activities are calculated by working forward through the network, but they are based on the actual finish times of completed activities and the estimated durations of the uncompleted activities.
- The latest start and finish times for the uncompleted activities are calculated by working backward through the network.

---

**Reinforce Your Learning**

24. Changes to the project can affect ________ , ________ , and/or ________.
As an illustration of the calculation of an updated schedule, let us consider the network diagram shown in Figure 5.15 for the consumer market study project. Assume the following:

1. Completed activities:
   a. Activity 1, “Identify Target Consumers,” actually finished on day 2.

2. Project changes:
   a. It was discovered that the database to be used to prepare the mailing labels was not up to date. A new database needs to be purchased before the mailing labels can be prepared. This new database was ordered on day 23. It will take 21 days to get it from the supplier.
   b. A preliminary review of comments from the pilot test of the questionnaire indicates that substantial revisions to the questionnaire are required. Therefore, the duration estimate for activity 4 needs to be increased from 5 days to 15 days.

The network diagram in Figure 5.15 incorporates the above information. Figure 5.16 shows the updated schedule. Note that the total slack for the critical path is now –5 days, instead of the +2 days in the baseline schedule in Figure 5.11. The anticipated project completion time is now day 135, which is beyond the required completion time of 130 days.

**Control Schedule**

Schedule control involves four steps:

1. Analyzing the schedule to determine which areas may need corrective action
2. Deciding what specific corrective actions should be taken
3. Revising the plan to incorporate the chosen corrective actions
4. Recalculating the schedule to evaluate the effects of the planned corrective actions

If the planned corrective actions do not result in an acceptable schedule, these steps need to be repeated.

Throughout a project, each time a schedule is recalculated—whether it is after actual performance data or project changes are incorporated or after corrective actions are planned—it is necessary to analyze the newly calculated schedule to determine whether it needs further revision. The schedule analysis should include identifying the critical path and any paths of activities that have negative slack, as well as those paths where slippages have occurred (the slack got worse) compared with the previously calculated schedule.

A concentrated effort to accelerate project progress must be applied to the paths with negative slack. The amount of slack should determine the priority with which these concentrated efforts are applied. For example, the path with the most negative slack should be given top priority.

Corrective actions that will eliminate the negative slack from the project schedule must be identified. These corrective actions must reduce the estimated durations of activities on the negative-slack paths. Remember, the slack for a path of activities is shared among all the activities on that path. Therefore, a change in the estimated duration of any activity on that path will cause a corresponding change in the slack for that path.

---

**Reinforce Your Learning**

25. In analyzing a project schedule, it is important to identify all the paths of activities that have _______ slack.
When analyzing a path of activities that has negative slack, you should focus on two kinds of activities:

1. *Activities that are near term (that is, in progress or to be started in the immediate future).* It is much wiser to take aggressive corrective action to reduce the estimated durations of activities that will be done in the near term than to plan to reduce the estimated durations of activities that are scheduled sometime in the future. If you postpone until the distant future taking corrective action that will reduce the estimated durations of activities, you may find that the negative slack has deteriorated even further by that time. As the project progresses, there is always less time remaining in which corrective action can be taken.

Looking at Figure 5.16, we can see that it would be better to try to reduce the durations of the near-term activities on the critical path, such as “Review Comments & Finalize Questionnaire” or “Print Questionnaire,” than to put off corrective action until the last activity, “Prepare Report.”

2. *Activities that have long estimated durations.* Taking corrective action that will reduce a 20-day activity by 20 percent (that is, by four days) has a greater impact than totally eliminating a one-day activity. Usually, longer-duration activities present the opportunity for larger reductions.

Look again at Figure 5.16. There may be more opportunity to reduce the 55-day duration estimate for “Mail Questionnaire & Get Responses” by five days (9 percent) than to reduce the shorter estimated durations of other activities on the critical path.
There are various approaches to reducing the estimated durations of activities. One obvious way is to apply more resources to accelerate an activity. This could be done by assigning more people to work on the activity or asking the people working on the activity to work more hours per day or more days per week. Additional appropriate resources might be transferred from concurrent activities that have positive slack. Sometimes, however, adding people to an activity may, in fact, result in the activity taking longer, because the people already assigned to the activity are diverted from their work in order to help the new people get up to speed. Another approach is to assign a person with greater expertise or more experience to perform or help with the activity, in order to get it done in a shorter time than was possible with the less experienced people originally assigned to it.

Reducing the scope or requirements for an activity is another way to reduce its estimated duration. For example, it might be acceptable to put only one coat of paint on a room rather than two coats, as originally planned. In some cases, a decision might be made to totally eliminate some activities, deleting them and their durations from the schedule, such as deciding not to install a fence around the property.

Increasing productivity through improved methods or technology is yet another approach to reducing the estimated durations of activities. For example, instead of having people keyboard data from a customer survey into a computer database, optical scanning equipment might be used.

Once specific corrective actions to reduce the negative slack have been decided on, the estimated durations for the appropriate activities must be revised in the
Then a revised schedule needs to be calculated to evaluate whether the planned corrective actions reduce the negative slack as anticipated.

In most cases, eliminating negative slack by reducing durations of activities will involve a trade-off in the form of an increase in costs or a reduction in scope. (For a further discussion of this topic, see the appendix on Time–Cost Trade-Off at the end of Chapter 7.) If the project is way behind schedule (has substantial negative slack), a substantial increase in costs and/or reduction in work scope or quality may be required to get it back on schedule. This could jeopardize elements of the overall project objective, such as scope, schedule, budget, and/or quality. In some cases, the customer and the contractor or project team may have to acknowledge that one or more of these elements cannot be achieved; therefore, the customer may have to extend the required completion time for the entire project, or there may be a dispute over who should absorb any increased cost to accelerate the schedule—the contractor or the customer.

Some contracts include a bonus provision, whereby the customer will pay the contractor a bonus if the project is completed ahead of schedule. Conversely, some contracts include a penalty provision, whereby the customer can reduce the final payment to the contractor if the project is not completed on time. Some of these penalties can be substantial. In either of these situations, effective schedule control is crucial.
The key to effective schedule control is to aggressively address any paths with negative or deteriorating slack values as soon as they are identified, rather than hoping that things will improve as the project goes on. Addressing schedule problems early will minimize the negative impact on budget and scope. If a project falls too far behind, getting back on schedule becomes more difficult, and it does not come free. It requires spending more money or reducing the scope or quality.

On projects that do not have negative slack, it is important not to let the slack deteriorate by accepting delays and slippages. If a project is ahead of schedule, a concentrated effort should be made to keep it ahead of schedule.

Project meetings are a good forum for addressing schedule control issues. See the section on meetings in Chapter 12, and the section on problem solving in Chapter 11 for related information.

**REAL WORLD PROJECT MANAGEMENT**

**DOE Announces the Completion of Cleanup Activities at GE Hitachi Nuclear Energy’s Vallecitos Nuclear Center**

From 1995 to 2006, the Department of Energy was focused on the accelerated clean-up of the Rocky Flats site in Colorado. The original plan was for 65 years and $37 billion to remove the contaminants, including buildings and remaining chemicals. Under the leadership of six different project managers, the site exceeded its goal by finishing 54 years ahead of schedule and with more than $30 billion in cost savings. The lessons learned from the project are ones that require intellectual consideration of the events, circumstances, and outcomes to apply them to other Department of Energy clean-up projects. The key success factors were: (1) a clear vision of the end state, (2) alignment of government agency and regulators, (3) sufficient site characterization to have accurate information for baseline and scope planning, (4) funding support, (5) fixed-price contracting with incentives for total project performance, (6) management of the contract instead of the contractor, and (7) continued focus on the goal. This project in Rocky Flats was the Project Management Institute’s 2006 Project of the Year.

From 1967 to 1975, the Vallecitos Nuclear Center conducted research for the Atomic Energy Commission’s Nuclear Energy Program, Fast Breeder Reactor Development Program, and the civilian nuclear power industry in the State of California. The Department of Energy’s Environmental Management program began a project to remove approximately 2,303 cubic feet of radioactive waste from the Vallecitos site. The 2.5-year project is complete due to the “cooperation of the State of California, the Western Governors’ Association, and the states along the shipping routes,” according to the Assistant Secretary for Environmental Management Dr. Inés Triay.

The Department of Energy learned valuable lessons that were applied at the Vallecitos site. The project managers for the Department of Energy were responsible for the handling of the shipping logistics. GE Hitachi Nuclear Energy managers prepared and packed all of the wastes. They removed:

- 758 cubic feet of transuranic waste from defense activities
- 1,521 cubic feet of low-level waste
- 24 cubic feet of mixed low-level waste

The transuranic wastes consist of tools, rags, protective clothing, sludge, soil, and other materials that have been contaminated by radioactive elements. While these
types of wastes do not seem to be all that bad, they still must be handled by following strict guidelines for packaging, shipping, and storage.

More projects are to follow these successes. The Cold War has left 1.5 million cubic meters of solid waste and 88 million gallons of liquid waste from five decades of nuclear weapons production to be dispositioned. The Department of Energy’s Office of Environmental Management is responsible for this nuclear clean-up. It may have taken five decades to create these wastes, but the Department of Energy is working to take less time on each project to remove the wastes.

With the clean-up complete at the Vallecitos site, the hot cell facility can now be reused for hot cell research and other commercial nuclear work. The project managers have changed a site from a shielded storage facility for radioactive waste products to one that now can be used for economic development. Planning that used lessons learned allowed for the development of a project schedule that has resulted in commercial opportunities. There are many more nuclear development sites to be cleaned by the Department of Energy. Strong project management and schedule planning based on lessons learned should provide for more projects that are completed under budget and under time.


Scheduling for Information Systems Development

Chapter 4 defined an information system (IS) as a computer-based system that accepts data as input, processes the data, and produces information required by users. Scheduling the development of an information system is a challenging process. Such scheduling is often done in a haphazard manner, and, as a result, a large number of IS projects are finished much later than originally promised or never finished at all. One of the most important factors in effective scheduling is estimating activity durations that are as realistic as possible. This is not an easy task; however, it does become easier with experience.

Among the common problems that often push IS development projects beyond their required completion time are the following:

- Failure to identify all user requirements
- Failure to identify user requirements properly
- Continuing growth of project scope
- Underestimating learning curves for new software packages
- Incompatible hardware
- Logical design flaws
- Poor selection of software
- Failure to select the best design strategy
- Data incompatibility issues
- Failure to perform all phases of the SDLC

Controlling the schedule for the development of an information system is a challenge. Numerous unexpected circumstances might arise that can push an IS development project well beyond its originally required completion date. However, just as with any other type of project, the key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis and taking any necessary corrective action immediately.
Like other forms of project control, schedule control for IS development projects is carried out according to the steps discussed earlier in this chapter. A project control process such as the one illustrated in Figure 5.13 should be used for comparing actual performance with the schedule. Once the customer and the project team agree on changes, these changes should be recorded and the schedule should be revised.

Among the changes that commonly become necessary during IS development projects are the following:

- **Changes to the interface**—such as added fields, different icons, different colors, different menu structures or buttons, or completely new screens.
- **Changes to reports**—such as added fields, different subtotals and totals, different sorts, different selection criteria, different order of fields, or completely new reports.
- **Changes to online queries**—such as different ad hoc capabilities, access to different fields or databases, different query structures, or additional queries.
- **Changes to database structures**—such as additional fields, different data field names, different data storage sizes, different relationships among the data, or completely new databases.

<table>
<thead>
<tr>
<th>Activity</th>
<th>Immediate Predecessors</th>
<th>Estimated Duration (days)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Gather Data</td>
<td>—</td>
<td>3</td>
</tr>
<tr>
<td>2. Study Feasibility</td>
<td>—</td>
<td>4</td>
</tr>
<tr>
<td>3. Prepare Problem Definition Report</td>
<td>1, 2</td>
<td>1</td>
</tr>
<tr>
<td>4. Interview Users</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>5. Study Existing System</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>6. Define User Requirements</td>
<td>4</td>
<td>5</td>
</tr>
<tr>
<td>7. Prepare System Analysis Report</td>
<td>5, 6</td>
<td>1</td>
</tr>
<tr>
<td>8. Input &amp; Output</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>9. Processing &amp; Database</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>10. Evaluation</td>
<td>8, 9</td>
<td>2</td>
</tr>
<tr>
<td>11. Prepare System Design Report</td>
<td>10</td>
<td>2</td>
</tr>
<tr>
<td>12. Software Development</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td>13. Hardware Development</td>
<td>11</td>
<td>10</td>
</tr>
<tr>
<td>14. Network Development</td>
<td>11</td>
<td>6</td>
</tr>
<tr>
<td>15. Prepare System Development Report</td>
<td>12, 13, 14</td>
<td>2</td>
</tr>
<tr>
<td>16. Software Testing</td>
<td>15</td>
<td>6</td>
</tr>
<tr>
<td>17. Hardware Testing</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>18. Network Testing</td>
<td>15</td>
<td>4</td>
</tr>
<tr>
<td>19. Prepare Testing Report</td>
<td>16, 17, 18</td>
<td>1</td>
</tr>
<tr>
<td>20. Training</td>
<td>19</td>
<td>4</td>
</tr>
<tr>
<td>21. System Conversion</td>
<td>19</td>
<td>2</td>
</tr>
<tr>
<td>22. Prepare Implementation Report</td>
<td>20, 21</td>
<td>1</td>
</tr>
</tbody>
</table>
Changes to software processing routines—such as different algorithms, different interfaces with other subroutines, different internal logic, or new procedures.

Changes to processing speeds—such as higher throughput rates or response times.

Changes to storage capacities—such as an increase in the maximum number of data records.

Changes to business processes—such as changes in work or data flow, addition of new clients that must have access, or completely new processes that must be supported.

Changes to software resulting from hardware upgrades or, conversely, hardware upgrades resulting from the availability of more powerful software.

**AN IS EXAMPLE: INTERNET APPLICATIONS DEVELOPMENT FOR ABC OFFICE DESIGNS (CONTINUED)**

Recall from Chapter 4 that ABC Office Designs has a large number of sales representatives who sell office furniture to major corporations. Each sales representative is assigned to a specific state, and each state is part of one of four regions in the country. To enable management to monitor the number and amount of sales for each representative, for each state, and for each region, ABC has decided to build a Web-based information system. In addition, the IS needs to be able to track prices, inventory, and the competition.

The IS department within the corporation assigned Beth Smith to be the project manager of the Web-based reporting system development project. Previously, Beth had identified all of the major tasks that needed to be accomplished and developed the work breakdown structure, responsibility assignment matrix, and network diagram. Her next step was to come up with estimated durations for the activities. After consulting extensively with the project team, she derived the estimates shown in Figure 5.17.
The project is required to be completed in 50 days, and it needs to be started as soon as possible. Having the estimated durations for each activity and the project required start and finish times, Beth was ready to perform the calculations for the earliest start (ES) and earliest finish (EF) times for each activity. These values are shown above each activity in Figure 5.18.

Beth calculated the ES and EF times by going forward through the network. The first tasks, “Gather Data” and “Study Feasibility,” have ES times of 0. Because “Gather Data” is estimated to take 3 days, its EF is 0 + 3 = 3 days. Because “Study Feasibility” is estimated to take 4 days, its EF is 0 + 4 = 4 days. Beth continued this process, moving forward through the network diagram until all activities had been assigned ES and EF times.

After the ES and EF times were calculated, Beth calculated the LS and LF times. The starting point here is the time by which the project must be completed—50 days. The LS and LF times are shown below each activity in Figure 5.19.

Beth calculated the LF and LS times by going backward through the network. The last task, “Prepare Implementation Report,” has an LF time of 50—the time by which the project needs to be completed. Because “Prepare Implementation Report” is estimated to take 1 day to perform, its LS is 50 – 1 = 49 days. This
means that “Prepare Implementation Report” must be started by day 49 at the latest, or the project will not finish by its required completion time. Beth continued this process, moving backward through the network diagram until all activities had been assigned LF and LS times.

After the ES, EF, LS, and LF times were calculated, Beth calculated the total slack. These values are shown in Figure 5.20. Recall that the total slack is calculated by either subtracting ES from LS or subtracting EF from LF for each activity.

After she calculated the total slack for each activity, Beth had to identify the critical path. For the Web-based reporting system development project, any activity with a slack of –9 is on the critical path. Figure 5.21 shows the critical path for this development project. At this point, Beth and her team must determine a way to reduce the development time by 9 days, request that the project completion date be extended from 50 to 59 days, or find some compromise.

However, after extensive discussions with upper management, in which she stressed the importance of developing the system right the first time and not having to rush through some critical phases of the SDLC, Beth convinced her superiors to extend the project completion time to 60 days.

Beth and her team proceeded with the project and completed activities 1 through 6:

Activity 1, “Gather Data,” actually finished on day 4.
Activity 3, “Prepare Problem Definition Report,” actually finished on day 5.
Activity 4, “Interview Users,” actually finished on day 10.
Activity 5, “Study Existing System,” actually finished on day 15.
Activity 6, “Define User Requirements,” actually finished on day 18.

They then discovered that, by using some reusable software for the database, they could reduce the estimated duration of activity 9, “Processing & Database,” from 10 days to 8 days.
Figures 5.22 and 5.23 show the updated network diagram and project schedule, respectively, after these changes have been incorporated. Notice that because of the above occurrences, the critical path now has a total slack of 0.

**Project Management Information Systems**

Almost all project management information systems allow you to perform the scheduling functions identified in this chapter. Specifically, activity estimated durations can be in hours, days, weeks, months, or years, and with a click of the mouse, time scales can easily be converted from days to weeks, weeks to days, and so on. The estimated durations can easily be updated and revised. In addition, calendaring systems provide the project manager with the ability to handle weekends, company holidays, and vacation days.

Project start and finish times can be entered as specific calendar dates (for example, June 1, 2012 or December 31, 2012), or an overall number of days (or weeks or months), without specific calendar dates assigned, can be entered (for example, the project needs to finish by week 50). Given the project required completion date and the list of activities with their estimated durations, the
software will calculate the date by which a project needs to start. Similarly, it will calculate the earliest project completion date, based on the actual start date and the list of activities with their estimated durations.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Start</td>
<td>Finish</td>
<td>Start</td>
<td>Finish</td>
</tr>
<tr>
<td>1 Gather Data</td>
<td>Beth</td>
<td>3</td>
<td>0</td>
<td>3</td>
<td>–8</td>
</tr>
<tr>
<td>2 Study Feasibility</td>
<td>Jack</td>
<td>4</td>
<td>0</td>
<td>4</td>
<td>–9</td>
</tr>
<tr>
<td>3 Prepare Problem Definition Report</td>
<td>Rose</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>–5</td>
</tr>
<tr>
<td>4 Interview Users</td>
<td>Jim</td>
<td>5</td>
<td>5</td>
<td>10</td>
<td>–4</td>
</tr>
<tr>
<td>5 Study Existing System</td>
<td>Steve</td>
<td>8</td>
<td>5</td>
<td>13</td>
<td>–2</td>
</tr>
<tr>
<td>6 Define User Requirements</td>
<td>Jeff</td>
<td>5</td>
<td>10</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>7 Prepare System Analysis Report</td>
<td>Jim</td>
<td>1</td>
<td>15</td>
<td>16</td>
<td>6</td>
</tr>
<tr>
<td>8 Input &amp; Output</td>
<td>Tyler</td>
<td>8</td>
<td>16</td>
<td>24</td>
<td>9</td>
</tr>
<tr>
<td>9 Processing &amp; Database</td>
<td>Joe</td>
<td>10</td>
<td>16</td>
<td>26</td>
<td>7</td>
</tr>
<tr>
<td>10 Evaluation</td>
<td>Cathy</td>
<td>2</td>
<td>26</td>
<td>28</td>
<td>17</td>
</tr>
<tr>
<td>11 Prepare System Design Report</td>
<td>Sharon</td>
<td>2</td>
<td>28</td>
<td>30</td>
<td>19</td>
</tr>
<tr>
<td>12 Software Development</td>
<td>Hannah</td>
<td>15</td>
<td>30</td>
<td>45</td>
<td>21</td>
</tr>
<tr>
<td>13 Hardware Development</td>
<td>Joe</td>
<td>10</td>
<td>30</td>
<td>40</td>
<td>26</td>
</tr>
<tr>
<td>14 Network Development</td>
<td>Gerri</td>
<td>6</td>
<td>30</td>
<td>36</td>
<td>30</td>
</tr>
<tr>
<td>15 Prepare System Development Report</td>
<td>Jack</td>
<td>2</td>
<td>45</td>
<td>47</td>
<td>36</td>
</tr>
<tr>
<td>16 Software Testing</td>
<td>Maggie</td>
<td>6</td>
<td>47</td>
<td>53</td>
<td>38</td>
</tr>
<tr>
<td>17 Hardware Testing</td>
<td>Gene</td>
<td>4</td>
<td>47</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>18 Network Testing</td>
<td>Greg</td>
<td>4</td>
<td>47</td>
<td>51</td>
<td>40</td>
</tr>
<tr>
<td>19 Prepare Testing Report</td>
<td>Rose</td>
<td>1</td>
<td>53</td>
<td>54</td>
<td>44</td>
</tr>
<tr>
<td>20 Training</td>
<td>Jim</td>
<td>4</td>
<td>54</td>
<td>58</td>
<td>45</td>
</tr>
<tr>
<td>21 System Conversion</td>
<td>Beth</td>
<td>2</td>
<td>54</td>
<td>56</td>
<td>47</td>
</tr>
<tr>
<td>22 Prepare Implementation Report</td>
<td>Jack</td>
<td>1</td>
<td>58</td>
<td>59</td>
<td>49</td>
</tr>
</tbody>
</table>
The software will also calculate ES, EF, LS, and LF times, total and free slack, and the critical path, all with a click of the mouse. It is important, however, for the project manager to understand what these terms are and what the calculations mean.

Most project management information systems have the ability to provide Gantt or bar charts that display the dependencies among tasks by connecting tasks and their predecessors with lines and arrowheads. The user can click back and forth between the Gantt or bar charts and the network diagrams.

Virtually all project management information systems allow you to perform the control functions identified in this chapter. Specifically, while an activity is in progress or once an activity has been completed, current information can be entered into the system and the software will automatically revise the project schedule. Likewise, if the estimated durations for any future activities change, these changes can be entered into the system and the information system will automatically update the schedule. All network diagrams, tables, and reports produced by the software will be updated to reflect the most recent information.

See Appendix A in the back of the book for a thorough discussion of project management information systems.

**CRITICAL SUCCESS FACTORS**

- The person who will be responsible for performing the activity should estimate the duration for that activity. This generates commitment from the person.
- The estimated duration for an activity must be based on the types and quantities of resources required to perform the activity.
- Activity estimated durations should be aggressive yet realistic.
- Activities should not be longer in estimated duration than the time intervals at which the actual progress will be reviewed and compared to planned progress.
- Project management involves a proactive approach to controlling a project to ensure that the project objective is accomplished, even when things do not go according to plan.
- Once the project starts, it is important to monitor progress to ensure that everything is going according to plan.
- The key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis and taking any needed corrective action immediately.
- The key to effective schedule control is to address any paths with negative or deteriorating slack values aggressively as soon as they are identified. A concentrated effort to accelerate project progress must be applied to these paths. The amount of negative slack should determine the priority for applying these concentrated efforts.
- When attempting to reduce the duration of a path of activities that has negative slack, focus on activities that are near term and on activities that have long estimated durations.
- Addressing schedule problems early will minimize the negative impact on scope and budget. If a project falls too far behind, getting it back on schedule becomes more difficult and usually requires spending more money or reducing the scope or quality.
- If corrective actions are necessary, decisions must be made regarding a trade-off of scope, time, and cost.
- A regular reporting period should be established for comparing actual progress to planned progress.
- The shorter the reporting period, the better the chances of identifying problems early and taking corrective actions.
- During each reporting period, data on actual performance and information on changes to the project scope, schedule, and budget need to be collected in a timely manner and used to calculate an updated schedule and budget.
When network planning techniques are used, the scheduling function depends on the planning function. A schedule is a timetable for the plan and, therefore, cannot be established until the network-based plan has been created.

It is necessary to estimate the types and quantities of resources that will be required to perform each specific activity in the network diagram in order to subsequently estimate how long it will take to perform the activity. When estimating resources for activities, the availability of each resource has to be taken into account. The estimated types and quantities of resources required for an activity together with the availability of those resources will influence the estimated duration for how long it will take to perform the activity.

Once the types and quantities of resources are estimated for each activity, estimates can then be made for how long it will take to perform each activity. The estimated duration for each activity must be the total elapsed time—the time for the work to be done plus any associated waiting time. An activity's estimated duration must be based on the quantity of resources required to perform the activity. The estimate should be aggressive, yet realistic. At the beginning of the project, it may not be possible to estimate durations for all activities with a level of confidence regarding their accuracy. This is especially true for longer-term projects. It may be easier to estimate the durations for near-term activities, but as the project progresses, the project team can progressively elaborate the estimated durations as more information is known or becomes clear to allow for more accurate estimated durations.

In order to establish a basis from which to calculate a schedule using the estimated durations for the activities, it is necessary to select an estimated start time and a required completion time for the overall project. These two times define the overall window, or envelope, of time in which the project must be completed.
A project schedule provides a timetable for each activity and shows the earliest start (ES) and earliest finish (EF) times and the latest start (LS) and latest finish (LF) times for each activity. The ES and EF times are calculated by working forward through the network. The earliest start time for an activity is calculated on the basis of the project estimated start time and the estimated durations of preceding activities. The earliest finish time for an activity is calculated by adding the activity’s estimated duration to the activity’s earliest start time. The earliest start time for a specific activity must be the same as or later than the latest of all the earliest finish times of all the activities leading directly into that specific activity.

The LS and LF times are calculated by working backward through the network. The latest finish time for an activity is calculated on the basis of the project required completion time and the estimated durations of succeeding activities. The latest start time is calculated by subtracting the activity’s estimated duration from the activity’s latest finish time. The latest finish time for a specific activity must be the same as or earlier than the earliest of all the latest start times of all the activities emerging directly from that specific activity.

The total slack for a particular path of activities through the network is common to and shared among all activities on that path. If it is positive, it represents the maximum amount of time that the activities on a particular path can be delayed without jeopardizing completion of the project by the required time. If
total slack is negative, it represents the amount of time that the activities on that path must be accelerated in order to complete the project by the required time. If it is zero, the activities on that path do not need to be accelerated but cannot be delayed. The critical path is the longest (most time-consuming) path of activities in the network diagram.

Once a project actually starts, it is necessary to monitor the progress to ensure that everything is going according to the plan. The key to effective project control is measuring actual progress and comparing it to planned progress on a timely and regular basis and taking any needed corrective action immediately. A regular reporting period should be established for comparing actual progress with planned progress. During each reporting period, two kinds of data or information need to be collected: data on actual performance and information on any changes to the project scope, schedule, and budget. The project control process continues throughout the project. In general, the shorter the reporting period, the better the chances of identifying problems early and taking effective corrective actions. If a project gets too far out of control, it may be difficult to achieve the project objective without sacrificing the scope, quality, schedule, or budget.

Throughout a project, some activities will be completed on time, some will be finished ahead of schedule, and others will be finished later than scheduled. Actual progress—whether faster or slower than planned—will have an effect on the schedule of the remaining, uncompleted activities of the project. Specifically, the actual finish times of completed activities will determine the earliest start and earliest finish times for the remaining activities in the network diagram, as well as the total slack.

Throughout a project, changes may occur that have an impact on the schedule. These changes might be initiated by the customer or the project team, or they might be the result of an unanticipated occurrence. Any type of change—whether initiated by the customer, the contractor, the project manager, a team member, or an unanticipated event—will require a modification to the plan in terms of scope, schedule, and/or budget. When such changes are agreed upon, a new baseline plan is established and used as the benchmark against which actual project performance will be compared.

Based on actual progress and on consideration of other changes that may occur, an updated project schedule can be generated regularly that forecasts whether the
Once data have been collected on the actual finish times of completed activities and the effects of any project changes, an updated project schedule can be calculated.

Schedule control involves four steps: analyzing the schedule to determine which areas may need corrective action, deciding what specific corrective actions should be taken, revising the plan to incorporate the chosen corrective actions, and recalculating the schedule to evaluate the effects of the planned corrective actions. Corrective actions that will eliminate the negative slack from the project schedule must be identified. These corrective actions must reduce the estimated durations of activities on the negative-slack paths. When analyzing a path of activities that has negative slack, the focus should be on two kinds of activities: activities that are near term and activities that have long estimated durations.

There are various approaches to reducing the estimated durations of activities. These include applying more resources to accelerate an activity, assigning individuals with greater expertise or more experience to work on the activity, reducing the scope or requirements for the activity, and increasing productivity through improved methods or technology.

Scheduling the development of an information system is a challenging process. Such scheduling is often done in a haphazard manner, and as a result, a large number of IS projects are finished much later than originally promised. One of the most important factors in effective scheduling is estimating activity durations that are as realistic as possible. The project manager should be aware of the common problems that often push IS development projects beyond their scheduled completion dates. Project management information systems can help with the scheduling process.
## FIGURE 5.23 Updated Schedule for Web-based Reporting System Project

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Gather Data</td>
<td>Beth</td>
<td>1</td>
<td>18</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2 Study Feasibility</td>
<td>Jack</td>
<td>8</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3 Prepare Problem Definition Report</td>
<td>Rose</td>
<td>8</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4 Interview Users</td>
<td>Jim</td>
<td>2</td>
<td>27</td>
<td>29</td>
<td>27</td>
<td>29</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5 Study Existing System</td>
<td>Steve</td>
<td>15</td>
<td>31</td>
<td>46</td>
<td>31</td>
<td>46</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6 Define User Requirements</td>
<td>Jeff</td>
<td>10</td>
<td>31</td>
<td>41</td>
<td>36</td>
<td>46</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>7 Prepare System Analysis Report</td>
<td>Jim</td>
<td>1</td>
<td>18</td>
<td>19</td>
<td>18</td>
<td>19</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8 Input &amp; Output</td>
<td>Tyler</td>
<td>8</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9 Processing &amp; Database</td>
<td>Joe</td>
<td>8</td>
<td>19</td>
<td>27</td>
<td>19</td>
<td>27</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10 Evaluation</td>
<td>Cathy</td>
<td>2</td>
<td>27</td>
<td>29</td>
<td>27</td>
<td>29</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>11 Prepare System Design Report</td>
<td>Sharon</td>
<td>2</td>
<td>29</td>
<td>31</td>
<td>29</td>
<td>31</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>12 Software Development</td>
<td>Hannah</td>
<td>15</td>
<td>31</td>
<td>46</td>
<td>31</td>
<td>46</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>13 Hardware Development</td>
<td>Joe</td>
<td>10</td>
<td>31</td>
<td>41</td>
<td>36</td>
<td>46</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>14 Network Development</td>
<td>Gerri</td>
<td>6</td>
<td>31</td>
<td>37</td>
<td>40</td>
<td>46</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>15 Prepare System Development Report</td>
<td>Jack</td>
<td>2</td>
<td>46</td>
<td>48</td>
<td>46</td>
<td>48</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>16 Software Testing</td>
<td>Maggie</td>
<td>6</td>
<td>48</td>
<td>54</td>
<td>48</td>
<td>54</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>17 Hardware Testing</td>
<td>Gene</td>
<td>4</td>
<td>48</td>
<td>52</td>
<td>50</td>
<td>54</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>18 Network Testing</td>
<td>Greg</td>
<td>4</td>
<td>48</td>
<td>52</td>
<td>50</td>
<td>54</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>19 Prepare Testing Report</td>
<td>Rose</td>
<td>1</td>
<td>54</td>
<td>55</td>
<td>54</td>
<td>55</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>20 Training</td>
<td>Jim</td>
<td>4</td>
<td>55</td>
<td>59</td>
<td>55</td>
<td>59</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>21 System Conversion</td>
<td>Beth</td>
<td>2</td>
<td>55</td>
<td>57</td>
<td>57</td>
<td>59</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>22 Prepare Implementation Report</td>
<td>Jack</td>
<td>1</td>
<td>59</td>
<td>60</td>
<td>59</td>
<td>60</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
QUESTIONS

1. Why does the scheduling function depend on the planning function? Which one must be done first? Why?
2. Describe what an activity estimated duration is. How is it determined?
3. Why might a contractor prefer to state a project completion time in terms of number of days after the project starts rather than a specific date? Give some examples of instances when this would be appropriate.
4. Refer to Figure 5.4. Why is the earliest start time for “Review Comments & Finalize Questionnaire” day 33? Why is the earliest finish time day 38?
5. Refer to Figure 5.7. Why is the latest start time for “Mail Questionnaires & Get Responses” day 40? Why is the latest finish time day 105?
6. Describe the different types of project slack and how are each calculated.
7. Why is it important to determine the critical path of a project? What happens if activities on this path are delayed? What happens if activities on this path are accelerated?
8. From your experience, describe how you have used a project control process. If you did not use continual monitoring of the progress, how would it have helped improve the project’s success if you did use it?
9. Why should a project have a regular reporting period? Should all projects have the same reporting period? Why or why not? What types of data should be collected during each reporting period?
10. Who can initiate changes to a project schedule? Describe why and when changes would occur in a project. How are the network diagram and schedule updated to reflect the changes?
11. Describe how you would apply the four steps of schedule control to a project. If the project needs to be accelerated, what kinds of activities would be the primary focus? Why?
12. Why is the scheduling of IS projects so challenging? What are some of the common problems that push IS projects beyond their due dates?
13. Calculate the ES, EF, LS, and LF times and the slack for each activity in the figure below, and identify the critical path for the project. Can the project be completed in 40 weeks? Assume that activity A actually finished at 3 weeks, activity B actually finished at 12 weeks, and activity C actually finished at 13 weeks. Recalculate the expected project completion time. Which activities would you focus on in order to get the project back on schedule?
14. Calculate the ES, EF, LS, and LF times and the slack for each activity in the figure below, and identify the critical path for the project. Can the project be completed in 30 weeks? Assume that “Systems Analysis” actually finished at 8 weeks, “Design Input & Output” actually finished at 15 weeks, and “Design Database” actually finished at 19 weeks. Recalculate the expected project completion time. Which activities would you focus on in order to get the project back on schedule?

15. Calculate the ES, EF, LS, and LF times and the slack for each activity in the figure below, and identify the critical path for the project. Can the project be completed in 30 weeks? Assume that activity A actually finished at 5 weeks and activity B actually finished at 5 weeks. Recalculate the expected project completion time. Which activities would you focus on in order to get the project back on schedule?
INTERNET EXERCISES

For the website addresses of the organizations mentioned in these exercises, go to “Internet Exercises” at the book’s companion website at www.cengagebrain.com. It is suggested that you save this website in your “Favorites” list for easy access in the future.

1. Search the Web for “project schedule.” Describe at least three sites that you find. Search with additional terms such as “tools” and “control.” List the terms that you have added, and describe at least three sites that you find.
2. For exercises 2 through 5, visit the website for the organization 4PM. Explore the site. What kind of information does it provide?
3. Explore the topics in the “Articles and Videos” link. Watch a video that interests you. Provide a one-page summary.
4. Click on the “PMTalk Newsletter” link and subscribe to the free newsletter. In addition, under the “Articles and Videos” link, read an article that interests you and provide a one-page summary.
5. Under the “Articles and Videos” link, explore the Project Management Blog. Describe what you find.

CASE STUDY 1  A Not-for-Profit Medical Research Center
This case study is a continuation of the one started in Chapter 4.

CASE QUESTIONS
1. Develop an estimated duration for each activity.
2. Using a project start time of 0 (or May 15) and a required project completion time of 180 days (or November 15), calculate the ES, EF, LS, and LF times and total slack for each activity. If your calculations result in a project schedule with negative total slack, revise the project scope, activity estimated durations, and/or sequence or dependent relationships among activities to arrive at an acceptable baseline schedule for completing the project within 180 days (or by November 15). Describe the revisions you made.
3. Determine the critical path, and identify the activities that make up the critical path.
4. Produce a bar chart (Gantt Chart) based on the ES and EF times from the schedule in item 2.

Note: This case study will continue in Chapters 6 through 8, so save the results of your work.

GROUP ACTIVITY
Divide the course participants into the same groups as for the previous chapter’s group activity. Then address each of the steps above.
CASE STUDY 2  

The Wedding  
This case study is a continuation of the one started in Chapter 4.

CASE QUESTIONS  
1. Develop an estimated duration for each activity.  
2. Using a project start time of 0 (or January 1) and a required project completion time of 180 days (or June 30), calculate the ES, EF, LS, and LF times and total slack for each activity. If your calculations result in a project schedule with negative total slack, revise the project scope, activity estimated durations, and/or sequence or dependent relationships among activities to arrive at an acceptable baseline schedule for completing the project within 180 days (or by June 15). Describe the revisions you made.  
3. Determine the critical path, and identify the activities that make up the critical path.  
4. Produce a bar chart (Gantt Chart) based on the ES and EF times from the schedule in item 2.  

Note: This case study will continue in Chapters 6 through 8, so save the results of your work.  

GROUP ACTIVITY  
Divide the course participants into the same groups as for the previous chapter’s group activity. Then address each of the steps above.  

REFERENCES  
A Guide to the Project Management Body of Knowledge (PMBOK® Guide),  
APPENDIX 1

Probabilistic Activity Durations

ESTIMATE ACTIVITY DURATIONS

Recall that the estimated duration for each activity is the estimated total elapsed time from when the activity is started until it is finished. With projects for which there is a high degree of uncertainty about the estimated duration for activities, it is possible to use three estimates for each activity:

1. **Optimistic time** \( (t_o) \) is the time in which a specific activity can be completed if everything goes perfectly well and there are no complications. A rule of thumb is that there should be only one chance in ten of completing the activity in less than the optimistic time estimate.

2. **Most likely time** \( (t_m) \) is the time in which a specific activity can most frequently be completed under normal conditions. If an activity has been repeated many times, the actual duration that occurs most frequently can be used as the most likely time estimate.

3. **Pessimistic time** \( (t_p) \) is the time in which a specific activity can be completed under adverse circumstances, such as in the presence of unusual or unforeseen complications. A rule of thumb is that there should be only one chance in ten of completing the activity in more than the pessimistic time estimate.

Establishing three time estimates makes it possible to take uncertainty into account when estimating how long an activity will take. The most likely time must be longer than or equal to the optimistic time, and the pessimistic time must be longer than or equal to the most likely time.

It is not required that three time estimates be made for each activity. If someone has experience or data on how long it took to perform very similar activities...
in completed projects, it may be preferable to make only one estimated duration for how long an activity will take (as discussed in this chapter). However, using three time estimates \((t_o, t_m, \text{ and } t_p)\) can be helpful when there is a high degree of uncertainty as to how long an activity may take.

**THE BETA PROBABILITY DISTRIBUTION**

When three time estimates are used for each activity, it is assumed that the three estimates follow a beta probability distribution. Based on this assumption, it is possible to calculate an expected duration, \(t_e\), (also called mean or average time) for each activity from the activity’s three time estimates. The expected duration is calculated using the following formula:

\[
t_e = \frac{t_o + 4(t_m) + t_p}{6}
\]

Assume that the optimistic time for an activity is 1 week, the most likely time is 5 weeks, and the pessimistic time is 15 weeks. The beta probability distribution for this activity is shown in Figure 5.24. The expected duration for this activity is

\[
t_e = \frac{1 + 4(5) + 15}{6} = 6 \text{ weeks}
\]

**FIGURE 5.24 Beta Probability Distribution**

Assume that the optimistic time for another activity is 10 weeks, the most likely time is 15 weeks, and the pessimistic time is 20 weeks. The beta probability distribution for this activity is shown in Figure 5.25. The expected duration for this activity is

\[
t_e = \frac{10 + 4(15) + 20}{6} = 15 \text{ weeks}
\]

Coincidentally, this happens to be the same as the most likely time estimate.

The peaks of the curves in Figures 5.24 and 5.25 represent the most likely times for their respective activities. The expected duration, \(t_e\), divides the total area under the beta probability curve into two equal parts. In other words, 50 percent of the area under any beta probability curve will be to the left of \(t_e\) and 50 percent will be to the right. For example, Figure 5.24 shows that 50 percent of the area under the curve is to the left of 6 weeks and 50 percent of the area is to the right of 6 weeks. Thus, there is a 50–50 chance that an activity will actually take more or less
time than its expected duration. Stated another way, there is a probability of 0.5 that an activity will take more time than \( t_e \), and a probability of 0.5 that it will take less time than \( t_e \). In Figure 5.24, there is a 50 percent chance that the activity will take longer than 6 weeks and a 50 percent chance that it will take less than 6 weeks.

It is assumed that, as a project progresses, some activities will take less time than their expected duration and some activities will take more time than their expected duration. It is further assumed that, by the time the entire project is completed, the total net difference between all expected durations and all actual durations will be minimal.

**PROBABILITY FUNDAMENTALS**

Network planning in which three time estimates are used for each activity can be considered a *stochastic or probabilistic technique*, because it allows for uncertainty in activity duration by incorporating three estimates that are assumed to be distributed according to the beta probability distribution. Any technique that uses only one estimated duration is considered a *deterministic technique*. Because it is assumed that the three time estimates for each activity follow a beta probability distribution, it is possible to calculate the probability, or likelihood, of actually completing the project before the required time. If only one estimated duration is used for each activity, probability calculations cannot be made.

When three time estimates are used, all of the activities on the critical path of the network diagram can be added together to obtain a total probability distribution. The central limit theorem of probability theory states that this total probability distribution is not a beta probability distribution but a *normal probability distribution*, which is bell-shaped and symmetrical around its mean (or expected) value. Furthermore, this total normal probability distribution has an expected duration that is equal to the sum of the expected durations of all of the activities that make up the total distribution.

Whereas the expected duration, which divides the area under a probability distribution into two equal parts, is a measure of the central tendency of a distribution, the *variance*, \( \sigma^2 \), is a measure of the dispersion, or spread, of a distribution from its
expected value. The variance for the beta probability distribution of an activity is calculated using the following formula:

$$\text{Variance} = \sigma^2 = \left[ \frac{t_p - t_o}{6} \right]^2$$

The variance of the total normal probability distribution is equal to the sum of the variances of all of the activities that make up the total normal distribution. The standard deviation, $\sigma$, is another measure of the dispersion of a distribution and is equal to the square root of the variance. The standard deviation gives a better visual representation of the spread of a distribution from its mean or expected value than does the variance. For a normal distribution (see Figure 5.26), the area within one standard deviation of the mean (to both sides) includes approximately 68 percent of the total area under the curve, the area within two standard deviations includes approximately 95 percent of the total area under the curve, and the area within three standard deviations includes approximately 99 percent of the total area under the curve.

FIGURE 5.26 Normal Probability Distribution

As noted above, the standard deviation is a measure of the dispersion of a distribution. Figure 5.27 shows two normal distributions. The distribution in (a) of Figure 5.27 is more widespread and thus has a larger standard deviation than that in (b). However, for both distributions 68 percent of the area under the curve is included within one standard deviation of the mean.

FIGURE 5.27 Normal Probability Distributions
The total probability distribution of all the activities on the critical path of a network diagram is a normal distribution, with a mean or expected value equal to the sum of the individual activity expected durations and a variance equal to the sum of the individual activity variances. Consider the simple network in Figure 5.28. Assume that the project can start at time 0 and must be completed by day 42. The probability distributions for the activities in Figure 5.28 are shown in Figure 5.29.

**FIGURE 5.29 Probability Distributions**

![Network Diagram](network_diagram)

**FIGURE 5.28 Example Project**

**Required Completion = 42 Days**

The expected duration for each activity is as follows.

- **Activity A**: $t_e = \frac{2 + 4(4) + 6}{6} = 4$ days
- **Activity B**: $t_e = \frac{5 + 4(13) + 15}{6} = 12$ days
- **Activity C**: $t_e = \frac{13 + 4(18) + 35}{6} = 20$ days

Total = 36 days
If we sum the three distributions, we obtain a total mean, or total $t_e$:

<table>
<thead>
<tr>
<th>Activity</th>
<th>$t_o$</th>
<th>$t_m$</th>
<th>$t_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>2</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>B</td>
<td>5</td>
<td>13</td>
<td>15</td>
</tr>
<tr>
<td>C</td>
<td>13</td>
<td>18</td>
<td>35</td>
</tr>
<tr>
<td>Total</td>
<td>20</td>
<td>35</td>
<td>56</td>
</tr>
</tbody>
</table>

$$t_e = \frac{20 + 4(35) + 56}{6} = 36 \text{ days}$$

This result is the same as the sum of the three individual expected durations calculated previously: $4 + 12 + 20 = 36$ days. The total probability distribution is shown in (d) of Figure 5.29. The total expected duration for path 1–2–3–4 is 36 days. Thus, the project has an earliest expected completion time of day 36. As previously stated, the project has a required completion time of day 42.

The total distribution has a mean elapsed time equal to the sum of the three individual means, or expected durations. There is a probability of 0.5 that the project will be completed before day 36 and a probability of 0.5 that it will be completed after day 36.

For the simple example in Figure 5.28, the variances for the beta distributions of the three activities are as follows.

Activity A \( \sigma^2 = \left( \frac{6 - 2}{6} \right)^2 = 0.444 \)

Activity B \( \sigma^2 = \left( \frac{15 - 5}{6} \right)^2 = 2.778 \)

Activity C \( \sigma^2 = \left( \frac{35 - 13}{6} \right)^2 = 13.444 \)

Total = 16.666

The variance for the total distribution, which is a normal probability distribution, is the sum of the three individual variances, or 16.666. The standard deviation, $\sigma$, of the total distribution is

$$\text{Standard deviation} = \sigma = \sqrt{\sigma^2} = \sqrt{16.666} = 4.08 \text{ days}$$

Figure 5.30, like (d) of Figure 5.29, shows the total probability curve, with the addition of the standard deviations.

**FIGURE 5.30** Normal Probability Distribution for Sample Project
Figure 5.30 is a normal curve, so 68 percent of its total area is contained within ±1σ (standard deviation) of 4, or between 31.92 days and 40.08 days; 95 percent of its area is between 27.84 days and 44.16 days; and 99 percent of its area is between 23.76 days and 48.24 days. This probability distribution can be interpreted as follows:

- There is a 99 percent chance (0.99 probability) of completing the project in 23.76 to 48.24 days.
- There is a 95 percent chance (0.95 probability) of completing the project in 27.84 to 44.16 days.
- There is a 47.5 percent chance (0.475 probability) of completing the project in 27.84 to 36 days.
- There is a 47.5 percent chance (0.475 probability) of completing the project in 36 to 44.16 days.
- There is a 68 percent chance (0.68 probability) of completing the project in 31.92 to 40.08 days.
- There is a 34 percent chance (0.34 probability) of completing the project in 31.92 to 36 days.
- There is a 34 percent chance (0.34 probability) of completing the project in 36 to 40.08 days.
- There is a 13.5 percent chance (0.135 probability) of completing the project in 27.84 to 31.92 days.
- There is a 13.5 percent chance (0.135 probability) of completing the project in 40.08 to 44.16 days.
- There is a 0.5 percent chance (0.005 probability) of completing the project before 23.76 days.
- There is a 0.5 percent chance (0.005 probability) of completing the project after 48.24 days.

Thus, it can be stated that the ratio of the area under certain parts of the normal curve to the total area under the curve is related to the probability.

**CALCULATING PROBABILITY**

The earliest expected finish time for a project is determined by the critical path through the network diagram. It is equal to the project estimated start time plus the sum of the expected durations of the activities on the critical path leading from project start to project completion. As stated previously, the probability of actually completing a project before its earliest expected finish time is 0.5, because half of the area under the normal distribution curve is to the left of this expected time; the probability of actually completing a project after its earliest expected finish time is also 0.5, because half of the area under the normal curve is to the right of this expected time. Knowing the required completion time for a project makes it possible to calculate the probability of actually completing the project before this time.

In order to find the probability of actually completing a project before its required completion time, the following formula is used:

\[
Z = \frac{LF - EF}{\sigma_t}
\]
The elements in this formula are as follows:

- LF is the required completion time (latest finish) for the project.
- EF is the earliest expected finish time for the project (mean of the normal distribution).
- \( \sigma_t \) is the standard deviation of the total distribution of the activities on the longest (most time-consuming) path leading to project completion.

In the above equation, \( Z \) measures the number of standard deviations between EF and LF on the normal probability curve. This \( Z \) value must be converted into a number that gives the proportion of the area under the normal curve that lies between EF and LF. Because the total area under a normal curve is equal to 1.0, the probability of finishing the project before its required completion time is equal to the proportion of the area under the curve that is to the left of LF.

The earliest expected finish time (EF) for the simple three-activity network in Figure 5.28 was calculated to be 36 days. Recall that the required completion time (LF) for the project is 42 days, or 6 days later than the EF. Figure 5.31 shows the normal curve for the project, with EF = 36 days and LF = 42 days.

**FIGURE 5.31** Normal Probability Distribution for Sample Project

The proportion of the area under the curve to the left of LF is equal to the probability of completing the project before 42 days. EF divides the area under the curve into two equal parts, each containing half of the area, so we know that the proportion of the area to the left of EF is 0.5. We must now find the proportion of the area between EF and LF and add this to 0.5 to obtain the proportion of the total area to the left of LF. Using the previous equation to find the proportion of the area between EF and LF, we can calculate \( Z \):

\[
Z = \frac{\text{LF} - \text{EF}}{\sigma_t} = \frac{42 - 36}{4.08} = \frac{6}{4.08} = 1.47
\]

The \( Z \) value of 1.47 indicates that there are 1.47 standard deviations (1 standard deviation = 4.08 days) between EF and LF. However, the \( Z \) value does not directly give the proportion of the area under the curve between EF and LF. In order to find this area, we must convert the \( Z \) value to a number that gives the area directly, using a standard conversion table such as Table 5.1.

The first column and top row of the table are used to find the desired \( Z \) value with a significance of 0.01. To find the area for a \( Z \) value of 1.47, first go down the column on the far left to 1.4, then go across this row to the 0.07 column. The number there is 0.42922. This means that for a \( Z \) value of 1.47, the proportion of the area under a normal curve is 0.42922. This number tells us that the probability of
actually completing the project between EF and LF, or in 36 to 42 days, is 0.42922; thus, there is a 42.922 percent chance. However, because we are interested in finding the probability of actually completing the project any time before 42 days, we must add the probability of finishing before 36 days. The probability of finishing the project any time before 42 days is equal to the probability of finishing before 36 days plus the probability of finishing between 36 days and 42 days:

\[ 0.50000 + 0.42922 = 0.92922 \]

The probability of actually completing the project before its required completion time of 42 days is 0.92922; there is a 92.922 percent chance.

**TABLE 5.1** Table of Areas of the Normal Curve Between the Maximum Ordinate and Values of Z

<table>
<thead>
<tr>
<th>Z</th>
<th>0.00</th>
<th>0.01</th>
<th>0.02</th>
<th>0.03</th>
<th>0.04</th>
<th>0.05</th>
<th>0.06</th>
<th>0.07</th>
<th>0.08</th>
<th>0.09</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.0</td>
<td>.00000</td>
<td>.00399</td>
<td>.00798</td>
<td>.01197</td>
<td>.01595</td>
<td>.01994</td>
<td>.02392</td>
<td>.02790</td>
<td>.03188</td>
<td>.03586</td>
</tr>
<tr>
<td>0.1</td>
<td>.03983</td>
<td>.04380</td>
<td>.04776</td>
<td>.05172</td>
<td>.05567</td>
<td>.05962</td>
<td>.06356</td>
<td>.06749</td>
<td>.07142</td>
<td>.07535</td>
</tr>
<tr>
<td>0.2</td>
<td>.07926</td>
<td>.08317</td>
<td>.08706</td>
<td>.09095</td>
<td>.09483</td>
<td>.09871</td>
<td>.10257</td>
<td>.10642</td>
<td>.11026</td>
<td>.11409</td>
</tr>
<tr>
<td>0.3</td>
<td>.11791</td>
<td>.12172</td>
<td>.12552</td>
<td>.12930</td>
<td>.13307</td>
<td>.13683</td>
<td>.14058</td>
<td>.14431</td>
<td>.14803</td>
<td>.15173</td>
</tr>
<tr>
<td>0.4</td>
<td>.15542</td>
<td>.15910</td>
<td>.16276</td>
<td>.16640</td>
<td>.17003</td>
<td>.17364</td>
<td>.17724</td>
<td>.18082</td>
<td>.18439</td>
<td>.18793</td>
</tr>
<tr>
<td>0.5</td>
<td>.19146</td>
<td>.19497</td>
<td>.19847</td>
<td>.20194</td>
<td>.20540</td>
<td>.20884</td>
<td>.21226</td>
<td>.21566</td>
<td>.21904</td>
<td>.22240</td>
</tr>
<tr>
<td>0.6</td>
<td>.22575</td>
<td>.22907</td>
<td>.23237</td>
<td>.23565</td>
<td>.23891</td>
<td>.24215</td>
<td>.24537</td>
<td>.24857</td>
<td>.25175</td>
<td>.25490</td>
</tr>
<tr>
<td>0.7</td>
<td>.25804</td>
<td>.26115</td>
<td>.26424</td>
<td>.26730</td>
<td>.27035</td>
<td>.27337</td>
<td>.27637</td>
<td>.27935</td>
<td>.28230</td>
<td>.28524</td>
</tr>
<tr>
<td>0.8</td>
<td>.28814</td>
<td>.29103</td>
<td>.29389</td>
<td>.29673</td>
<td>.29955</td>
<td>.30234</td>
<td>.30511</td>
<td>.30785</td>
<td>.31057</td>
<td>.31327</td>
</tr>
<tr>
<td>0.9</td>
<td>.31594</td>
<td>.31859</td>
<td>.32121</td>
<td>.32381</td>
<td>.32639</td>
<td>.32894</td>
<td>.33147</td>
<td>.33398</td>
<td>.33646</td>
<td>.33891</td>
</tr>
<tr>
<td>1.0</td>
<td>.34134</td>
<td>.34375</td>
<td>.34614</td>
<td>.34850</td>
<td>.35083</td>
<td>.35314</td>
<td>.35543</td>
<td>.35769</td>
<td>.35993</td>
<td>.36214</td>
</tr>
<tr>
<td>1.1</td>
<td>.36433</td>
<td>.36650</td>
<td>.36864</td>
<td>.37076</td>
<td>.37286</td>
<td>.37493</td>
<td>.37698</td>
<td>.37900</td>
<td>.38100</td>
<td>.38298</td>
</tr>
<tr>
<td>1.2</td>
<td>.38493</td>
<td>.38686</td>
<td>.38877</td>
<td>.39065</td>
<td>.39251</td>
<td>.39435</td>
<td>.39617</td>
<td>.39796</td>
<td>.39973</td>
<td>.40147</td>
</tr>
<tr>
<td>1.3</td>
<td>.40320</td>
<td>.40490</td>
<td>.40658</td>
<td>.40824</td>
<td>.40988</td>
<td>.41149</td>
<td>.41309</td>
<td>.41466</td>
<td>.41621</td>
<td>.41774</td>
</tr>
<tr>
<td>1.4</td>
<td>.41924</td>
<td>.42073</td>
<td>.42220</td>
<td>.42364</td>
<td>.42507</td>
<td>.42647</td>
<td>.42786</td>
<td>.42922</td>
<td>.43056</td>
<td>.43189</td>
</tr>
<tr>
<td>1.5</td>
<td>.43319</td>
<td>.43448</td>
<td>.43574</td>
<td>.43699</td>
<td>.43822</td>
<td>.43943</td>
<td>.44062</td>
<td>.44179</td>
<td>.44295</td>
<td>.44408</td>
</tr>
<tr>
<td>1.6</td>
<td>.44520</td>
<td>.44630</td>
<td>.44738</td>
<td>.44845</td>
<td>.44950</td>
<td>.45053</td>
<td>.45154</td>
<td>.45254</td>
<td>.45352</td>
<td>.45449</td>
</tr>
<tr>
<td>1.7</td>
<td>.45543</td>
<td>.45637</td>
<td>.45728</td>
<td>.45818</td>
<td>.45907</td>
<td>.45994</td>
<td>.46080</td>
<td>.46164</td>
<td>.46246</td>
<td>.46327</td>
</tr>
<tr>
<td>1.8</td>
<td>.46407</td>
<td>.46485</td>
<td>.46562</td>
<td>.46638</td>
<td>.46712</td>
<td>.46784</td>
<td>.46856</td>
<td>.46926</td>
<td>.46995</td>
<td>.47062</td>
</tr>
<tr>
<td>1.9</td>
<td>.47128</td>
<td>.47193</td>
<td>.47257</td>
<td>.47320</td>
<td>.47381</td>
<td>.47441</td>
<td>.47500</td>
<td>.47558</td>
<td>.47615</td>
<td>.47670</td>
</tr>
<tr>
<td>2.0</td>
<td>.47725</td>
<td>.47778</td>
<td>.47831</td>
<td>.47882</td>
<td>.47932</td>
<td>.47982</td>
<td>.48030</td>
<td>.48077</td>
<td>.48124</td>
<td>.48169</td>
</tr>
<tr>
<td>2.1</td>
<td>.48214</td>
<td>.48257</td>
<td>.48300</td>
<td>.48341</td>
<td>.48382</td>
<td>.48422</td>
<td>.48461</td>
<td>.48500</td>
<td>.48537</td>
<td>.48574</td>
</tr>
<tr>
<td>2.2</td>
<td>.48610</td>
<td>.48645</td>
<td>.48679</td>
<td>.48713</td>
<td>.48745</td>
<td>.48778</td>
<td>.48809</td>
<td>.48840</td>
<td>.48870</td>
<td>.48899</td>
</tr>
<tr>
<td>2.3</td>
<td>.48928</td>
<td>.48956</td>
<td>.48983</td>
<td>.49010</td>
<td>.49036</td>
<td>.49061</td>
<td>.49086</td>
<td>.49111</td>
<td>.49134</td>
<td>.49158</td>
</tr>
<tr>
<td>2.4</td>
<td>.49180</td>
<td>.49202</td>
<td>.49224</td>
<td>.49245</td>
<td>.49266</td>
<td>.49286</td>
<td>.49305</td>
<td>.49324</td>
<td>.49343</td>
<td>.49361</td>
</tr>
<tr>
<td>2.5</td>
<td>.49377</td>
<td>.49396</td>
<td>.49413</td>
<td>.49430</td>
<td>.49446</td>
<td>.49461</td>
<td>.49477</td>
<td>.49492</td>
<td>.49506</td>
<td>.49520</td>
</tr>
<tr>
<td>2.6</td>
<td>.49534</td>
<td>.49547</td>
<td>.49560</td>
<td>.49573</td>
<td>.49585</td>
<td>.49598</td>
<td>.49609</td>
<td>.49621</td>
<td>.49632</td>
<td>.49643</td>
</tr>
<tr>
<td>2.7</td>
<td>.49653</td>
<td>.49664</td>
<td>.49674</td>
<td>.49683</td>
<td>.49693</td>
<td>.49702</td>
<td>.49711</td>
<td>.49720</td>
<td>.49728</td>
<td>.49736</td>
</tr>
<tr>
<td>2.8</td>
<td>.49744</td>
<td>.49752</td>
<td>.49760</td>
<td>.49767</td>
<td>.49774</td>
<td>.49781</td>
<td>.49788</td>
<td>.49795</td>
<td>.49801</td>
<td>.49807</td>
</tr>
<tr>
<td>2.9</td>
<td>.49813</td>
<td>.49819</td>
<td>.49825</td>
<td>.49831</td>
<td>.49836</td>
<td>.49841</td>
<td>.49846</td>
<td>.49851</td>
<td>.49856</td>
<td>.49861</td>
</tr>
<tr>
<td>3.0</td>
<td>.49865</td>
<td>.49869</td>
<td>.49874</td>
<td>.49878</td>
<td>.49882</td>
<td>.49886</td>
<td>.49889</td>
<td>.49893</td>
<td>.49897</td>
<td>.49900</td>
</tr>
</tbody>
</table>
SUMMARY

If each activity in the network diagram for a project has three time estimates (optimistic, most likely, and pessimistic), it is possible to calculate the probability of actually completing the project before its required completion time using the methods discussed in this appendix. However, you should be careful in interpreting this probability, especially when there are several paths that are nearly as long as the critical path. If the standard deviations of these alternative paths are substantially different from that of the critical path, the probability of the project actually being finished before its required completion time may be lower when these paths are used in the probability calculations than when the critical path is used. This discrepancy usually arises only when two or more paths that are equal or nearly equal in length lead to project completion.

QUESTIONS

1. True or false: In order to calculate the probability of finishing a project by its required completion time, it is necessary to have three time estimates for each activity and the required completion time for the project.

2. What are the expected duration, variance, and standard deviation for an activity whose three time estimates are $t_o = 2$, $t_m = 14$, and $t_p = 14$?

3. Which of the following is not a measure of the dispersion, or spread, of a distribution: variance, mean, or standard deviation?

4. The earliest expected finish time for a project is 138 days, and its required completion time is 130 days. What is the probability of completing the project before its required time if $σ_t$ (the standard deviation of the total distribution of the activities on the longest path) is 6?

APPENDIX 2  Microsoft Project

In this appendix, we will discuss how Microsoft Project can be used to support the techniques discussed in this chapter based on the consumer market study example. To retrieve your project information, on the File menu, click Open and locate the consumer market study file you saved in Chapter 4. We are now ready to enter the estimated durations for each task, examine the project sched-
ule, produce a Gantt chart, determine the critical path, set a baseline to help track the project, monitor and control the schedule, edit task information, and produce reports.

Enter duration data directly into the Duration column in the Gantt Chart View. If you are not in the Gantt Chart View, click on Gantt Chart in the Task Views group on the Task ribbon. Check that the words “Gantt Chart Tools” are above the Format tab on the menu. Please see Figure 5A.1 for the duration data to enter. Note that when you enter the duration for each task, the default time unit is “d” for days. You can enter “m” after the number to represent minutes; “h” for hours; “d” for days; “w” for weeks; or “mon” for months. For example, an entry of “2w” would equal a two-week duration estimate. As you modify the duration estimates, the system automatically updates the start and finish dates for each task if Auto Schedule is selected in the Task group on the Task ribbon.

As you enter durations, the durations for the work packages total the duration for their activities. The task row for the title shows the total of the durations for all the activities in the project. The work packages and the project title operate as summary tasks. Note the total duration of the project is 138 days.

**FIGURE 5A.1 Add Duration Data**

![Add Duration Data](image-url)
Microsoft Project 2010 has already calculated the earliest and latest start and finish times, free slack, and total slack for each task. To see these values, you need to view the Schedule Table from the Gantt Chart View. On the View ribbon, click on Tables in the Data group. Then, click on Schedule in the menu. You should see the table shown in Figure 5A.2.

Microsoft project automatically creates the Gantt chart to the right of the tables in the Gantt Chart View as you enter tasks and their task information. The Gantt chart displays the dependencies between tasks with arrows. To highlight the critical path in red, on the Format ribbon for Gantt Chart Tools, click in the box to put a check mark next to Critical Tasks in the Bar Styles group. Figure 5A.3 shows the Gantt chart with the critical path highlighted.

FIGURE 5A.2 Gantt Chart View/Schedule Table

<table>
<thead>
<tr>
<th>Task Mode</th>
<th>Task Name</th>
<th>Start</th>
<th>Finish</th>
<th>Late Start</th>
<th>Late Finish</th>
<th>Free Slack</th>
<th>Total Slack</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Consumer Market Study</td>
<td>Mon 3/9/12</td>
<td>Wed 7/18/12</td>
<td>Mon 3/9/12</td>
<td>Wed 7/18/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Questionnaire</td>
<td>Mon 3/9/12</td>
<td>Wed 6/13/12</td>
<td>Mon 3/9/12</td>
<td>Wed 6/13/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Design</td>
<td>Mon 3/9/12</td>
<td>Fri 3/12/12</td>
<td>Mon 3/9/12</td>
<td>Wed 6/6/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Identify Target Consumers</td>
<td>Mon 3/9/12</td>
<td>Wed 1/11/12</td>
<td>Mon 3/9/12</td>
<td>Wed 1/11/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Develop Draft Questionnaire</td>
<td>Thu 1/12/12</td>
<td>Wed 1/25/12</td>
<td>Thu 1/12/12</td>
<td>Wed 1/25/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Pilot-Test Questionnaire</td>
<td>Thu 1/26/12</td>
<td>Wed 2/22/12</td>
<td>Thu 1/26/12</td>
<td>Wed 2/22/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Review Comments &amp; Finalize Questionnaire</td>
<td>Thu 2/23/12</td>
<td>Wed 2/29/12</td>
<td>Thu 2/23/12</td>
<td>Wed 2/29/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Develop Software Test Data</td>
<td>Thu 3/1/12</td>
<td>Fri 3/7/12</td>
<td>Tue 6/5/12</td>
<td>Wed 6/6/12</td>
<td>10 days</td>
<td>68 days</td>
</tr>
<tr>
<td></td>
<td>Responses</td>
<td>Thu 3/1/12</td>
<td>Wed 6/3/12</td>
<td>Thu 3/1/12</td>
<td>Wed 6/3/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Print Questionnaire</td>
<td>Thu 3/1/12</td>
<td>Wed 3/14/12</td>
<td>Thu 3/1/12</td>
<td>Wed 3/14/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Prepare Mailing Labels</td>
<td>Thu 3/1/12</td>
<td>Fri 3/12/12</td>
<td>Tue 3/13/12</td>
<td>Wed 3/14/12</td>
<td>8 days</td>
<td>8 days</td>
</tr>
<tr>
<td></td>
<td>Mail Questionnaire &amp; Get Responses</td>
<td>Thu 3/12/12</td>
<td>Wed 6/13/12</td>
<td>Thu 3/12/12</td>
<td>Wed 6/13/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Report</td>
<td>Thu 3/1/12</td>
<td>Wed 7/18/12</td>
<td>Tue 5/22/12</td>
<td>Wed 7/18/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Software</td>
<td>Thu 3/1/12</td>
<td>Fri 3/23/12</td>
<td>Tue 5/22/12</td>
<td>Wed 6/13/12</td>
<td>58 days</td>
<td>58 days</td>
</tr>
<tr>
<td></td>
<td>Develop Data Analysis Software</td>
<td>Thu 3/1/12</td>
<td>Fri 3/16/12</td>
<td>Tue 5/22/12</td>
<td>Wed 6/6/12</td>
<td>0 days</td>
<td>58 days</td>
</tr>
<tr>
<td></td>
<td>Test Software</td>
<td>Mon 3/19/12</td>
<td>Fri 3/23/12</td>
<td>Thu 6/7/12</td>
<td>Wed 6/13/12</td>
<td>58 days</td>
<td>58 days</td>
</tr>
<tr>
<td></td>
<td>Report</td>
<td>Thu 0/14/12</td>
<td>Wed 7/18/12</td>
<td>Thu 0/14/12</td>
<td>Wed 7/18/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Input Response Data</td>
<td>Thu 6/14/12</td>
<td>Fri 6/22/12</td>
<td>Thu 6/14/12</td>
<td>Fri 6/22/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Analyze Results</td>
<td>Mon 6/25/12</td>
<td>Wed 7/4/12</td>
<td>Mon 6/25/12</td>
<td>Wed 7/4/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
<tr>
<td></td>
<td>Prepare Report</td>
<td>Thu 7/5/12</td>
<td>Wed 7/18/12</td>
<td>Thu 7/5/12</td>
<td>Wed 7/18/12</td>
<td>0 days</td>
<td>0 days</td>
</tr>
</tbody>
</table>
FIGURE 5A.3  Gantt Chart with Critical Path

FIGURE 5A.4  Previewing a Report to Print
You can request a report of all critical tasks in the Consumer Market Study project. On the Project ribbon in the Reports group, click on Reports. You should see the Reports window containing a menu of report types, as in Figure 5A.4. Choose Overview, click on Select, choose Critical Tasks, and click on Select. You should see the Critical Tasks Report as in Figure 5A.5.

Recall the total duration for the project is 138 days. The project needs to be completed in 130 days. Note that the Schedule view shows the earliest day the project can be completed and the latest start dates for each task. To reduce the total duration of the project, the duration of at least one task on the critical path needs to be reduced. It is decided that the Mail Questionnaire & Get Responses task will be reduced from 65 days to 55 days. Change the duration of the task on the Entry Table in the Gantt Chart View. The Entry Table is accessed by clicking on Entry Table in the Tables menu in the Data group on the View ribbon. Microsoft Project automatically updates the Gantt Chart, network diagram, and the schedule with the change. Note that the total duration of the project reduces to 128 days, as shown in Figure 5A.6.

**FIGURE 5A.5  Critical Tasks Report**
It is important to periodically save the baseline of your project to monitor changes. To save baseline project data, on the Project ribbon, click on Set Baseline in the Schedule group, and click on Set Baseline. Save your file at this point with the file name Consumer Market Study to continue the planning presented in Chapters 6 and 7.

Microsoft Project helps to determine the effects of actual performance on the project completion date. Actual finish dates are entered in the task information window. Susan completed the Identify Target Consumers in two days instead of three days. She developed the draft questionnaire in 9 days and pilot-tested the questionnaire in 19 days. Susan discovered that she needed to make substantial revisions to the questionnaire and changed the duration to finish the revisions from 5 days to 15 days. Steve had to order a new database for the labels on day 23 of the project because the database was not up to date. The time for Steve to receive the database is 21 days and the activity is a predecessor to the Prepare Mailing Labels activity. Update the schedule with the actual finish dates for the activities, and add an activity to the project for the new database.
To update information about any task, right-click on the task name to select Information from the menu or double-click on the task name. The General tab is selected by default in the Task Information window. Here you can indicate the percentage of work completed for that task and the actual time duration. Figure 5A.7 shows the input screen within the General tab. After the task information has been modified, the Gantt chart and network diagrams will automatically be updated. Note that a check mark appears in the Information Column on the Entry Table for any tasks that are 100 percent complete.

To enter the new task, click on the row where the new task will be entered, then click on the top part of the Task button in the Insert group on the Task ribbon. To add the new activity for Steve, click on row 10, Print Questionnaire. On the Task ribbon in the Insert group, click on the top part of the Task button to insert a blank row. Then, type in the name of the activity, Order New Database for Labels. Enter the duration of 21 days. Set the Task Mode to Manually Schedule. The start date for this new task is day 23 of the project. The project started on January 9. February 9 is 23 days after January 9. Update the task information by opening the Task Information window and entering 2/9/2012 in the Start box. You can also select the date from the drop-down calendar. This new task is a predecessor to the task Prepare Mailing Labels. Update the predecessors for Prepare Mailing Labels. Note that Microsoft Project automatically adjusted the task numbers for the remaining tasks and their predecessors. Figure 5A.8 displays the addition of the new task and the updates.
Valuable tracking data can be displayed through the Tracking Table. While in the Gantt Chart View, on the View ribbon, click on Table in the Data group, and click on Tracking in the menu. This table, as seen in Figure 5A.9, shows actual start and finish times, percent complete, actual duration, remaining duration, actual costs, and actual work time for each activity. Note the actual finish times are reflected for the three tasks Susan has completed. The Gantt chart is updated with the actual finish dates and the percent complete.

To get a visual representation of actual versus planned progress, on the Task ribbon, click on the down arrow on the Gantt Chart icon in the View group, and select Tracking Gantt from the menu. The Tracking Gantt chart, shown in Figure 5A.10, displays two bars for each task. The lower bar shows the baseline start and finish dates, and the upper bar shows the current start and finish dates, so that you can see the difference between your baseline plan and the current schedule.
To obtain information on variances within your project, you need to select a table that will display variance values. On the View ribbon, click on Tables in the Data group, and select Variance from the menu. You should see the table that is shown in Figure 5A.11. This table shows the actual start and finish times compared to the baseline start and finish times for each activity, along with any variances. Note that at this point we see the results of the three tasks Susan has completed. The times will change as your project progresses and you update the percent complete and the actual finish dates for tasks.

It is helpful to save your project as you work. To save your project information, on the File tab, click on Save As and enter the file name `Consumer Market Study with Actual Finish Entries`.

To obtain information on variances within your project, you need to select a table that will display variance values. On the View ribbon, click on Tables in the Data group, and select Variance from the menu. You should see the table that is shown in Figure 5A.11. This table shows the actual start and finish times compared to the baseline start and finish times for each activity, along with any variances. Note that at this point we see the results of the three tasks Susan has completed. The times will change as your project progresses and you update the percent complete and the actual finish dates for tasks.

It is helpful to save your project as you work. To save your project information, on the File tab, click on Save As and enter the file name `Consumer Market Study with Actual Finish Entries`. 
Chapter 5  Developing the Schedule  207

FIGURE 5A.10  Tracking Gantt

FIGURE 5A.11  Variance Table