Successful Project Management
Third Edition
LARRY RICHMAN, PMP

Successful Project Management

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Larry Richman

Contents

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About This Course

Successful Project Management, Third Edition, is the introductory course in AMA's self-study program on project management. This practical, concise course covers the fundamentals of project management, focusing on practical skills you can apply immediately to complete projects on time, on budget, and on target.

This course teaches you how to use proven strategies in large or small projects to clarify the objectives, avoid serious errors of omission, and eliminate costly mistakes.

Gain the skills to:

- Set measurable project objectives and create a practical plan to achieve them.
- Manage the time, cost, and scope of the project.
- Lead the project team and manage relationships effectively and productively across the spectrum of project stakeholders.

Modern project management is a premier solution in business and non-profit organizations. Project managers find success using a structured approach to project planning, scheduling, resourcing, decision making, and management.

This course isn't just for project managers. Team members need to know how to carry out their part of the project, and business executives need to understand how they must support project management efforts in the organization. Now you can master the skills and techniques you need to bring projects in on schedule, and on budget, with *Successful Project Management.* No matter how complex or extensive your project, you'll understand how to exercise the strict planning, tracking, monitoring, and management techniques needed to stay on top of every project.

Course Objective: Develop skills to plan and execute projects to ensure that they meet agreed goals of time, cost, and scope.

Larry Richman is a certified Project Management Professional® (PMP®) with 30 years of experience. As the Director of the Publications and Media Project Office of The Church of Jesus Christ of Latter-Day Saints, he leads a project office that manages 8,000 printed, audiovisual, software, and Web projects each year in 185 languages. He has also developed and implemented computer-assisted project management systems. Mr. Richman has authored thirteen books, including four on project management, as well as articles in professional journals.

Mr. Richman specializes in teaching the basic principles and processes of project management. As a management consultant, he provides one-on-one coaching to executives and managers and has taught hundreds of corporate employees in classroom settings. Mr. Richman holds an M.S. in Instructional Science and lives in Salt Lake City, Utah.
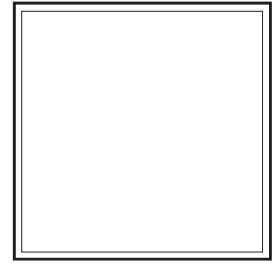
How to Take This Course

This course consists of text material for you to read and three types of activities (the pre- and post-test, in-text exercises, and end-of-chapter review questions) for you to complete. These activities are designed to reinforce the concepts introduced in the text portion of the course and to enable you to evaluate your progress.

PRE- AND POST-TESTS*

Both a pre-test and post-test are included in this course. Take the pre-test before you study any of the course material to determine your existing knowledge of the subject matter. Submit one of the scannable answer forms enclosed with this course for grading. On return of the graded pre-test, complete the course material. Take the post-test after you have completed all the course material. By comparing results of the pre-test and the post-test, you can measure how effective the course has been for you.

To have your pre-test and post-test graded, please mail your answer forms to:

Educational Services
American Management Association
P.O. Box 133
Florida, NY 10921

All tests are reviewed thoroughly by our instructors and will be returned to you promptly.

*If you are viewing the course digitally, the scannable forms enclosed in the hard copy of AMA Self-Study titles are not available digitally. If you would like to take the course for credit, you will need to either purchase a hard copy of the course from www.amaselfstudy.org or you can purchase an online version of the course from www.flexstudy.com.

THE TEXT

The most important component of this course is the text, where the concepts and methods are presented. Reading each chapter twice will increase the likelihood of your understanding the text fully.

We recommend that you work on this course in a systematic way. Reading the text and working through the exercises at a regular and steady pace will help ensure that you get the most out of this course and retain what you have learned.

In your first reading, concentrate on getting an overview of the chapter content. Read the learning objectives at the beginning of the chapter first. They will act as guidelines to the major topics of the chapter and identify the skills you should master as you study the text. As you read the chapter, pay attention to the headings and subheadings. Find the general theme of each section and see how that theme relates to others. Don't let yourself get bogged down with details during the first reading; simply concentrate on understanding and remembering the major themes.

In your second reading, look for the details that underlie the themes. Read the entire chapter carefully and methodically, underlining key points, working out the details of examples, and making marginal notes as you go. Complete the activities.

ACTIVITIES

Interspersed with the text of each chapter you will find a series of activities. These can take a variety of forms, including essays, short-answer quizzes, or charts and questionnaires. Completing the activities will enable you to try out new ideas, practice and improve new skills, and test your understanding of the course content.

THE REVIEW QUESTIONS

After reading a chapter and before going on to the next chapter, work through the Review Questions. Answering the questions and comparing your answers to those given will help you grasp the major ideas of that chapter. If you perform these self-check exercises consistently, you will develop a framework in which to place material presented in later chapters.

GRADING POLICY

The American Management Association will continue to grade examinations and tests for one year after the course's out-of-print date.

If you have questions regarding the tests, the grading, or the course itself, call Educational Services at 1-800-225-3215 or send an e-mail to ed_svc@amanet.org.

Pre-Test

Successful Project Management
Third Edition

Course Code 98005

INSTRUCTIONS: *Record your answers on one of the scannable forms enclosed. Please follow the directions on the form <u>carefully</u>. Be sure to keep a copy of the completed answer form for your records. <u>No photocopies will be graded</u>. When completed, mail your answer form to:*

Educational Services
American Management Association
P.O. Box 133
Florida, NY 10921

If you are viewing the course digitally, the scannable forms enclosed in the hard copy of AMA Self-Study titles are not available digitally. If you would like to take the course for credit, you will need to either purchase a hard copy of the course from www.amaselfstudy.org or you can purchase an online version of the course from www.flexstudy.com.

1. Which of the following is true of functional work?
   (a) Functional work is routine, ongoing work.
   (b) Functional work is a unique, temporary endeavor.
   (c) A functional manager is responsible for the approved objectives of a project (budget, schedule, and scope).
   (d) Functional work has a specific beginning and end.

2. Project quality management encompasses which of the following areas:
   (a) customer satisfaction.
   (b) prevention over inspection.
   (c) continuous quality improvement.
   (d) all of the above.

3. The critical path generally has:
   (a) zero duration.
   (b) zero float.
   (c) zero lag.
   (d) zero resources.

4. _____ reports include only major variations from the plan.
   (a) Schedule status
   (b) Cumulative
   (c) Exception
   (d) Summary schedule status

5. Potential risks can be classified in the following four ways:
   1. low impact; high probability
   2. high impact; high probability
   3. low impact; low probability
   4. high impact; low probability

   Which of the following describes the priority order in which you should address these risks (with the most important listed first)?
   (a) 2, 4, 3, 1
   (b) 4, 2, 3, 1
   (c) 2, 4, 1, 3
   (d) 4, 2, 1, 3

6. The major organizational structures are:
   (a) functional, project, and matrix.
   (b) project, operational, and functional.
   (c) reactive, proactive, and functional.
   (d) matrix, project, and operational.

7. Which of the following is the most common type of activity relationship used in a network diagram?
   (a) Start-to-start
   (b) Finish-to-finish
   (c) Start-to-finish
   (d) Finish-to-start

8. Which of the following is *not* true of project management?
    (a) Project management skills can help you complete projects on time, on budget, and on target.
    (b) Project management is a reactive management style.
    (c) Project management helps you avoid serious errors of omission and eliminate costly mistakes.
    (d) The objective of project management is to ensure that projects meet agreed goals of time, cost, and scope.

9. Which of the following is true about managing project objectives?
    (a) Logic network diagrams, schedules, and budget plans are used to manage the project.
    (b) A project activity that is completed early is a variance that causes no harm.
    (c) Quality and cost are more difficult to measure than scope and time.
    (d) The cause of a variance is of little consequence in managing project objectives.

10. Which of the following is true about project evaluations?
    (a) Reviews help ensure that the standards included in the project scope statement are being applied to the work.
    (b) Work on a project should be reviewed weekly as part of an ongoing quality assurance program.
    (c) Evaluation results should not be shared with workers because it can decrease motivation.
    (d) Periodic evaluations are necessary only on large projects to ensure compliance with industry standards.

11. A rolling wave estimate would be most appropriate in which of the following situations?
    (a) In projects with greater risk
    (b) In times of inflation when the cost of materials is increasing rapidly
    (c) In projects with a unit-price contract
    (d) When a novice project manager is assigned to a project

12. Which of the following is true in managing projects?
    (a) Accountability is an agreement between two or more people for the purpose of achieving a desired result.
    (b) Authority should be given commensurate with the responsibility.
    (c) Accountability is a detriment to good performance.
    (d) Responsibility is the power given to a person to complete an assignment.

13. Which of the following is true about risk management?
    (a) Potential risks should be identified before the project begins and during the course of the project.
    (b) Risks are uncertain events that have a negative effect on the project; those with positive effects are not considered risks.
    (c) Risk management should plan for all possible negative events, regardless of their impact or likelihood.
    (d) The purpose of risk management is to ensure that no negative events occur.

14. Which of the following statements is *not* true about the skills of a project manager?
    (a) The stronger a project manager's interpersonal skills, the greater the chance of successfully leading the project team.
    (b) A successful project manager needs to understand the culture of the organization.
    (c) A project manager needs greater technical skills than the team members.
    (d) Project managers typically use a combination of formal authority and persuasion skill.

15. Which of the following is true about evaluating team performance?
    (a) Team performance should be audited weekly to ensure schedules are met.
    (b) If consistent data are gathered over time, periodic reviews are not needed.
    (c) Team performance should not be compared with other companies since every project is unique.
    (d) Benchmarking can be a helpful point of reference to measure performance.

16. Which of the following is true about work breakdown structures?
    (a) Each box is a summary of the boxes in the levels below it.
    (b) The sum total of boxes must represent the complete project.
    (c) The boxes in the top level are called work packages.
    (d) The diagram should represent a logical or time sequence of events.

17. Which of the following is true about activities on the critical path?
    (a) The late start and early finish are the same.
    (b) The early start and late start are the same.
    (c) The early start and early finish are the same.
    (d) The early start and late finish are the same.

18. Budget cuts and cash flow problems are examples of:
    (a) logistical risks.
    (b) mitigation strategies.
    (c) financial risks.
    (d) contingency reserves.

19. Which of the statements below correctly identifies the relationship between project personnel?
    (a) Functional managers lead project team members.
    (b) Team members work with the project manager in the planning process.
    (c) Customers and project sponsors determine the sequence of individual project activities.
    (d) The project sponsor provides performance reviews for team members.

20. Which of the following is true about earned value analysis?
    (a) Schedule variance is determined by subtracting the earned value from the planned value.
    (b) The cost performance index is a ratio of budgeted costs to actual costs.
    (c) Cost variance is determined by subtracting the earned value from the actual cost.
    (d) A schedule performance index (SPI = EV/PV) greater than 1 means the project is behind schedule.

21. When using a cost-plus contract, who assumes the risk of unforeseen problems?
    (a) Contractor
    (b) Project manager
    (c) Worker
    (d) No one

22. A planning tool that displays the levels of project work is a:
    (a) Gantt chart.
    (b) Pareto diagram.
    (c) skills inventory.
    (d) work breakdown structure.

23. If you contract with a vendor to do a job for $90 per hour, you are using which type of contract?
    (a) Fixed-price
    (b) Unit-price
    (c) Cost-plus
    (d) Incentive

24. A risk response plan includes all of the following *except*:
    (a) possible risks, potential causes, and how they may affect the project.
    (b) a prioritized list of project risks, their owners, and planned responses.
    (c) warning signs of a possible risk occurrence.
    (d) a mitigation strategy to eliminate the possibility of risk events from occurring.

25. When a project schedule is slipping, corrective action might entail all of the following *except*:

(a) adding more or higher-skilled personnel.

(b) adding additional equipment or other resources.

(c) changing the sequence to allow activities to be done in parallel or to overlap.

(d) negotiating with preceding activities to complete their activities in a shorter time.

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Understanding Project Management

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Learning Objectives

By the end of this chapter, you should be able to:

• Identify the differences between functional and project management.
• Explain why project management is necessary in business today.
• Name the major organizational structures and explain the advantages and disadvantages of each.
• Identify the requirements of an effective project management system.

Many people become project managers by accident. Someone names you to manage a project because of your areas of expertise, not because you have any project management training. However, even if you *become* a project manager by accident, managing a project by accident is an invitation to disaster!

Learning project management skills can help you complete projects on time, on budget, and on target. The discipline of project management includes proven strategies for clarifying project objectives, avoiding serious errors of omission, and eliminating costly mistakes. It also addresses the necessary interpersonal skills for acquiring the cooperation, support, and resources to get the job done.

Project management is not just for project managers. Team members need to know how to carry out their parts of the project, and business executives need to understand how to support project management efforts in the organization.

WHAT IS PROJECT MANAGEMENT?

Project management consists of the knowledge, skills, methods, techniques, and tools used to plan and manage project work. It establishes a sound basis for effective planning, scheduling, resourcing, decision making, management, and plan revision.

Project management skills help complete projects on schedule, within budget, and in full accordance with project specifications. At the same time, they help achieve the other goals of the organization, such as productivity, quality, and cost-effectiveness. The objective of project management is to ensure that projects meet agreed goals of time, cost, and scope.

THE HISTORY OF PROJECT MANAGEMENT

Project management has been around since the beginning of time. Noah was a project manager. It took careful planning and execution to construct the ark and gather two of every animal on earth, including all the necessary food and water. The pyramids of Egypt stand today because of countless successful projects and project managers.

Although there have been brilliant project managers over the years, project management was not recognized as a formal management concept until operations research in the 1950s and 1960s pioneered methods and specialized tools to manage expensive, high-profile aerospace projects such as Polaris and Apollo. NASA and the U.S. Department of Defense established project management standards that they expected their contractors to follow. In the middle and late 1960s, business managers began searching for new techniques and organizational structures that would help them adapt quickly to changing environments. The 1970s and 1980s brought more published data on project management, leading to the development of theories, methods, and standards. The construction industry, for example, saw the potential benefits of formal project management and began to adopt standards and develop new techniques. Large-scale initiatives such as quality improvement and reengineering provided data, analysis, and problem-solving techniques, but no structured discipline to implement them. Therefore, managers turned to project management for direction in implementing and tracking such large-scale projects.

By the 1990s, industries in both profit and nonprofit sectors realized that the size and complexity of their activities were unmanageable without formal project management processes and tools.

PROJECT MANAGEMENT TODAY

Today, modern project management is a premier solution in business operations. Large and small organizations recognize that a structured approach to planning and managing projects is a necessary core competency for success.

International organizations such as the Project Management Institute (PMI®) and the International Project Management Association (IPMA) promote

project management by providing professional development programs. (Appendix C has contact information for these and other organizations.) PMI offers credentialed certifications (such as the PMP® Project Management Professional) to those who demonstrate competency in the field of project management through education and experience—and by passing rigorous certification exams. PMI sets standards and accredits degree-granting educational programs in project management. In 1987, PMI published the first *Project Management Body of Knowledge* (*PMBOK®*) to document and standardize generally accepted project management information and practices. The current edition, *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*), is a basic reference for anyone interested in project management. It provides a common lexicon and consistent structure for the field of project management. The *PMBOK® Guide*, which is studied and cited by thousands of project managers, is updated regularly.

Universities offer undergraduate and graduate degree programs in project management. Organizations such as PMI and ProjectWorld hold symposia and seminars throughout the year, which are great opportunities to increase skills, pick up new ideas from others' success stories, and network with other professionals. (See Appendix C for a list of organizations and websites.)

? Think About It . . .

Would applying project management standards in your organization produce benefits? How?

_____

_____

_____

_____

FUNCTIONAL WORK VS. PROJECT WORK

Project work and traditional functional work differ in significant ways. It is important to understand the differences.

Functional Work

Functional work is routine, ongoing work. Each day, secretaries, financial analysts, and car salespeople perform functional work that is mostly repetitive, even if their activities vary somewhat from day to day. A manager assigned to the specific function provides training and supervision, and manages them according to standards of productivity, such as quantity of work performed or number of sales.

The following are distinguishing characteristics of functional work:

- Functional work is ongoing, routine work.
- Managers manage the specific function and provide technical direction.
- People and other resources are assigned to the functional department.
- Functional departments are responsible for the approved objectives of the function, such as technical competency, standards of performance and quality, and efficient use of resources.

Functional work is typically structured as a hierarchical organization with traditional formal lines of authority, as shown in Exhibit 1-1.

Project Work

In contrast to ongoing, functional work, a project is "a temporary endeavor undertaken to create a unique product, service, or result" (*A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*), Project Management Institute, 2008, p. 5). Projects are *temporary* because they have a defined beginning and end. They are *unique* because the product, service, or result is different in some distinguishing way from similar products, services, or results. The construction of a headquarters building for ABC Industries is an example of a project. The unique work is defined by the building plans and has a specific beginning and end. A project manager is responsible for the project, overseeing the contractors, and managing the schedule and budget.

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*E*xhibit 1-1
Functional Organizational Structure
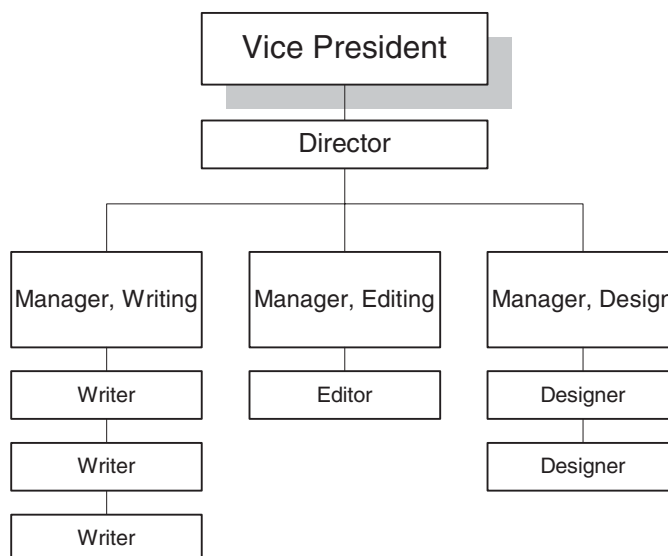
The following are distinguishing characteristics of project work:

- Project work is a unique endeavor that has a defined beginning and end.
- A project manager manages a specific project or projects.
- People and other resources are typically not assigned to project managers on an ongoing basis, except for project management support.
- A project manager is responsible for the approved objectives of a project, such as budget, schedule, and scope.

In mature organizations, multiple projects may be grouped and managed together in a *program* to obtain benefits and control not available from managing them individually. Multiple programs may be grouped and prioritized into *portfolios* aligned around larger strategic organizational objectives. *Portfolio management* is the "centralized management of one or more portfolios, which includes identifying, prioritizing, authorizing, managing, and controlling projects, programs, and other related work, to achieve specific strategic business objectives" *(A Guide to the Project Management Body of Knowledge (PMBOK® Guide)—Fourth Edition,* Project Management Institute, 2008, p. 9).

Project teams typically are not organized in the same hierarchical structure as that used by traditional functional groups. Project teams are organized in various ways, which are described later in this chapter.

Exhibit 1-2 illustrates how functional and project responsibility fit together, using the functional departments in a publishing company, with project managers assigned to accomplish specific publication projects. Solid vertical lines show the functional responsibilities of the writing, editing, design, printing, and distribution departments. Broken horizontal lines show the project responsibilities of specific project managers assigned to given publications (projects). Because not all projects require the services of every functional department, circles indicate where people are assigned to a project. Project #2 uses outsourced resources. Project #3 is a video that uses an external video duplication company rather than the internal printing facility.

A project manager manages horizontally via projects rather than vertically via functional experts. Exhibit 1-2 shows that Dennis is responsible for Project #1. To get the job done, he must enlist the help of editors and designers from one functional manager, and printers and distributors from another functional manager. In some organizations, functional managers are called *resource managers* because they are responsible for assigning resources to the project.

In the real world, there are at times overlaps between project and functional managers. If functional resources (other than a project management staff) are assigned to a project manager, then the manager has functional responsibility and is acting as both project manager and functional manager.

E xhibit 1-2
Functional and Project Responsibilities

Responsibility Grid

Project Manager		Functional Manager			Functional Manager	
		Writing	Editing	Design	Printing	Distribution
Dennis	Project #1		○	○	○	○
Carla	Project #2					
Larry	Project #3	○	○	○		○
Larry	Project #4	○			○	
Carla	Project #5			○		
Frank	Project #6	○		○	○	○
Carla	Project #7	○		○		
Frank	Project #8		○		○	○
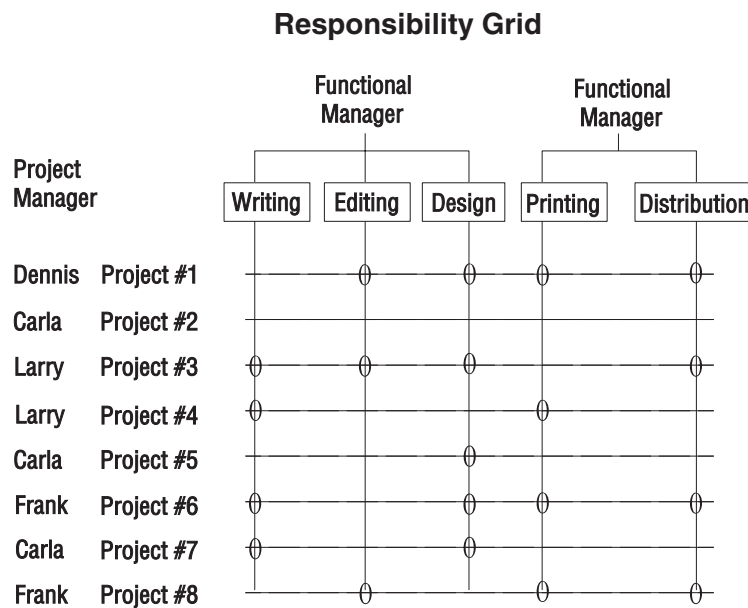
If projects are assigned to a functional manager, then the functional manager also has project responsibility and is acting in both roles. Exhibit 1-3 compares functional and project work.

The traditional functional approach is not adequate in a project environment and does not promote quality work on time and within budget. The project approach promotes the innovation, experimentation, and entrepreneurship needed in the workplace today.

E xhibit 1-3
Comparison of Project and Functional Work

	Functional	Project
Type of work	Repeated, ongoing.	Unique, no rehearsal. Often involves change.
Focus	Operations, accomplishing effective work.	Completing the project.
Management responsibility	Managing people.	Managing work.
Budgets	Ongoing operational budgets.	Project budgets to fund specific projects.

Exhibit 1-3 continues on next page.

Exhibit 1-3 continued from previous page.

	Functional	**Project**
Responsiveness to customers and changing environments	Less responsive. Longer response time.	More responsive. Shorter response time.
Consistency and standards	Industry standards.	May have fewer standards because work is unique.
Cross-cultural relevance	Varies across cultures.	More constant across cultures.
Risk	Ongoing work is stable and less risky.	Higher risk because work is unique and unknown.
Visibility	May have little visibility if standards are not met.	Obviously noted when project objectives are not met.

❓ Think About It . . .

Think of two examples of functional work:

_____

_____

Think of two examples of project work:

_____

_____

Does your organization understand the difference between project and functional work?

_____

_____

How can you help coworkers and management implement project management philosophies?

_____

_____

Think About It continued from previous page.

Draw a diagram showing how your organization manages projects.

WHY PROJECT MANAGEMENT IS NECESSARY IN TODAY'S WORLD

The need for project management is becoming increasingly apparent in the world today. Speed, quality, and cost management are taking on increased significance in business, government, and nonprofit sectors. Project management allows managers to plan and manage strategic initiatives that generate new revenue in expanding sectors of the market. Project management tools decrease time to market, manage expenses, ensure quality products, and enhance profitability. Project management helps sell products and services by positively differentiating them from their competitors. Project management is one of the most important management techniques for ensuring the success of an organization.

The global marketplace and e-commerce are forcing organizations to change. Consider the business trends in the next section.

Today's Business Trends

- The focus is on high quality, speed to market, and superior customer satisfaction. This can be accomplished only across functional lines of authority in a project environment. With the shift from mass production to custom production of goods and services, project management is an increasingly important aspect of a responsive management style. Businesses are shifting from traditional hierarchical management to project management. Organizational charts are changing from vertical structures to team-centered project structures.
- The traditional job, which consisted of doing the same tasks every day, is disappearing as routine office and factory work become automated. Middle management is also disappearing as companies rely on computers to gather and analyze information. The new focus is on projects and project teams assigned to solve specific problems. Teams might be set up to design a new product or reengineer the ordering process. Projects are conceived, staffed,

completed, then shut down. Project teams come and go as new problems and opportunities arise.

- The traditional career path is changing (Exhibit 1-4). Companies offer less job security as they refocus on core competencies and outsource noncore work. They teach marketable skills but do not promise a job tomorrow. People define their careers less by companies ("I work for Microsoft") and more by professions ("I design computer programs"). Personal success is measured by the value of the projects on which a person works. The goal is growth in the profession, not movement up the corporate ladder into management.
- Pay is determined by skill level and the marketability of a person's services rather than by managerial hierarchy.
- The typical company of tomorrow has four basic careers, as illustrated in Exhibit 1-4. This has been the norm for decades in Hollywood, where casting agents match actors with projects. In the entertainment industry, producers are the top-level management, casting and talent agents are the resource providers, movie directors are the project managers, and actors and crew are the talent.

A Proactive Management Style

Today's trends mean that management expects more with less. There is more pressure with less time, more work with less staff, and more cost management with less tolerance for mistakes. The solution to this dilemma lies in a proactive rather than reactive management style. Systematic project management is a proactive style. Exhibit 1-5 compares reactive and proactive styles.

Many companies conduct business as a series of projects. Each project is justified because it creates a product or service that the company can sell or because it reduces or controls costs. As the number of potential projects increases, there is a greater need to choose the right projects and execute them

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E xhibit 1-4
Careers in the Typical Company of Tomorrow

Career	Title	Function
Top-level management	CEO, president, executive VP	sets strategy
Resource provider	CFO, CIO, HR manager, VP of marketing, engineering, etc.	provides budget; develops and manages expert staffs
Project manager	project manager	uses money and people from the resource providers
Talent	chemist, engineer, accountant, programmer	reports to resource provider but spends much time on project teams

E | xhibit 1-5
Comparison of Reactive and Proactive Management Styles

Reactive	Proactive
Fire fighting	Planning and control

Managing by:
    instinct
    gut feel
    notes on a napkin
	Managing by:
	    information
	    analysis
	    control system

Speaking in generalizations	Using charts and graphs
Not seeing the big picture	Seeing the big picture
Not planning because it is a waste of time Not anticipating changes	Planning thoroughly on the front end with contingency plans for potential problems
Solving problems when they arise	Managing risk by identifying and avoiding problems rather than having to solve them

more efficiently. As competition between vendors increases, the winning company is the one with superior project management processes, reports, tools, and organization.

Organizations that were once hierarchical and bureaucratic now realize that success requires internal and external networking. Functional departments are no longer self-sufficient, but interdependent. Teams are formed from various functional departments to accomplish project work. When one project is complete, individuals are reassembled into another team to take on another project.

Exercise 1-1
Project Management in Today's World

Why is project management a sound strategy in today's business world?

_____

_____

How could you benefit from using more project management principles?

_____

Exercise 1-1 continued from previous page.

List projects you manage or would like to manage in the future. What problems do you see in managing the projects you have listed? As you read subsequent chapters, try to identify ways you can address these problems.

_____

_____

_____

_____

(Suggested answers are given in Appendix A.)

ORGANIZING FOR PROJECT MANAGEMENT EFFICIENCY

Smaller organizations may not have a formal project management structure. When a project is conceived, management might appoint a project manager and team members with little attention to the skills needed for the job. They take people from their regular jobs to work on the project, or worse yet, they ask team members to do the project in addition to their regular work.

This section discusses the need for an organization to formally adopt project management methodologies. It presents the major organizational structures and discusses the advantages and disadvantages of each. Finally, it gives some considerations on how to organize for greater efficiency and continuity in projects.

ADOPTING A PROJECT MANAGEMENT PHILOSOPHY

Many organizations have no formal project management system. They operate using rationalizations:

> "We have a set delivery date, so the project has to be completed by then."
> "Budget as much as you think will be approved, then don't spend any more than that."
> "Since the project must fit into our current environment, estimate its size to be no larger than we can handle."

People throughout the organization must understand and implement common project management principles. Everyone must recognize project manage-

ment as a professional discipline with specific skills and tools.

Senior management must recognize the need for project management and be willing to establish a formal project management system. Managing projects is considerably different from managing functional groups. Senior executives need to recognize that project management requires special concepts, skills, and tools. Managers schooled in traditional concepts of business management might find this difficult to understand. Also, functional line managers might have difficulty understanding the difference between functional and project responsibilities.

Implementing a project management system requires more than lip service; senior management must provide the time, budget, and resources to do it. The entire organization must have a long-term commitment to the project management process and support it without constantly shifting priorities.

The role and authority of the project managers must be clearly defined and supported. Project managers are not simply people selected from among the project teams; they need to have project management skills. If management simply assigns a technical person to be the project manager, the organization loses in two ways. First, if the person does not also have project management skills, the project might fail. Second, the organization loses a good technical person from the project team.

Also, the organization must be willing to change. Functional departments with a strong and unique sense of identity might feel that project managers cannot fully understand or correct their problems. Functional managers who have been unable to solve problems might work against the project manager's success. In some cases, people resist the project manager's tools (such as network planning and computerized tracking) because they represent change, which takes time and is often painful.

Your project management system needs to be adapted to your organization's specific corporate culture and needs. No one system works equally well in all organizations. Be willing to adapt the system as you experience successes or failures, so the system can operate at optimum efficiency in your organization. You may need to be patient in helping your organization adopt a project management system because it will take time to implement.

For project management to be effective in any organization, there should be formal, written policies and procedures that explain the role and authority of project managers and how project management functions in the organization. Exhibit 1-6 is an example of such a written policy statement.

E xhibit 1-6
Example of a Project Management Policy Statement

Project Management Division

Subject: Project Management System	Policy 5
Date of Origin: 15 December 2010	Revised 16 January 2011

Policy

   The company manages projects according to the project management system outlined in this policy.

Definition of a project

   A temporary endeavor undertaken to create a unique product, service, or result.

Responsibility

   The director of the Project Management Division is responsible for the operation of the project management system. The director prepares policy statements and maintains the policy and procedure manual. The director tracks all approved projects and reports project status to senior management.

Project objectives

   All projects are defined in terms of (1) cost, (2) time, and (3) project scope. These objectives are the basis for project approval, budgeting, tracking, and reporting.

Project managers

   A project manager is assigned to each project when it is approved. The manager may be from the Project Management Division or from another functional division as needed. The project manager is responsible to see that the project accomplishes its objectives of cost, time, and project scope. The lines of responsibility and communication with senior management will be identified as needed with each project.

? Think About It . . .

Does your organization have written statements like Exhibit 1-6? Could it benefit from such a statement?

ORGANIZATIONAL STRUCTURES

The organizational structure strongly influences how efficiently project management operates. It often constrains the availability of resources or the terms under which resources are available to the project. Organizational structures typically span the spectrum from functional to project, with a variety of matrix structures in between. The next sections describe the characteristics, advantages, and disadvantages of functional, project, and matrix organizational structures. It is important to understand how your organization is structured so you can decide how to use project management techniques within that context.

Functional Organization

The classic functional organization is a hierarchy in which people are grouped into functional divisions, such as marketing or production. Each employee has one clear superior. In functional organizations, the scope of projects is typically limited to the boundaries of the functional division. Each division has its own project managers who report to the head of the division, as illustrated in Exhibit 1-7. These project managers operate independently from project managers in other divisions.

Characteristics

- Project managers operate within the division and have a level of expertise within their areas of responsibility. For example, project managers in the marketing division come from the ranks of salespeople.
- Directors of the functional divisions manage both project and functional personnel. They are responsible for defining requirements, scheduling work, setting priorities, providing facilities, acquiring and managing resources, adhering to company policies, and ensuring quality.
- People are assigned to work on projects for which their skills and services are needed. They might be moved around within the division as needed.

E **xhibit 1-7**
Functional Organizational Structure
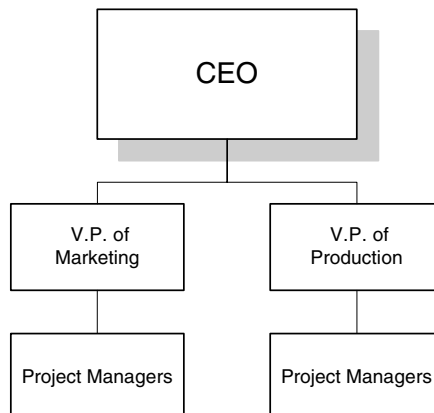
Advantages

- Projects can be completed more accurately. Because project managers and team members have expertise in the functional area, project requirements can be defined and challenged intelligently. This means that fewer changes will be made and that a more practical end product can result.
- Project personnel are accountable for their work. Since they must live with the end result of the project, they are committed to it.
- Because personnel have functional expertise, learning time is reduced. Problem situations can be identified and corrected quickly.

Disadvantages

- The focus on the needs of the functional division might make it difficult to see and respond to the needs of the organization as a whole. Enterprise policies and practices might not be enforced uniformly across divisions.
- Project management and status reporting to upper management is not standardized across the organization. It might be difficult for senior executives to manage the various projects within the organization.
- Project costs tend to have little or no accounting. Many aspects of a project are handled as ongoing functional work of the division, so it might be difficult to identify and account for the true cost of a project.
- The distinction between project and functional roles might be vague, and projects might be lost in routine work.
- It is more difficult to staff and run projects that span divisions.
- Good project managers cannot easily be moved across divisions to more critical projects.

Project Organization

In a project organization, projects are centralized in a separate division of skilled project managers that serves the project management needs of all divisions of the company (see Exhibit 1-8). This is often referred to as a *project management office (PMO).* A centralized project management office is responsible for the direct management of all the projects in an organization.

E xhibit 1-8
Project Organizational Structure
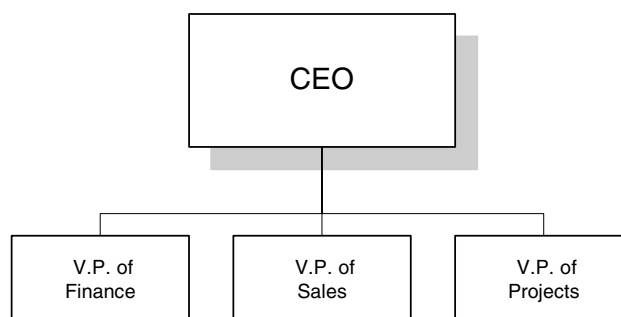
Typical responsibilities of a project management office include the following:

- Enterprise policies, processes, methodologies, and templates.
- Resourcing and training of project managers.
- Project support services, including project management computer systems.

Characteristics

- A central group is responsible for planning, managing, and reporting the progress of all projects under its domain.
- This centralized project office develops and refines project management processes, practices, and standards and implements them uniformly throughout the organization.
- Project managers typically manage shared resources across all projects.

Advantages

- Common standards of planning, managing, and reporting exist throughout the life of each project and are applied across all projects. These common standards aid communication and provide efficiency.
- Highly skilled project managers can be available for the benefit of all.
- Refined project management processes usually result in projects being completed more often on time, within budget, and in accordance with project scope.
- Costs can be reduced by using common tools (such as project management software) to manage all projects.
- Centralized data from all projects can be analyzed and applied to future projects to improve the accuracy of estimates and practices. A centralized organizational structure makes it easier to see productivity trends and take steps to improve processes in the organization.
- All projects of the organization can be managed as a whole. Enterprise portfolio management allows senior management to set priorities across projects and allocate resources for the overall good of the organization.

Disadvantages

- Standards and documentation can become excessive, and without careful vigilance, the centralization of project managers and practices can become self-serving. Rather than serving the needs of the project office, careful focus must be given to the needs of the project and the people it benefits.
- If processes become excessive, the total cost to manage a project under a centralized organizational structure can be higher than under other structures. The project office must constantly assess the value they provide to ensure that the value exceeds the cost.
- Project managers might not have the technical background needed for a project, and might have little access to people with the appropriate knowledge and skills.
- Project managers might seem unresponsive to the needs of people who request their time and skills. Because project managers are located in a sep-

arate project office, they might become out of touch with the needs and practices of individual departments.

Matrix Organizations

Matrix organizations are a blend of functional and project organizations. A weak matrix (see Exhibit 1-9) has many of the characteristics of a functional organization, and the project manager role is more of a coordinator or expediter with limited authority. A strong matrix organization (see Exhibit 1-10) has many of the characteristics of a project organization, with a full-time project manager who has significant authority and a project administrative staff. In a matrix organization, the project team has a dual reporting role to a project manager, coordinator, or expediter (who provides project management skills) and a functional manager (who provides technical and functional skills).

Characteristics

- Because a matrix organization has characteristics of both the project and functional organizations, project personnel report to both functional and project lines.
- Project personnel report to a functional manager for definition of requirements, feasibility and economic evaluation, changes in priorities, allocation of work, and ultimate success or failure in meeting their goals.
- Project personnel report to a project manager for refining tasks and assignments, planning and budgets, and project schedules.

In a strong matrix organizational structure, the project manager has more power than the functional manager. In a weak matrix structure, the balance of power leans toward the functional manager.

E | xhibit 1-9
Weak Matrix Organization
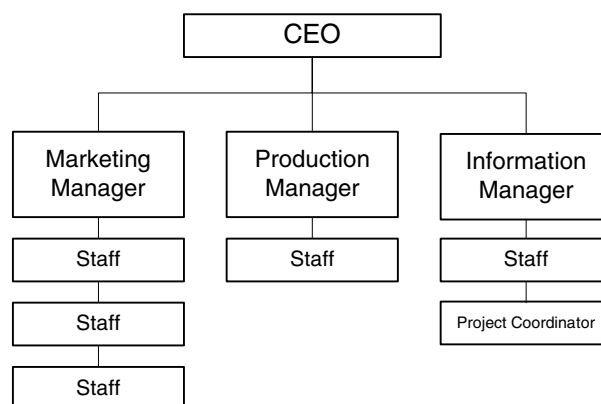
Staff from different functional departments are assigned to a project.
One staff member is assigned to coordinate the project.

E xhibit 1-10
Strong Matrix Organization
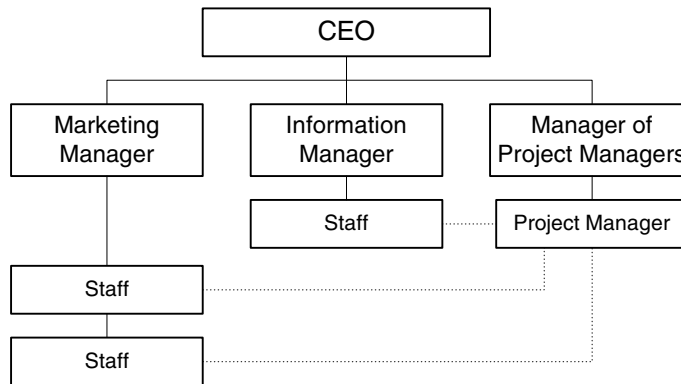
Project Manager is assigned to manage the project and staff from different functional
departments are assigned to work on the project.

Advantages

- A matrix structure combines a project structure (project office) and a functional structure. Personnel and skills are less redundant, and when expertise is scarce, it may be applied more flexibly to different projects.
- The focus on teamwork accommodates changes in personnel requirements. Conflicts between project requirements and functional organization policies may be perceived and resolved readily.
- The expertise of both project and functional management is available to assist in the project, and both can be applied to handle complex issues and coordinate various tasks.

Disadvantages

- Dual management lines make communications more difficult to manage. When team members receive conflicting instructions from project and functional managers, time and effort are wasted clarifying the communication. The team might be unable to react fast enough to meet changing project requirements.
- Conflicts and competition can exist between project and functional management. In the process of resolving conflicting priorities, project personnel can become confused and demoralized.
- If conflicting priorities and personal power struggles are not quickly resolved, it can be damaging—or fatal—to the project.
- Projects are influenced by the organizational structure under which they operate. The chart in Exhibit 1-11 shows project manager authority in each of the organizational types.

E xhibit 1-11
Project Manager Authority by Organizational Type

Organizational Structure	Project Manager Authority	Percent of Personnel Assigned Full-Time to Project Work	Project Manager's Role	Common Titles for Project Manager	Project Management Staff
Functional	little or none	none	part-time	Project Facilitator or Coordinator	part-time
Weak matrix	limited	0–25%	part-time	Project Coordinator or Leader	part-time
Balanced matrix	low	15–60%	part-time or full-time	Project Coordinator or Manager	part-time
Strong matrix	moderate	50–95%	full-time	Project or Program Manager	full-time
Project	high to almost total	85–100%	full-time	Project or Program Manager	full-time

FUNCTIONING EFFECTIVELY

Now that you understand the basic organizational structures, compare them with your organization and identify your current structure. Reread the advantages and disadvantages of your organizational structure and keep them in mind as you operate within that structure.

When faced with difficulties, many project managers jump to the conclusion that restructuring the organization will solve all the problems. Although it is important to have the right organizational structure, it is unhealthy to reorganize too often. Petronius Arbeiter illustrated this fallacy about two thousand years ago (Townsend, 1970):

> We trained hard, but it seemed that every time we were beginning to form up into teams we would be reorganized. I was to learn later in life that we tend to meet any new situation by reorganizing, and a wonderful method it can be for producing the illusion of progress while creating confusion, inefficiency, and demoralization.

As you have seen, each possible organizational structure has both advan-

tages and disadvantages. Before your organization considers reorganizing, be sure that the advantages outweigh the disadvantages to your organization. The advantages must be significant enough to make up for the confusion and pain of making the change. Reorganizing has a significant impact on any organization. Do not underestimate the lost productivity during the time it takes to make the change. It will take time for people to function efficiently under the new structure.

Exercise 1-2
Organizational Types

Determine which of the basic organizational types describes your current organization. Draw a chart of your current organizational structure, using solid lines to show formal reporting relationships and broken lines to show lines of communication.

Review the characteristics, advantages, and disadvantages listed in this chapter for your organizational type. List the things you need to do to work effectively within this structure.

_____

_____

_____

How often does your organization follow effective project management processes? Score your responses in the appropriate spaces on a scale of 0 to 10 as indicated below:

0	1	2	3	4	5	6	7	8	9	10
Never		Almost never			Sometimes		Almost always			Always

What can you do to better implement project management?

_____

_____

_____

PROJECT LIFE CYCLE

A good project management system follows a standard project life cycle with defined project phases. *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*) draws from best practices in the project management profession to provide a general framework for starting projects, organizing and preparing, carrying out the project work, and closing projects. Although this generic life cycle may be adapted to the specific needs of your organization, it is important to have a structure in place to provide a common reference for comparing projects and communicating throughout the organization. The

PMBOK® Guide defines five general process groups:

1. *Initiating:* Defining and authorizing the project.

2. *Planning:* Establishing the project scope, refining the objectives, and defining the course of action to attain the objectives.

3. *Executing:* Integrating people and other resources to carry out the work defined in the project plan.

4. *Monitoring and Controlling:* Tracking, reviewing, and regulating the progress and performance of the project plan, identifying where changes to the plan are required, and taking corrective action.

5. *Closing:* Finalizing all activities across all the process groups to formally close the project.

Although it is important to understand these general processes and learn the skills needed to execute each process, in practice, these processes overlap and interact in iterative ways, and many processes are repeated during the project. More detail about each of these processes is found in chapters throughout this course.

Exercise 1-3
Project Life Cycle

Consider how you or others in your organization initiate, plan, execute, monitor, control, and close projects. Rate the current effectiveness according to the following statements.

Project plans are in sufficient detail to effectively manage projects.

0	1	2	3	4	5	6	7	8	9	10
Strongly disagree			Disagree		Neutral		Agree			Strongly agree

The level of management is at the same level of detail as the plan.

0	1	2	3	4	5	6	7	8	9	10
Strongly disagree			Disagree		Neutral		Agree			Strongly agree

My organization is able to respond to changes during the life of a project.

0	1	2	3	4	5	6	7	8	9	10
Strongly disagree			Disagree		Neutral		Agree			Strongly agree

As you read subsequent chapters in this course, consider things you could do to improve the above scores.

Exercise 1-4
CXI Cellular Case Study

CXI Cellular of Salt Lake City, Utah, is an innovative manufacturer of cellular phone products. One of their bright, young engineers has designed a new cellular phone that is 25 percent smaller and lighter than any competitor's phone. The vice president of marketing has named Robert, her top salesman, to manage a project to engineer and manufacture the new product. She asks Robert to develop a schedule and budget and present it to the executive management team the following week.

When Robert presents his plans to the executive management team, there is considerable discussion about whether the company should begin manufacturing the new phone. After the meeting, the chief operations officer (COO) of the company approaches Robert and asks him to move forward with the project and report directly to him. The COO asks to personally approve each project expense. In the meantime, the COO will work on getting the approval of the executive team.

Based on the concepts presented in this chapter, what steps should Robert take to ensure the success of the project? Consider the following in your answer:

- Have project management principles been followed?
- Have roles and responsibilities been properly defined?
- Is Robert qualified to be a project manager?
- Has there been proper management approval?

(Suggested answers are in Appendix A.)

recap

Project management is a set of knowledge, skills, methods, techniques, and tools that people use to effectively plan and manage project work. It establishes a sound basis for effective planning, scheduling, resourcing, decision making, managing, and plan revision. The objective of project management is to ensure that projects meet agreed goals of time, cost, and scope.

Today, modern project management is a premier solution in business operations. Large and small organizations recognize that a structured approach to planning and managing projects is a necessary core competency for success.

Project work and traditional functional work differ in significant ways. Functional work is routine, ongoing work. A manager is assigned to the specific function and provides worker training and supervision. In contrast, a project is "a temporary endeavor undertaken to create a unique product, service, or result." A project manager is responsible for the approved objectives of a project, such as budget, schedule, and scope.

The need for project management is apparent in the world today as speed, quality, and cost management are becoming increasingly important. Implementing a project management system requires a long-term commitment and management support. It is important to understand how your organization is structured so you can decide how to fit project management

techniques into it. Organizational structures typically span the spectrum from functional to project types, with a variety of matrix structures in between. A functional organization is a hierarchy in which people are grouped into functional divisions, such as marketing or production. Each employee has one clear superior. In a project organization, projects are centralized in a separate division of skilled project managers that serves the project management needs of all divisions of the company. This is often referred to as a *project management office.*

Matrix organizations are a blend of functional and project structures. A weak matrix has many of the characteristics of a functional organization and the project manager role is more that of a coordinator or expediter with limited authority. A strong matrix organization has many of the characteristics of a project organization, with a full-time project manager who has significant authority and a project administrative staff. In a matrix organization, the project team has a dual reporting role to a project manager, coordinator, or expediter (who provides project management skills) and a functional manager (who provides technical and functional skills). In a strong matrix organizational structure, the project manager has more power than the functional manager. In a weak matrix structure, the balance of power leans toward the functional manager.

It is important to set up a formal planning and management system that is flexible enough to operate in the real world, but still rigorous enough to provide control. A project management system must allow for adjustments to the plan as needed throughout the project's life. The system helps you define the problem or opportunity, establish project objectives, develop the project plan, begin project work, monitor and manage the work, and then close the project.

Review Questions

INSTRUCTIONS: Here is the first set of review questions in this course. Answering the questions following each chapter will give you a chance to check your comprehension of the concepts as they are presented and will reinforce your understanding of them.

As you can see below, the answer to each numbered question is printed to the side of the question. Before beginning, you should conceal the answers by placing a sheet of paper over the answers as you work down the page. Then read and answer each question. Compare your answers with those given. For any questions you answer incorrectly, make an effort to understand why the answer given is the correct one. You may find it helpful to turn back to the appropriate section of the chapter and review the material of which you were unsure. At any rate, be sure you understand all the review questions before going on to the next chapter.

1. Which of the following is true of a matrix organization?   1. (b)
    (a) In a strong matrix, the functional manager has more power than the
        project manager.
    (b) Conflicts between project requirements and functional organization
        policies are perceived and resolved more readily.
    (c) A matrix reduces conflicts and competition between project and
        functional management.
    (d) Dual management lines facilitate communication.

2. Which of the following is true of project and functional work?   2. (a)
    (a) Secretaries, financial analysts, and car salespeople are examples of
        those who perform functional work.
    (b) Project managers are responsible to deliver the agreed-upon outcomes
        of a project.
    (c) The focus of project work is accomplishing effective, ongoing work.
    (d) Functional managers are responsible for achieving the approved
        objectives of a project.

3. Which of the following is true of project planning?   3. (c)
    (a) Planning must be completed before any project work begins.
    (b) Since things invariably change during the life of the project, you
        should spend no more than 5 percent of the project on planning.
    (c) You cannot manage without a plan.
    (d) Once you develop a plan, it is important to stick with it throughout the
        life of the project.

4. Which of the following describes the proper sequence of elements in   4. (d)
a planning and management system?
  (a) Establish project objectives, define the problem or opportunity, develop
      the plan, begin project work, monitor, manage, close the project.
  (b) Establish project objectives, develop the plan, define the problem or
      opportunity, begin project work, monitor, manage, close the project.
  (c) Define the problem or opportunity, develop the plan, establish project
      objectives, begin project work, monitor, manage, close the project.
  (d) Define the problem or opportunity, establish project objectives,
      develop the plan, begin project work, monitor, manage, close the
      project.

5. All of the following are true of project management *except:*   5. (c)
  (a) projects and project teams help an organization solve specific problems.
  (b) project management can help deliver projects on time and decrease
      time to market.
  (c) project management works best in a functional organizational
      structure.
  (d) project management tools help manage expenses and ensure quality
      products.

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Defining the Roles of the Project Manager and the Team
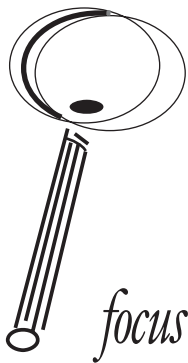
Learning Objectives

By the end of this chapter, you should be able to:

- Define the roles of the project manager and the project team members.
- List the skills of a project manager.
- Explain the balance needed in responsibility, accountability, and authority.
- Define the roles of project sponsor, customer, and other stakeholders.

The role of the project manager can be a tricky one, especially when the project manager has no formal authority over the people he or she must work with to get the job done.

THE ROLE OF THE PROJECT MANAGER

The project manager is the person assigned to manage a specific project, and the one who is expected to meet the approved objectives of a project—including project scope, budget, and schedule. She or he has overall responsibility for planning, organizing, integrating, managing, leading, decision making, communicating, and building a supportive climate for the project.

Specifically, the project manager:

- Leads the project and provides vision, direction, and encouragement.
- Balances quality, availability of resources, and risk management.
- Schedules appropriate feasibility reviews, in order to ensure that the project is realistic, necessary, and well defined.

- Determines the schedules, resource plans, and budgets necessary to accomplish the project objectives.

Once top management has approved the project plan, the project manager carries it out. This includes carefully monitoring and reporting on progress, resolving problems as they arise, controlling any changes in the project plan, and managing risk. When all project objectives are met, the project manager declares the project complete.

Except for a project management support team, people and other resources are not typically assigned directly to the project manager. In a large project, a support team of clerks, accountants, and others might be assigned to help with specific management tasks. In a small project, there might be no support team.

PROJECT MANAGER SKILLS

Exhibit 2-1 shows the basic skills a project manager needs. A project manager needs to be strong in all five areas to be successful.

Project Management Skills

Project management skills include the tools needed to plan and execute a project, such as being able to estimate costs, and to prepare workable schedules and adequate budget plans. To execute a project, a project manager needs to be able to analyze status information, prepare clear reports, and conduct project audits. These technical skills are discussed in Chapters 3 to 8.

E xhibit 2-1
Basic Project Manager Skills
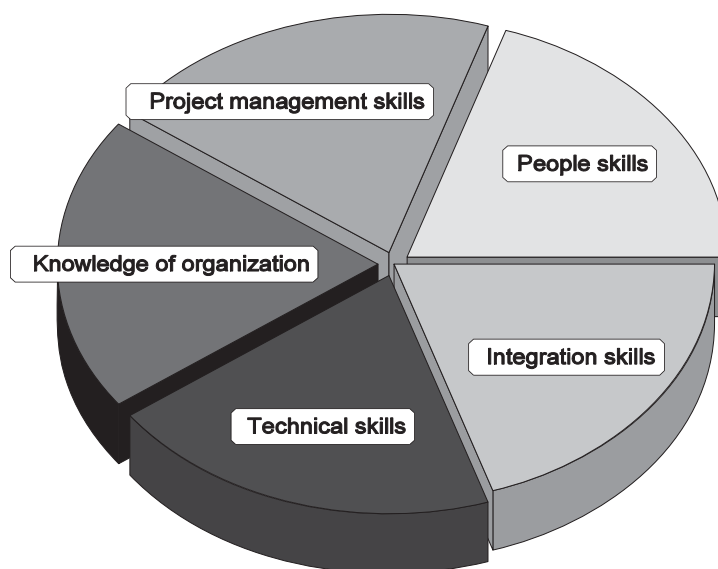
To be successful, a project manager should constantly improve management skills through reading or attending seminars and workshops. Universities, private training companies, and organizations such as the American Management Association and the Project Management Institute routinely offer training opportunities. (See Appendix C for a list of organizations that provide training.)

Teamwork

In working with team members, project managers use a combination of formal authority and persuasion skills. Teamwork is a critical factor in a project's success, and one of the primary responsibilities of a project manager is to lead an effective project team. Project managers should have the interpersonal skills necessary to build, motivate, lead, and inspire a project team to perform well and achieve the project objectives. Critical skills needed by a project manager include the following:

- Developing a trusting, dynamic, and cohesive team culture.
- Providing mentoring and training opportunities for the team to acquire the knowledge and skills necessary.
- Motivating the team by providing challenges and opportunities and helping them understand the importance of the project.
- Providing timely feedback and support to the team.
- Recognizing and rewarding good performance.
- Communicating effectively.
- Managing change.
- Resolving conflict.
- Encouraging collaborative problem-solving and decision-making.

Integration Skills

One of the project manager's primary duties is to coordinate the many elements of the project. In particular, the various phases of project work such as planning, execution, reporting, and management must be integrated. The more complex the product, the greater the need for integration. For example, the project manager might have to integrate electrical drawings from the engineering staff with functional specifications from the civil engineers. Engineers and designers should be involved not only in the design process, but also in the approval of the final design and specifications. Other players that likely need to be involved in the approval and acceptance phases include accounting and executive management to sign off on the project.

Project integration management also involves making trade-offs among competing options to accomplish the project objectives.

Technical Skills

Since project managers do not perform the actual work of the project, they do not need the same technical skill level as the people doing the work. However, the more expertise the project manager has in the technical area of the project, especially in highly technical projects, the greater the manager's effectiveness

in managing the project. As the project manager integrates all aspects of the project, technical expertise is essential to identify potential problems.

However, as the project manager gains technical experience, she or he must also be careful to maintain a broad perspective and not let technical expertise lead to micromanaging, or worse yet, doing the project work! The project manager must concentrate on managing the project, allowing team members to perform the technical work and confining his or her technical involvement to evaluating the work of the team.

Knowledge of the Organization

The most proficient project management skills in the world will not compensate for a procedural blunder caused by not understanding the company culture, policies, personalities, or politics. The project manager negotiates with many people and needs to know their personalities, needs, and desires.

The more the project manager knows about the organization, the better equipped that manager is to maneuver around pitfalls and get what is needed for the project. Every organization has a unique culture, and individual divisions within an organization often have their own personalities. Understanding these cultures and personalities can help a project manager be more successful.

? Think About It . . .

Think of one or two things in each skill area that you need to improve:

Project management skills

_____

_____

Interpersonal skills

_____

_____

Integration skills

_____

_____

Technical skills

_____

_____

Think About It continued from previous page.

Knowledge of the organization

The Makeup of a Project Manager

Project management is a combination of many ingredients, including large measures of common sense, ambition, flexibility, resourcefulness, a healthy appetite for negotiation, and a genuine belief that the service performed is of value to the organization.

An effective project manager involves many people in the planning process and asks many questions, such as: "What could go wrong?" or "What if this happens?" The project manager anticipates problems and disagreements and builds agreements out of these conflicts. The manager takes every opportunity to build commitment from the various members of the project team. The project manager keeps appropriate people informed and involved throughout the process, soliciting input and suggestions.

No matter how well a project manager plans and executes a project, there will always be problems. The creative challenge is to be able to use imagination and experience to solve problems in creative ways. The problems that arise are seldom unique. Successful project managers solve problems by applying their cumulative knowledge and experience to each obstacle. Over time, their experience likely offers a precedent to almost any problem. Lessons learned in dealing with one project, if applied imaginatively, can go a long way toward solving similar problems in other projects.

However, experience alone is not enough to make an individual a successful project manager. Experience without the imagination to use it constructively and creatively is more likely to be a handicap than an advantage. For some people, years of experience can serve as a straitjacket. Such managers are blinded by their past experience and can only repeat what they first learned, unable to imagine new ways of addressing problems. Instead of adapting what they know to new situations, they try to make all new situations conform to patterns with which they are familiar.

The successful project manager is both a content specialist and a generalist. As a generalist, the manager has broad technical knowledge of the diverse factors that affect a project, including aspects of the organization's operation and the industry as a whole. As a content specialist, the manager has a depth of technical knowledge about the project at hand. He or she succeeds because of a drive to understand the requirements, operations, and problems of project sponsors, the project team, and the industry.

A good example of the importance of gaining both specific and general knowledge is found in the book *How to Be a Successful Executive* by J. Paul Getty.

It tells of a company that was embarking on an extensive plant modernization and expansion program. Just before the company placed an order for expensive production machinery, one of the company's junior executives learned that an obscure manufacturer had developed vastly improved machinery that was more suitable for its needs. Not only was the company saved from making a huge investment in machinery that would have soon been obsolete, but it also obtained the latest equipment well ahead of its competitors.

This is a good example of an individual's alertness and enterprise, but it is not the full story. The junior executive was not a technical expert or engineer. His duties were concerned with sales, not production. After a meeting where the plant modernization program was discussed, he took the initiative to research the problem, and found information about the new machinery in an obscure trade journal. His keen interest helped the company succeed.

A project manager who shows this type of initiative and understanding can have a positive impact on the cost, quality, and timeliness of projects.

Exercise 2-1
Project Manager Effectiveness

Rate yourself on how effectively you manage projects according to the statements below. If you have not yet managed projects, consider how well projects are managed in your organization.

I involve many people in the planning process.

0	1	2	3	4	5	6	7	8	9	10
Strongly disagree			Disagree		Neutral		Agree			Strongly agree

I find creative ways to solve problems.

0	1	2	3	4	5	6	7	8	9	10
Strongly disagree			Disagree		Neutral		Agree			Strongly agree

I apply specialized and general knowledge to the project.

0	1	2	3	4	5	6	7	8	9	10
Strongly disagree			Disagree		Neutral		Agree			Strongly agree

Now list five factors (labeled A through E) that inhibit your success in managing projects:

_____

_____

_____

_____

_____

Exercise 2-1 continued from previous page.

Prioritize the five factors in order of their importance to you (with number 1 being the most important), then rank each factor on your ability to change it (with number 1 being the most open to change). Plot factors A to E on the grid in Exhibit 2-2, using the Priority ranking along the left side and the Ability to Change across the bottom. Place the letter of the factor in the grid where the two coordinates meet.
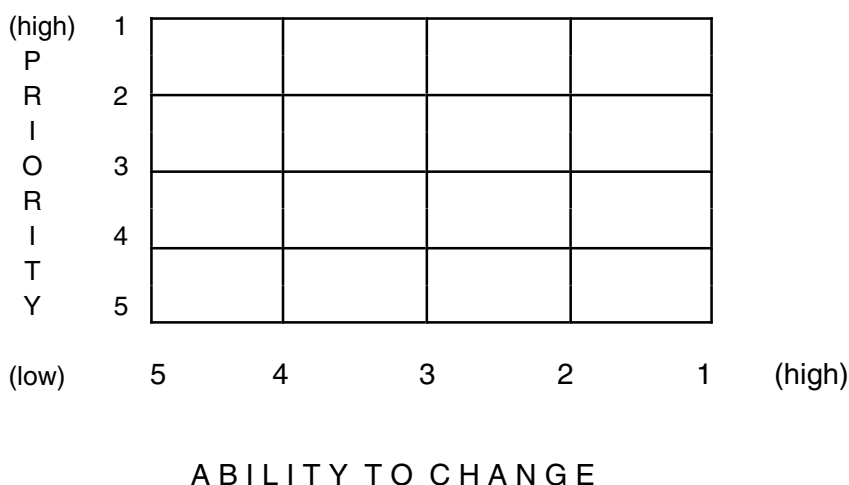
The chart in Exhibit 2-3 divides the grid in Exhibit 2-2 into four quadrants, then rates the items as they fall into the quadrants. Focus first on issues with high priority and high ability to change. These issues are most important and deserve your attention. Bring those with high priority and low ability to change to the attention of management, so they can determine how these issues can be addressed.

Focus next on issues of low priority and high ability to change. Although these are not as important, they may be worth pursuing since you have an ability to change them. The low priority issues with low ability to change probably do not deserve much attention.

PROJECT MANAGER RELATIONSHIPS AND TOOLS

The skills you use as a project manager vary depending on your relationship with others. You might be more effective as a leader, negotiator, salesperson, or broker of information and services, depending on whom you are dealing with and the nature of your relationship with them, as illustrated in Exhibit 2-4.

E xhibit 2-2
Grid for Ranking Issues Inhibiting Success in Managing Projects

A B I L I T Y   T O   C H A N G E

E xhibit 2-3
Chart for Rating Issues Inhibiting Success in Managing Projects

		(high) 1	High Priority; Low Ability to Change	High Priority; High Ability to Change

Priority axis (top to bottom): (high) 1, 2, 3, 4, 5; labeled P R I O R I T Y; (low) at bottom.

	High Priority; Low Ability to Change	High Priority; High Ability to Change
	Low Priority; Low Ability to Change	Low Priority; High Ability to Change

(low) 5   4   3   2   1   (high)

ABILITY TO CHANGE

E xhibit 2-4
Project Manager Relationships and Tools

Relationship	Your Role	Negotiating Tools
Subordinate (people who report directly to you, team members, or vendors) You rely on them for results. They rely on you for performance reviews and payment.	Leader	Formal, written objectives Performance management (feedback, consequences)
Peer (support groups, team members, functional managers) You rely on them for results. They do not rely on you for performance reviews or payment.	Negotiator, salesperson, or broker	Informal goals Performance management Performance contract (when necessary)
Superior (your boss, senior management, client, or customers) You rely on them to define the project and to provide resources, your performance review, and payment. They rely on you for results.	Salesperson and broker	Technical analysis and information Alternatives and recommendations Sales presentation

? Think About It . . .

Does your management understand and respect the role of a project manager? What could you do to help management understand it better?

_____

_____

_____

_____

_____

RESPONSIBILITY, ACCOUNTABILITY, AND AUTHORITY

A common cause of problems in managing projects is a breakdown in the balance of responsibility, accountability, and authority. Therefore, it is important that the project manager understand these issues and be able to keep them in balance, since they can dramatically affect performance. Exhibit 2-5 illustrates the relationship among these three aspects of management.
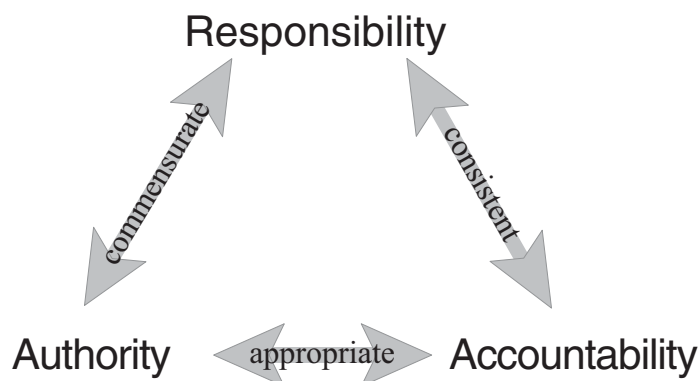
Responsibility

Responsibility requires an agreement between two or more people for the purpose of achieving a desired result. A project manager is responsible for ac-

E xhibit 2-5
The Relationship of Responsibility, Authority, and Accountability

complishing the goals of the project; however, the team leader might assign all or part of that responsibility to other people on the team. It is important to remember, though, that even when the manager has passed along all or part of the responsibility for completing tasks associated with the project, the project manager still retains *full* responsibility for the final result. The project manager must make sure the assigned responsibility is clearly stated and the expected results are mutually understood and accepted by all parties.

Accountability

Accountability is a consequence of assigned responsibility. When a project manager assigns responsibility to another person, the manager must hold that person accountable for achieving the desired result or provide consequences for poor performance, such as a negative employee rating, deduction in pay, reassignment, probation, or termination. The accountability must be consistent with the responsibility assigned. For example, if a manager assigns a contractor to remodel an office, the manager should hold the contractor accountable for the responsibility assigned. This may include quality of work performed, adherence to schedule, and completing the job within budget. However, the manager must assess responsibility with care. In this example, the contractor should not be held responsible for lost productivity when workers are moved to temporary offices during remodeling, since this is out of the contractor's control. Although such inconsistent accountability is clearly unreasonable, it can and does happen.

Accountability is a major source of information and motivation. A reliable system of accountability makes good performance visible and provides a basis for accurate performance appraisals. It shows team members that good performance matters and is rewarded. When a project manager holds team members accountable, it helps identify and focus on the sources of problems. Accountability helps decrease poor performance and increase good performance.

Authority

Authority is the power given to a person to complete the assigned responsibility. It includes the appropriate access to resources to complete the job, such as access to personnel or signature authority for the expenditure of funds. Authority must be commensurate with the responsibility assigned and appropriate to the accountability. To continue with our previous example of the office remodeling job, the manager should give the contractor the appropriate authority to complete the work. This may include a budget and access to the building commensurate with the size and scope of the remodeling job. A budget of $25,000 for a job estimated at $50,000 would not grant the contractor the authority, or power, to complete the job. If the schedule requires overtime and night work, the manager needs to grant workers 24-hour access to the building. If this access is denied, the contractor cannot be held accountable if the schedule is not met.

If a person has little experience or skill in a particular area, the project manager might need to grant authority incrementally and monitor the project

closely at the beginning. Then, as skill level and experience increase, the manager can grant more authority and check up less often, until full authority is warranted.

Maintaining the Balance

Project managers must maintain good balance in assigning responsibility, delegating authority, and holding people accountable. The authority must be appropriate for the responsibility, and the accountability must be commensurate with the authority and the responsibility.

Successful organizations have written policies and procedures that define how responsibility, accountability, and authority work in the project management environment. It is important to define in writing the specific responsibilities and authority given to the project manager, in terms of personnel, equipment, materials, and funds. Will the project manager have authority to hire and terminate team members, or will the functional managers handle these responsibilities? What purchase authority will the project manager have to obtain equipment and materials necessary to the project? What signature authority will the project manager have for other project expenditures? If such policies are not in place in your organization, it may be important to your success as a project manager to help get these established.

Exercise 2-2
Responsibility, Accountability, and Authority

How well do you balance responsibility, accountability, and authority? Score your responses in the appropriate spaces on a scale of 0 to 10, as indicated below:

When you assign responsibility, how clearly do you state the expected results and ensure they are mutually understood and accepted?

0	1	2	3	4	5	6	7	8	9	10
Never		Almost never			Sometimes			Almost always		Always

How well do you hold the person accountable for achieving the desired results?

0	1	2	3	4	5	6	7	8	9	10
Never		Almost never			Sometimes			Almost always		Always

How consistently do you grant authority commensurate with the responsibility assigned and appropriate to the accountability?

0	1	2	3	4	5	6	7	8	9	10
Never		Almost never			Sometimes			Almost always		Always

What can you do to improve?

ROLES OF TEAM MEMBERS

Team members are the people who work with the project manager directly or indirectly to accomplish project goals and complete project activities. Team members can have various roles in the project, such as engineers, technicians, construction workers, and others needed to perform the project work. Each project is unique, and so are the roles of the people performing the work.

In each project, it is important to identify all the players and define their roles and responsibilities. An information technology project, for example, might include the roles shown in Exhibit 2-6. Defining roles only takes a short while, yet it pays great dividends throughout the life of the project, by making sure that individuals understand their roles and how to interface with other team members. If this does not happen, communication can be confused or misdirected, and conflicts and power struggles can arise.

Exercise 2-3
Role of Team Members

Consider a project at work that you are familiar with. Think of one or two team members in that project and write a role description for them. Be sure to include the key responsibilities, account-abilities, and authority needed for each team member.

_____

_____

Did those team members understand and work within those definitions?

_____

_____

Could any possible conflicts or confusion have been cleared up by better role definition?

_____

_____

DEFINING THE ROLES OF PROJECT SPONSORS, CUSTOMERS, AND OTHER STAKEHOLDERS

For every project, it is important to clearly identify the project sponsor who requested the project, the stakeholders who have an interest in the project, and the customer who will use the product, service, or result the project produces. For example, the president of a company may request a project to develop an

E xhibit 2-6
Typical Management Roles and Responsibilities in an Information Technology Project

Role	Responsibilities
Product Manager	• Represents the needs of customers and stakeholders • Defines business requirements • Manages customer expectations • Manages the product launch
Project Manager	• Manages systems planning and analysis • Prepares the functional specification document • Identifies and procures resources • Manages the master schedule • Coordinates team • Reports status
Development Manager	• Performs system design • Writes reliable code • Maintains development schedule
Test / QA Manager	• Owns the quality of the product • Participates in code review • Performs integration testing (migration and process) • Tracks bugs and issues
User Education Manager	• Writes online help and user documentation • Participates in usability testing • Prepares and delivers the training
Logistics Planner	• Plans the alpha and beta roll-out • Coordinates with help desk and IT operations • Plans the installation of hardware and software • Provides support and troubleshooting • Creates a disaster recovery plan
Systems Architect	• Assists in definition of business requirements • Provides project design assistance • Defines product technical and location architectures • Ensures architecture issues and questions are resolved
Executive Committee	• Provides executive direction and issue resolution • Ensures stakeholder views are represented • Encourages compliance with company IT architecture • Ensures operability and integration between departments • Obtains funding

order tracking system so customers can look up the status of their orders on the Internet. The president is the project sponsor, the customers of the project are the people who will use the system to review order status, and the stakeholders include others in the company who benefit from the system, such as the marketing or finance departments. Although you might think these roles are obvious, they often are not.

Some projects get into serious trouble because they have several project sponsors who each want different results from the project. Other projects have no project sponsors who want to take responsibility for the project. Still other projects are in trouble because the customer is not well defined—believe it or not, sometimes no one knows who will use the product or service that the project will create! Other projects fail because the needs of a stakeholder were not addressed or their expectations were not properly managed.

Project Sponsor(s)

The project sponsor is the person (or group) who requests the project. The project sponsor might come from a variety of sources, such as senior management, middle management, functional managers, or other project managers. Someone in the organization might generate an idea for a project, which then percolates to someone in upper management, who approves the project. In this case, who is the project sponsor? The individual who came up with the idea or the senior manager who approved the project? The key is to determine who takes responsibility for the project and who has the authority to give direction to the project by approving its objectives and making decisions when issues arise.

It is critical that you identify the individual or group of individuals with the authority to approve the project objectives and give direction to the project. If senior management identifies a person to be the project sponsor for a project, be sure that management also delegates to that individual the authority to approve project objectives and make decisions for the project. Some project managers assume that an individual has such authority, only to find out much too late that someone else actually has approval authority and has reversed earlier decisions! Once you have identified the project sponsor, it is important to get a commitment of support for the project. Discussions with the project sponsor can confirm understanding of the project scope and its relative priority when compared with other projects in the organization.

For each project, determine the following about the project's project sponsors:

- Who (by name) is authorized to make decisions for the project?
- What access does the project manager have to this project sponsor?
- What approvals does the project sponsor require at which stages of the project?
- How will these approvals be obtained and how long will they take?
- Who (by name) has the authority to formally accept the project when it is completed?

If the project is cosponsored by more than one individual or group, it is important to define the role each will play in the decision-making process.

Customers

The customer is the person or group of people who will use the product, service, or result that the project creates.

For each project, it is important to determine the following about the project's customers:

- Who are the customers that will use the outcome of the project?
- What access does the project team have to the customer?
- What approvals does the customer require at what stages of the project?
- How will these approvals be obtained, and how long will they take?

Once you have identified your customers, it is important to get their commitment to support the project. If there is more than one group of customers, it is important to define the role each will play in the project.

It is important to identify and consult with the customer throughout the life of the project. Many projects fail because they do not meet the needs of the customer. You cannot assume that the needs of the customer have been fairly represented by the project sponsor when the project was approved. You must confirm and reconfirm customer needs as the project progresses to ensure that the final result will meet their requirements.

Other Stakeholders

In addition to the project sponsor and customers, most projects have additional stakeholders who have an interest in (and perhaps control over) the project. It is important to identify all these stakeholders, then define their needs relative to the project and manage their expectations. Stakeholders may be people in other departments, suppliers, contractors, vendors, government agencies, management, or stockholders in the company. Some projects fail because the needs of a stakeholder were not addressed. It is as important to manage stakeholder expectations as it is to manage the expectations of project sponsors and customers. If stakeholders have concerns about the project, they may be able to exert considerable influence on those who make project decisions.

The following are helpful steps to identify the stakeholders and to decide how the project manager and project team need to interact with each stakeholder during the project:

1. Identify all potential stakeholders, including their roles, level of interest, expectations, and levels of influence. Consider everyone in a decision-making or management role.
2. Determine what role each of the stakeholders will play. Determine what approvals, review, or information each stakeholder requires at which stages of the project. Identify what access the project team will have to each of the stakeholders.
3. Identify the potential impact or support each stakeholder could generate.

Prioritize the list based on their authority, influence, interest in the project, and expected level of involvement in the project.

4. Assess how each stakeholder is likely to respond in various situations and plan how to influence them to enhance their support or to mitigate the impact of potentially negative actions.

? Think About It . . .

Think of a past or current project. Can you clearly identify the project sponsor, customer(s), and other stakeholders?

_____

_____

Is your relationship with each of these people or groups clear and functional?

_____

_____

What can you do to better define these relationships?

_____

_____

_____

---

recap

The project manager is the person assigned to manage a project and is responsible to meet its approved objectives, including project scope, budget, and schedule. At the same time, project managers must also balance appropriate quality, availability of resources, and the management of risk. The project manager leads the project team and provides vision, direction, and encouragement. To be successful, he or she must possess project management skills, interpersonal skills, integration skills, technical skills, and knowledge of the organization. Project management is a combination of many ingredients, such as large measures of common sense, ambition, flexibility, resourcefulness, and a healthy appetite for negotiation. Project managers must maintain good balance in assigning responsibility, delegating authority, and holding people accountable. The authority must be appropriate for the responsibility, and the accountability must be commensurate with the authority and the responsibility.

Team members (engineers, technicians, construction workers, etc.) are the people who work with the project manager directly or indirectly to complete project activities. The project sponsor is the person (or group) who requests the project and has the authority to approve the project objectives and give direction to the project.

The customer is the person or group who will use the product or service the project creates.

There may be other stakeholders who have an interest in (and perhaps control over) the project. It is important to identify these people and define their needs relative to the project.
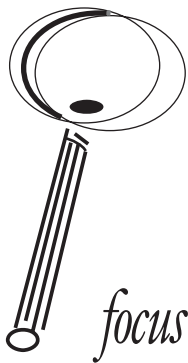
Review Questions

1. Which of the following is true about managing projects?   1. (a)
   (a) The authority given must be commensurate with the responsibility assigned.
   (b) The accountability must be greater than the responsibility assigned.
   (c) The authority given must be less than the accountability.
   (d) A project manager gives up responsibility by assigning it to team members.

2. Which of the following is a key role of the project manager?   2. (c)
   (a) Sponsoring the project
   (b) Using the results of the completed project
   (c) Planning the schedule, cost, and scope
   (d) Accomplishing project work

3. Which of the following describes a role of the project sponsor?   3. (c)
   (a) Develops the project plan
   (b) Develops schedules for individual project activities
   (c) Formally accepts the project when completed
   (d) Accomplishes the approved objectives of the project

4. Which of the following is *not* a purpose of integration management?   4. (c)
   (a) Ensuring that the various elements of the project are properly coordinated
   (b) Determining trade-offs among competing options to accomplish the project objectives
   (c) Managing the expectations of project sponsors and stakeholders
   (d) Correlating the phases of planning, execution, reporting, and management

5. Which of the following is *not* true?   5. (c)
   (a) A project may fail if it doesn't consider customer needs.
   (b) A stakeholder may be a person in another department.
   (c) A project sponsor is the person or group who uses what the project creates.
   (d) Team members work with the project manager directly or indirectly to complete the project.

Defining the Project

focus

Learning Objectives

By the end of this chapter, you should be able to:

- Collect requirements, including identifying problems or opportunities that a project will address.
- Define a project in terms of its basic objectives (time, cost, and scope), and understand the basic project reviews that may be conducted.
- Create a work breakdown structure for a simple project.

This chapter covers the initial steps in project planning. The first step is to define the problem or opportunity that the project will address, and collect project requirements. The next step is to define the project objectives in terms of time, cost, and project scope. At this point, conduct various reviews to ensure the integrity of the project plan. The final step is to break the project down into its component pieces in a work breakdown structure.

PROJECT PLANNING

Some people put a minimum of effort into planning. They argue that since things invariably change during the life of the project, it is a waste of effort to make up-front plans. The average organization spends only a small percentage of the total project effort on planning. However, more successful organizations spend much more time planning—sometimes up to a quarter of the total project effort.

The amount of planning depends largely upon the nature of the project work and the maturity of the project organization. Some approaches, such as agile project management, provide methodologies for delivering projects in stages in a highly flexible, interactive, and iterative manner. These approaches are especially helpful in projects involving highly unknown and highly technical work. Even though factors introduced during the life of the project may necessitate minor or major adjustments to the plan, it is still important to have a solid plan in place. Without a plan, a project becomes even more chaotic in the face of change. If plans are described in project management software, it is easy to adjust details as needed.

In an ideal world, a project would be planned and approved, and then work would start and be completed according to the plan. In practice, however, you might have to adjust the plan throughout the life of the project. Therefore, any good planning and management system must be flexible enough to operate in the real world, and yet be rigorous enough to provide control.

Some projects are managed in pieces. Because of time constraints or other factors, the project manager might have to develop a plan for only part of the project, get it approved, and begin that portion while other parts of the project are still in the planning stage.

Often, planning continues to some extent throughout the life of the project. Recognizing this reality, the successful project manager establishes a project management system that allows for adjustments to the plan as needed.

The key steps in planning are listed below. These steps are described in Chapters 3 to 6.

- *Perform feasibility studies* to ensure the project is needed and is practical.
- *Define the work* (*activities*) that must be done to complete the project.
- *Estimate the cost and time* needed to accomplish each activity.
- *Sequence the activities* into a logical order, considering the dependencies between activities.
- *Calculate the critical path* to determine the most effective sequence of activities.
- *Schedule the activities* by applying calendar dates.
- *Prepare resource plans* by assigning specific personnel and equipment to each activity.
- *Prepare budget plans* to determine what funds are needed at what times.
- *Plan for risk* to be ready to respond to events that may affect the project for better or worse.
- *Get approvals and compile a formal project plan.*

A clear project definition and detailed objectives are critical to the success of the project. If the definition and objectives are ambiguous, unrealistic, not agreed upon, or not written down, the project is in serious trouble before it begins. Whatever time and energy you need to define the project properly in the planning stage is much less than what it will cost to fix problems after the project is completed.

DEFINING THE PROBLEM OR OPPORTUNITY

Although project sponsors might spend hours discussing a proposed project, they might not think to communicate this insight to the project manager. The more the project manager understands the issues surrounding the project, the greater the likelihood of a successful outcome. For example, if a project involves the construction of a new plant, the project manager needs to:

- Know how the new plant will operate.
- Understand the needs of the users of the new plant.
- Understand why the project sponsor wants the new plant.
- Clearly view what is involved in constructing the plant and what is expected of him.
- Be sure the new plant will actually solve the problem at hand or address the presenting opportunity. If the problem or opportunity has not been correctly identified, the plant, even if constructed successfully, could be a failure!

The following actions may help you define the problem or opportunity:

- *Get from the project sponsor a clear definition of the problem to be solved or the opportunity the project will take advantage of.* A clear and succinct definition will help keep the project focused and may help you avoid damaging oversights that may not be obvious to the project sponsor.
- *Determine the project sponsor's needs and wants.* It might take some time to help the sponsor distinguish between needs and wants, but it is important to understand the difference. When time and money are limited, the planning and budgeting process may have to sacrifice some wants in favor of needs.
- *Gather sufficient background information about the current situation.* Do not blindly accept information you are given without appropriate confirmation. Since well-intentioned stakeholders may only see things from their point of view, be sure you investigate sufficiently to discover all the issues.
- *Learn and thoroughly understand the business reasons for the project and the sponsor's motive in undertaking it.* This understanding provides a basis for balancing the budget, schedule, scope, quality, resources, and risk. It might also help you capitalize on opportunities to improve the outcome of the project.

Exercise 3-1
Defining the Problem or Opportunity

Consider a project you are familiar with, or one that you have worked on, that did not have a clear definition of the problem to be solved or the target opportunity. Which of the actions mentioned could have helped achieve a better definition? What would the results have revealed about the project?

Exercise 3-1 continues on next page.

Exercise 3-1 continued from previous page.

What are the dangers of proceeding with a project without a clear definition of the problem?

_____

_____

_____

Collect Project Requirements

Once you are clear about the overall objectives of the project, your task is to collect the project requirements. Be sure to consider the following types of requirements for your project:

- Business need (the problem or opportunity).
- Business objectives (what the organization expects to accomplish by the project).
- Functional requirements (considering the business processes that the project will need to function within).
- Non-functional requirements (such as level of service, performance, security, safety, compliance with regulations, etc.).
- Quality requirements.
- Acceptance criteria.
- Impacts to other departments within the organization (or outside the organization).
- Support requirements.
- Training requirements.

Types of Projects

Projects may be categorized as one of three types:

1. *Market-driven:* Producing a new product in response to market needs. For example, a software company sells products and maintains market share by creating quality programs that meet consumer needs.
2. *Crisis-driven:* Quickly solving a specific problem. For instance, in response to defective automobile tires, a manufacturer may quickly organize a project to manage their recall and replacement, and create a public relations campaign to address the issue.
3. *Change-driven:* Changing operations to match the current environment or to be more effective. For example, projects may be driven by regulatory needs, be defined by maintenance requirements, be research-driven to explore a problem or opportunity, or be driven to maintain market share.

    Understanding the purpose of the project is essential to comprehending the underlying needs, so you can make appropriate trade-offs in time, cost, scope, quality, resources, and risk as you manage the project.

Exercise 3-2
Identifying the Type of Project

What type of project is described in Exercise 3-1 (*market-driven, crisis-driven, or change-driven*)?

_____

How does understanding the purpose of this project help you better define it?

_____

_____

ESTABLISHING PROJECT OBJECTIVES

Once you have clearly identified the problem or opportunity, the next step is to define the basic objectives of the project, including *what is to be done* (specific end results), *how it will be done* (quantity, quality, or special requirements), *when it will be complete* (deadline), and *how much* it will cost. Clearly define the project objectives in terms of the desired end results.

The project objectives should describe what the project will accomplish. Ask yourself, "If we achieve the stated objectives, will we consider the project a success?" Consider the three main aspects of project objectives:

1. *Cost:* The money and resources required to get the job done—including people, equipment, and other allocations.
2. *Time:* The time required to get the job done.
3. *Scope:* A description of all the *deliverables*—the end products, services, processes, or other results to be provided at the end of the project, along with their features, functions, and a description of their quality.

The project objectives must define the conditions for completion, detailing what will and will not have been completed when the project is finished. They provide measurable criteria for project success.

These objectives define not only the project, but also the responsibilities of the project manager, who is measured against the objectives and held accountable for them.

The project objectives must be SMART (*S*pecific, *M*easurable, *A*greed-upon, *R*ealistic, and *T*ime/Cost-limited), as explained in Exhibit 3-1.

If the objectives are not SMART, keep working with them until they are. Objectives that are excessive can be detrimental to the project and the company. If project managers include too large a contingency (in an effort to ensure their success), they run the risk that the project becomes too expensive to be approved. Even if approved, such a project may tie up large amounts of allocated funds that the company could better use elsewhere. The other

E xhibit 3-1
SMART Objectives

SMART objectives are:

- *Specific.* The objectives must be so clear and well defined that anyone with a basic knowledge of the project area can understand them. They must precisely define what the project will and will not do.

- *Measurable.* Objectives must be defined in measurable terms. If they cannot be measured, they are too ambiguous and you need to define them more clearly. To be successful, you must be able to measure and report on the progress.

- *Agreed-upon.* The project manager, project sponsors, and customers must agree on the project objectives. All stakeholders must agree that the end result will solve the problem or respond to the opportunity defined.

- *Realistic.* The project objectives must be achievable, given the available resources, knowledge, skills, and time. It might take some time and energy to negotiate project objectives that are realistic.

- *Time/cost-limited.* The objectives need to be framed within clear time/cost goals. The amount of available time (budget) as well as any available flexibility, should be defined,

extreme is an objective that is too lean. Project managers should include reasonable contingency in the objectives to give the project manager and team a fair chance for success. The project manager's task is to find a competitive, yet fair, middle ground between these two extremes.

? Think About It . . .

SMART OBJECTIVES

Think of a project you have been involved with or are aware of. Score your responses in the appropriate spaces on a scale of 0 to 10 as indicated below.

How specific were the objectives?

0	1	2	3	4	5	6	7	8	9	10
Not at all			Very little		Somewhat			Fairly		Very

How measurable were the objectives?

0	1	2	3	4	5	6	7	8	9	10
Not at all			Very little		Somewhat			Fairly		Very

How agreed-upon were the objectives?

0	1	2	3	4	5	6	7	8	9	10
Not at all			Very little		Somewhat			Fairly		Very

"Think About It" continues on next page.

Think About It continued from previous page.

How realistic were the objectives?

0	1	2	3	4	5	6	7	8	9	10
Not at all			Very little			Somewhat		Fairly		Very

How time/cost-limited were the objectives?

0	1	2	3	4	5	6	7	8	9	10
Not at all			Very little			Somewhat		Fairly		Very

Exercise 3-3
Project Objectives

Assume you are the project manager for a project to construct a building. Define the project objectives in terms of cost, time, and scope, following the SMART principles (Specific, Measurable, Agreed-upon, Realistic, and Time/cost-limited). (A suggested answer is in Appendix A.)

_____

_____

_____

_____

Keeping the Objectives in Balance

The triangle in Exhibit 3-2 shows the three principal aspects of a project: time, cost, and scope. The project manager's job is to keep these three elements in balance.

- If time is short, the resources (cost) must increase, the scope must decrease, or both.
- If funds are short, the time can be extended, the scope must decrease, or both.
- If the scope is large, the cost will be greater, the time must be extended, or both.

The frustration of trying to keep these three elements in balance has led to the saying, "You can have it quick, cheap, or done right. Pick any two."

In an ideal world, project objectives would remain constant throughout the life of the project. In reality, however, the relative importance of each objective can change over time. It can be fatal to overemphasize the schedule when funds have become critical. The skillful project manager aims for a balanced emphasis, remaining flexible to adapt to new circumstances as they occur.

Consider the following issues as you balance cost, time, and scope:

Cost Considerations

Costs include the money and resources required to complete the project, including people, equipment, and materials. The project sponsor usually wants the project at the lowest cost possible. The budget for the project is approved based on the scope and schedule. The cost of the project is influenced by:

- Specifications of the end products (such as levels of performance, quality, and reliability).
- Compliance with governmental, institutional, or internal standards.
- Technical requirements (such as a need to upgrade computer hardware) and administrative needs (such as a company's financial policies).
- Availability of resources with the appropriate skill. For example, if in-house resources are not available when needed, it may be necessary to contract with outside resources at an extra cost.

The project manager must establish performance standards to determine how to measure cost performance.

Time Considerations

The project schedule is easy to measure and is often given more attention than cost and scope.

- The project sponsor usually wants the project NOW.
- Project sponsors might choose speed over cost and quality.

Project managers must balance the schedule with the project scope, budget, and resources available. Project managers must establish performance standards to determine how schedule performance will be measured.

Scope Considerations

A good scope statement clearly defines all the work that must be performed to deliver a product, service, or result with the specified features, functions, and level of quality. It describes what will *and will not* be completed at the end of the project. A complete scope statement includes technical specifications, performance requirements, facilities requirements, ground rules, constraints, exclusions, procedures, logistics, safety regulations, security issues, and environmental considerations.

The scope statement should also consider how this project will change the way the company does business. What other aspects of the business will be affected by this project (in positive or negative ways)? What other departments will be involved with this project, and what are the impacts on their resources? The scope statement identifies the quality standards that are relevant to the project and establishes performance standards to determine how to measure quality and compliance with scope specifications. A complete scope statement also includes a list of items that are *not* included, although some stakeholders might expect them to be included.

In a project to build an order-processing system, for example, the scope statement would define the software and hardware requirements. It would describe the order-processing methods, identifying any changes from current methods and plans for training those who will be affected by it. The scope statement would also identify which types of orders the system would process, and specify any that would not be handled by the new system.

Scope is often the most difficult project feature to define, and the most difficult to agree upon. The project scope must be balanced with the time, budget, and resources available. It may increase over time ("*scope creep*") because of an inadequately defined problem or opportunity, overlooked details, unforeseen problems, or changes in the market or company. Scope creep also happens when scope change processes are not built into the work ethic of the organization. A formal change control process (see Chapter 7) is key to scope management.

Final Statement of Project Objectives

Once project objectives are defined, they should be clearly spelled out in a comprehensive *scope statement* that provides a documented basis for making future project decisions. It should include justification for the project, description of the product or service the project is to create, and a description of the project deliverables. This written documentation is shared with all stakeholders and project team members. As the project progresses, you might need to refine or revise the scope statement to reflect approved changes in scope.

? | **Think About It . . .**

Did you have a written scope statement for your last project? If so, how did it help you to manage the project?

_____

_____

_____

PERFORMING PROJECT REVIEWS

Before a project is approved, a number of reviews should be performed to ensure the project makes sense, and that it is feasible, worthwhile, and not overly risky. The project manager can perform many of these reviews with input from management and the project team. In some cases, an independent appraisal can be helpful to reinforce the project manager's recommendations to management.

Conceptual Review

A conceptual review addresses these questions:

- Does the project fit within the mission, goals, and objectives of the company?
- Does this project support a specific business plan already in place?
- Will the project solve the stated problem or appropriately take advantage of the current opportunity?

A management team within the organization typically undertakes this type of review. It simply involves asking the hard questions of how the project fits within the organization's goals. However, if management is enamored with a project that has no place within the organization's objectives, you may want to suggest that an independent consultant or other third party be brought in to conduct an objective review.

Feasibility Study

A feasibility study addresses questions such as the following:

- How realistic is it to expect that the project can meet the stated objectives?
- How realistic are the project scope, budget, and time requirements?
- Can the appropriate resources be made available when needed to complete the project?
- Are sufficient funds available to complete the project?
- Does the organization have the technical expertise to accomplish the project?

A feasibility study can be done in-house or by an external group. It can be useful to benchmark other organizations that have tried similar projects and to learn from their failures and successes. A complex or high-profile project might warrant a feasibility review by an independent party to be sure the organization has the expertise and experience to handle the project. For example, if a small utility company planned to build its first nuclear power plant, an extensive feasibility study by an independent party would be in order.

Benefit-Cost Analysis

A benefit-cost review analyzes the costs and expected benefits of the project:

- What benefit will the organization get from completing this project?
- What is the value of the promised advantages, considering the amount of money involved, the time needed to complete the project, and the resources required?
- What is the project's value compared to other projects that could be done instead ("opportunity cost")?

A benefit-cost ratio provides a measure of the expected profitability of a project by dividing expected revenues by expected costs. A ratio of 1.0 means that expected benefits and costs are equal and you have a "break-even" project. Ratios below 1.0 mean that costs are expected to exceed benefits and the project is not financially attractive. Ratios above 1.0 indicate profitable projects. The higher the ratio, the better the project. A major overhaul of a company's telephone system, which is expected to save the company $1,000,000, has estimated costs of $800,000. Thus the overhaul project has a benefit-cost ratio of 1.25.

Again, benchmarking data from other organizations may be helpful to confirm the expected costs and returns.

Profitability Measures

There are several quantitative measures that may be applied at senior and executive management levels that can indicate the expected profitability of a project and impact project selection. Some of the more common are:

- *Payback period* is the number of periods (usually years) until cumulative revenues exceed cumulative costs; that is, the time until the project has turned a profit. The shorter the payback period, the better. However, payback period does not identify the expected magnitude of the total profit.
- *Internal rate of return* represents an average rate of return for the project, expressed as a percentage. A rate of 35 percent means you expect the project to return an average of 35 percent per year.
- *Return on assets* is a measure of net profit divided by total assets.
- *Return on investment* is a measure of net profit divided by total investment.
- *Return on sales* is a measure of net profit divided by total sales.

Alternative Course of Action Review

A review of alternative courses of action is done to ensure that the intended course of action is the best. It addresses these questions:

- What other things could be done to solve the problem or take advantage of the opportunity instead of the approach taken by the proposed project?
- What are the positive and negative consequences of each potential course of action?
- What will happen if you take no action at all?

Opportunity Cost Review

Opportunity cost is the cost of choosing one among several alternatives (projects) and, therefore, giving up the potential benefits of another. If an organization chooses Project A (to manufacture a product that has an identified buyer and will generate a profit of $500,000) instead of Project B (to develop an experimental product with no identified buyer and a potential profit of $800,000), the organization is knowingly giving up the potential $800,000 for the more secure $500,000 profit. In selecting a project, the company commits finite resources, time, and energy. Therefore, it is important to take project selection seriously. Making poor choices in approving projects can cause the company to miss out on better opportunities.

Preliminary Risk Assessment

A risk assessment addresses these questions:

- What could go wrong in the project, and what are the potential consequences?
- What are the uncertainties in the project?
- What are the consequences if the project fails to meet its objectives?
- What is the risk that it will not solve the problem?

The project manager and management need to determine whether the expected benefits of the project are worth the risk. They might decide to modify certain aspects of the project to reduce risk.

Possible Review Outcomes

At the conclusion of the reviews, the project sponsor, project manager, and customer determine whether to:

- Proceed with the project.
- Change the project objectives.
- Drop the project.

You might need to repeat one or more of these reviews at certain points during the project to ensure the integrity of the project, especially if project objectives or assumptions change during the life of the project.
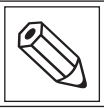
Exercise 3-4
Project Reviews

Consider the building construction project in Exercise 3-3. Which project reviews mentioned above would you conduct for this project? What would you expect to learn from each type of review? (Suggested answers are in Appendix A.)

CREATING A WORK BREAKDOWN STRUCTURE

After defining the objectives of the project, the next step is to break the project down into manageable pieces in a *work breakdown structure.*

A *work breakdown structure* defines the work to be completed in the project. It is a graphical representation (diagram) of the project, showing its component parts. It provides definition to the project scope by showing the hierarchical breakdown of activities and listing the end products that must be completed to finish the project.

The work breakdown structure is the basis for estimating time and costs and for allocating resources. If the work breakdown structure is faulty, all further planning will also be faulty. The work breakdown structure example in Exhibit 3-3 illustrates the Noah's Ark project.

In preparing a work breakdown structure, keep the following in mind:

- *Use any category that makes sense for your project.* This might include components of the product, functions, organizational units, geographical areas, cost accounts, time phases, or activities.
- *Do not be constrained by sequence.* The diagram does not need to represent a logical or time sequence of events.
- *The diagram does not have to be symmetrical.* The number of levels might vary from one branch to the next. Divide each branch into the number of levels needed to adequately define the project.
- *Each box is a summary of the boxes in the levels below it.*
- *The final box in each branch must end in a product or deliverable.* These must be measurable and definable in terms of an end result.

Exhibit 3-3
Work Breakdown Structure of the Noah's Ark Project
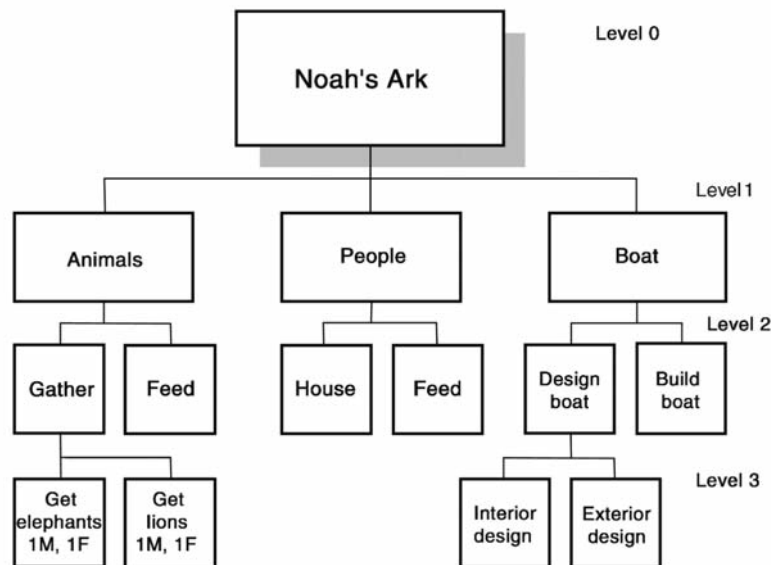
- *The boxes in the lowest level are called work packages.* They represent the lowest level of detail you want to estimate, schedule, monitor, and manage. They should represent eight to eighty hours of work. Each work package can be divided into specific activities. For each work package, describe the conditions that indicate task completion—what must be delivered to consider the activity finished.
- *The sum total of boxes must represent the complete project.* Be sure to leave nothing out. When all these deliverables are completed, will the project be done?
- *The entire project team should be involved in developing the work breakdown structure.*
- *When you finish the work breakdown, you should review it with the project sponsor and customers.* This is to ensure that it is complete and that it addresses their specific concerns.

Exhibit 3-4 shows an example work breakdown structure for building an order processing system. Exhibit 3–5 shows the same project in text format, which could be expanded as needed to provide explanations and specifications about each element. This detailed textual explanation is sometimes called a work breakdown structure dictionary.

Job Aid: Work Breakdown Structure Checklist

When you develop a work breakdown structure, be sure to include these often-overlooked activities:

E xhibit 3-4
Work Breakdown Structure of an Order Processing System
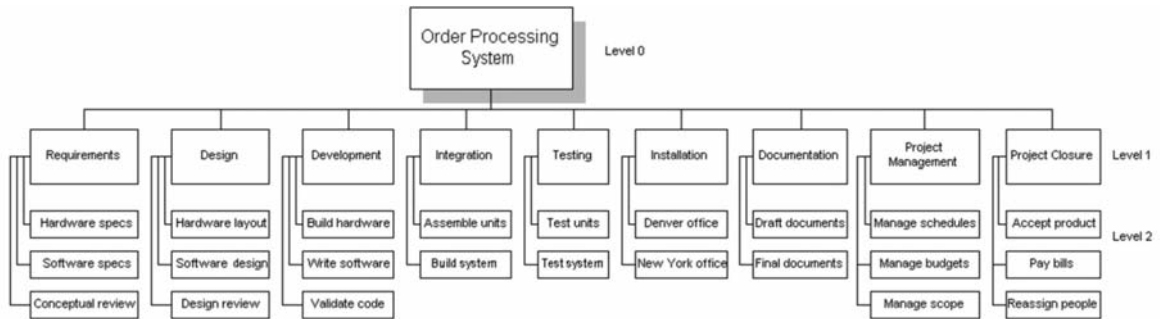
- *Project management.* Include the budgets and resources needed to manage the project. Include costs for the project manager, support staff, project office, and computer support.
- *Documentation.* The documentation includes lessons learned, how the end product differs from the project plan (describe the "as-built" condition), and how the end product functions.
- *Nonwork financial components.* If you include items such as purchases, travel, and consulting fees, the work breakdown structure can create a complete project budget consisting of all the work components and these nonwork financial components.

E xhibit 3-5
Textual Representation of a Work Breakdown Structure

Order Processing System
1.0 Requirements
 1.1 Hardware specs
 1.2 Software specs
 1.3 Conceptual review
2.0 Design
 2.1 Hardware layout
 2.2 Software design
 2.3 Design review
3.0 Development
 3.1 Purchase hardware
 3.2 Write software
 3.3 Validate code
4.0 Integration
 4.1 Assemble units
 4.2 Build system
 Etc.

- *Product implementation.* Projects that deliver a great product or system can fail if they do not implement the product or system. This can include product delivery, user training, communication plans, or marketing plans.
- *End product evaluation.* Does the product perform as expected? Is the problem solved? Have you successfully taken advantage of the opportunity?
- *Project closure.* This includes the time, budget, and resources needed to close the project office, reassign project personnel, and close financial accounts.
- *Product retirement.* Include the plans to retire the product after its useful life. Organizations often require that the project that created the product or system include the plans—and even the budget and resources—to retire it at the end of its useful life.

? Think About It . . .

Why should the entire project team be involved in creating the work breakdown structure? What are the dangers of a single person creating a work breakdown structure?

_____

_____

_____

Exercise 3-5
Work Breakdown Structure

Create a work breakdown structure for the building construction project in Exercises 3-3 and 3-4. Define it in at least two levels. (A suggested answer is in Appendix A.)

recap

This chapter covers the first steps in project planning. It is important that the project manager understands why the project is being undertaken and how it will solve the problem at hand (or appropriately address the presenting opportunity). The project manager must also learn the issues and needs of the project in sufficient depth so she or he can make wise trade-offs in time, cost, scope, quality, resources, and risk throughout management of the project.

The next step is to establish basic project objectives of *time*, *cost*, and *scope*. These project objectives provide measurable criteria for project success and will guide the project manager in all decisions. A clear understanding of these three objectives at the beginning will help the project manager keep them in balance throughout the life of the project, since priorities may change and assumptions may be challenged later.

After the objectives are established, it may be helpful to perform various reviews to be sure the project is feasible, worthwhile, and not overly risky. Such reviews may include a conceptual review, feasibility study, benefit-cost analysis, profitability measures review, alternative course of action review, opportunity cost review, and preliminary risk assessment. You may need to repeat some of these reviews at critical points during the project, especially if project objectives, priorities, or assumptions change during the life of the project.

The final step covered in this chapter is to create a work breakdown structure that defines the work to be completed in the project. This work breakdown structure will be used for estimating time and costs and allocating resources. It can also be a useful tool for managing the project.

Review Questions

1. A work breakdown structure defines: 1. (c)
  (a) the payback period of the project.
  (b) the cost, time, and scope of the project.
  (c) the work to be completed in the project.
  (d) how the project fits within the mission, goals, and objectives of
      the company.

2. Project objectives must be SMART, which means: 2. (b)
  (a) Scheduled, Measurable, Accurate, Reliable, Time/cost-limited.
  (b) Specific, Measurable, Agreed-upon, Realistic, Time/cost-limited.
  (c) Specific, Meaningful, Agreed-upon, Reliable, Time/cost-limited.
  (d) Scheduled, Meaningful, Accurate, Reliable, Time/cost-limited.

3. To identify problems or opportunities that a project will address,   3. (d)
  all of the following are important actions *except*:
  (a) getting the project sponsor to provide a clear definition of the
      problem or opportunity.
  (b) learning the business reasons for the project and the project
      sponsor's motive in undertaking it.
  (c) gathering background information about the current situation.
  (d) establishing the basic project objectives of time, cost, and scope.

4. The three main aspects of project objectives are: 4. (b)
  (a) cost, people, schedule.
  (b) cost, time, scope.
  (c) cost, time, complexity.
  (d) cost, time, resources.

5. Project reviews that may be performed during the planning phase   5. (a)
  include:
  (a) Feasibility, Benefit-Cost, Profitability, Alternative Course of Action.
  (b) Conceptual, Periodic Inspections, Profitability, Opportunity Cost.
  (c) Feasibility, Milestone, Profitability, Preliminary Risk Assessment.
  (d) Conceptual, Benefit-Cost, Team Performance, Alternative Course
      of Action.

Estimating the Activities
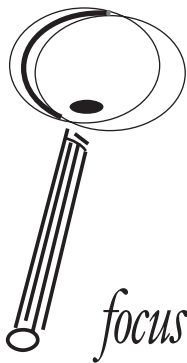
Learning Objectives

By the end of this chapter, you should be able to:

- Estimate the time and cost needed to complete each of the activities in a project.
- Describe various estimating methods.
- Explain why estimates are not always precise.
- Describe the three basic types of contracts and explain when to use each.

focus

THE IMPORTANCE OF ESTIMATING

A novice project manager might believe it a waste of time to spend much effort estimating. However, experienced project managers recognize the importance of estimating as precisely as possible, using the best estimating methods. For this reason, it is preferable to have estimates created by those who are experts in the field, preferably those who will actually work on the project.

Project estimating is difficult for two important reasons:

1. Estimating is not an exact science. Even under the best conditions, an estimate is only a prediction of the time, resources, and funds required to complete an activity.
2. By its very nature, a project is a unique undertaking and involves a degree of uncertainty.

Avoid creating estimates based on predetermined deadlines or budgets. Although those constraints might be real, you must be objective and honest in your assessment of the time, resources, and funds needed to complete your project. Once you complete the estimates, you can negotiate with the project sponsor to reconcile them with the project requirements. If they do not fit, it

might be possible to adjust the project scope, deadline, or basic approach. It might also be possible to sequence the activities differently, in order to complete the project in less time. Finally, it might be possible to complete the project at a lower cost by using alternative resources.

STEPS IN ESTIMATING ACTIVITIES

The work packages (the boxes in the lowest level of the work breakdown structure) identify the specific activities that must be performed to complete the project. To properly estimate each activity, use the following three steps:

1. Referring to the work breakdown structure (see Exercise 3-5), ask the team members to complete an activity estimate sheet such as the one shown in Exhibit 4-1 for each work package. For each activity, develop a *statement of work* that succinctly defines the work to be accomplished in the activity. Each statement of work should be supported by the following:

E xhibit 4-1
Activity Estimate Sheet

Activity #_____   Title_____

Team Responsible _____

Team Leader _____

Statement of work: _____

_____

_____

Describe completion condition: _____

_____

_____

Describe assumptions, exclusions, constraints: _____

_____

_____

_____

Exhibit 4-1 continued from previous page.

Time Number of working days needed _____

Personnel

___ person hours of _____skill group

___ person hours of _____skill group

___ person hours of _____skill group

___ person hours of _____skill group

___ person hours of _____skill group

Direct costs

item _____ cost $____ needed at day __. __ days to pay

item _____ cost $____ needed at day __. __ days to pay

item _____ cost $____ needed at day __. __ days to pay

item _____ cost $____ needed at day __. __ days to pay

item _____ cost $____ needed at day __. __ days to pay

Inputs to this activity

_____

_____

Outputs to other activities

_____

_____

Predecessor activities
This activity cannot begin until   Define if less than 100%

__% of activity # __ is complete. _____

__% of activity # __ is complete. _____

__% of activity # __ is complete. _____

Exhibit 4-1 continued from **previous page.**

Successor activities

This activity cannot begin until   Define if less than 100%

Activity #___ can begin when this activity is ___% complete.   _____

Activity #___ can begin when this activity is ___% complete.   _____

Activity #___ can begin when this activity is ___% complete.   _____

- Technical specifications of the end products, such as performance, quality, reliability, survivability, operability, and maintainability.
- Compliance with standards (governmental, institutional, international, and organizational).
- Project assumptions, constraints, and exclusions (a description of what is *not* included in this work package).

2. Ask the functional groups to document how the estimate is made, including assumptions and factors that might affect the validity of the estimate. For example, did the cost projections make allowances for the suppliers' annual price increases?

3. Review the estimate sheets for all the activities in the project and clear up discrepancies. For example, the estimate sheet requests both predecessor activities and successor activities. *Predecessor activities* are those that occur before the current activity, and *successor activities* are those that occur after it. If the successor activity listed on one sheet does not show up as a predecessor activity on the other, check with the team members to make sure they have a common understanding of the intended workflow. (This is the reason for asking for both successor and predecessor activities on each sheet.) Compare the inputs and outputs between sheets to clear up any orphans. You might also want to compare relative material costs and person-hours across various activities.

Exercise 4-1
Activity Estimate Sheet

You are assigned as project manager to create an order processing system for ABC Enterprises. The project consists of the following activities: (1) design the system, (2) write computer code for the system, (3) test the code, and (4) implement the system. Fill out an activity estimate sheet for Activity #2, "write computer code for the system." (A suggested answer is in Appendix A.)

Although you might be tempted to skip over some information on the activity estimate, it is all essential. For example, the breakdown by skill group in the personnel section is necessary to identify the specific resources (personnel) needed and to determine whether they are available when needed. Since people with different skill levels are typically paid different rates, the breakdown by skill group captures the resource costs. The detail by item in the direct costs section can identify any cost overlap from one activity to the next. For example, if two activities each require purchasing the same equipment, the equipment cost can be charged to one activity for use by both. The identification of the number of days to pay for each cost is needed to determine cash flow.

The inputs to the activity covered in the estimate sheet are things needed to begin the activity—either external to the project or generated by it. The outputs are either inputs to another activity or a project deliverable. Although it may appear redundant to ask each activity to list both the predecessor and successor activities, it can help isolate inconsistencies from one activity sheet to another. Orphan inputs and outputs are a key tool to verify the completeness of the work breakdown structure. Not all activity workers view their interrelationships in the same way.

ESTIMATING METHODS

The following are the most effective estimating approaches: expert judgment, analogous estimating, parametric modeling, bottom-up estimating, and simulation modeling.

Expert Judgment

Expert judgment is an estimating technique that relies on the experience of others to provide cost or duration estimates. It involves consulting with experts who, based on their history of working on similar projects, know and understand the project and its application. It is important that the "experts" use historical information from other projects. Experts can also help to determine whether to combine elements from the other estimating approaches or advise how to reconcile differences in estimates obtained from the other approaches.

Analogous Estimating

Analogous estimating uses the actual costs and durations of previous, similar projects as the basis for estimating the current project. It uses historical information from the organization as well as industry standards. It is also called a *top-down estimate,* because it relies on information from the top row of activities of the work breakdown structure. It can be used to estimate projects with a limited amount of detailed information. For example, a project to implement a new accounts payable process in one company might be estimated by reference to a similar accounts payable process that was recently implemented in another company. The analogous approach is generally less costly than other approaches, but is also generally less accurate.

Parametric Modeling

Parametric modeling uses mathematical parameters to predict project costs. An example is residential home construction that is often estimated using a certain dollar amount per square foot of floor space. Complex examples can be found in the software development industry where one model uses thirteen separate adjustment factors, each of which has five to seven points. The accuracy and availability of parametric estimates vary widely. In industries where accurate metrics have been developed over time, you would be wise to use them.

Bottom-Up Estimating

A bottom-up approach estimates the cost and duration of the individual work packages from the bottom row of activities of the work breakdown structure, then totals the amounts up each row until reaching an estimate for the total project. This approach can produce a more accurate estimate, but at a higher cost.

Simulation Modeling

In this approach, a computer calculates multiple costs or durations with different sets of assumptions. The most common simulation is Monte Carlo Analysis, in which a range of probable results is defined for each activity and used to calculate a range of probable results for the total project. Simulation can be more accurate than other types of estimates, and is principally used on large or complex projects.

Exercise 4-2
Estimating Methods

Which of the four estimating methods is most appropriate for the activity you defined in Exercise 4-1 (writing computer code for the order processing system)? Why?

_____

_____

Why might different estimating approaches be appropriate under different conditions? How can you help your team, department, or division to understand this?

_____

_____

_____

_____

PRECISION OF ESTIMATES

In early planning, you might be asked to provide a preliminary or conceptual estimate, also called an *order-of-magnitude estimate*. This level of estimate is usually -25 percent to +75 percent. Thus, the range of the order-of-magnitude for a $50,000 estimate would be $37,500 to $87,500. Later, at the project approval stage when more definition is available, you might be asked for a budget estimate, which usually ranges from -10 percent to +25 percent. During project planning, when well-defined specifications are available for individual activities, you might need to provide definitive estimates that can be used for bid proposals or contract negotiations. Definitive estimates usually use a bottom-up approach, and typically range from -5 percent to +10 percent.

The more specific the details, the better the estimate, which means you have a greater chance of meeting the project objectives. However, the greater the detail, the greater the cost and time required to get the estimate— leaving less time and budget to accomplish the project.

To increase the accuracy and consistency of your estimates, you might want to:

- Use several independent techniques and sources.
- Compare and iterate estimates.

For example, you might ask two independent groups to use the same estimating method, or one group to use two different methods. Investigate the differences among the estimates and adjust the estimating approach to what is appropriate for your project. An analysis after the project is important to determine if your approach was valid. This helps you learn from each project and produce a better estimate on the next.

Exercise 4-3
Precision of Estimates

How precise do the estimates need to be for Activity #2 (writing computer code) for the order processing system described in Exercise 4-1? Why?

_____

_____

_____

Underestimating Activities

Managers often underestimate activities, and projects run over budget and over schedule. Here are some common reasons why:

- Team members are usually optimistic and anxious to please. They might say what they think the project manager wants to hear.

- People might underestimate the amount of nonproductive time in a day (such as personal distractions, fatigue, interruptions, meetings, administrative tasks, sick leave, vacations, training, crisis management, and so on).
- Workers might be overly optimistic about the number of calendar days it takes to complete the number of work hours estimated.
- People tend to have incomplete recall of previous experience. They remember successes better than failures and tend to forget pain.
- Team members might not be familiar with the complete scope of the project when they make their estimates.
- Workers might have no experience with this activity to draw upon.

Before beginning the estimating process, it may be helpful to discuss these issues with all who will be involved so they can deal with them appropriately. Peer reviews during the process may also help identify underestimating.

Inflating Estimates

Novice project managers might be tempted to inflate estimates so they can come in ahead of schedule and under budget. However, from the point of view of resource utilization, projects running ahead of schedule may be as bad as projects running behind schedule. If a new office building is completed six months ahead of schedule because of an inflated estimate, the building may sit vacant until tenants are able to occupy it. The owner may lose months of rental revenue that he could have received if he had known when the building would be available and had scheduled the tenants for occupancy sooner. Inflating the estimates defeats the purpose of planning. Expert project managers have a few projects that come in ahead of schedule and under budget, a few that are behind schedule and over budget, and many that come in close to the plan.

Project managers should estimate what they think the project will actually cost, then add a reasonable contingency amount for unknown variables. The percentage of contingency varies depending on the kind of activity, environment, and degree of risk. There is no magical percentage to plan as a contingency. A 3 to 5 percent contingency might be sufficient for work that is fairly routine, whereas 10 to 15 percent might be appropriate for unusual work that has many unknowns. The contingency reserve can be drawn upon if needed to reduce the impact of missing cost or schedule objectives.

Exercise 4-4
Underestimating and Inflating Estimates

If you were to estimate the activity "write computer code for the order processing system" described in Exercise 4-1, which issues about underestimating or inflating estimates described should you consider?

Exercise 4-4 continued from previous page.

What are some of the factors that would influence the precision of your estimates?

_____

_____

Should you add a contingency? What is an appropriate amount?

_____

_____

Estimating Familiar Work vs. New Work

If the work to be estimated is familiar, the work breakdown structure is also familiar and you can rely on performance standards, historical databases, established guidelines, and standard costs. You can improve performance on these projects over time. However, how do you reliably estimate new work or work that uses new technology? Consider the estimating issues shown in Exhibit 4-2.

Exercise 4-5
Familiar Work vs. New Work

Think about the activity "write computer code for the order processing system" described in Exercise 4-1. Did it involve familiar work or new work? Did it involve familiar technology or new technology? How did this issue influence the estimating process?

_____

_____

_____

Weighted Estimating Formula

If the activity is well known and has little risk, a single estimate might be sufficient. However, if the activity is less well known or the risk is higher, you might want to gather a three-point estimate: a *most likely estimate* (given what you expect to happen), an *optimistic estimate* (best-case scenario), and a *pessimistic estimate* (worst-case scenario). You can then combine the three estimates to calculate the average expected duration or cost for the activity, using the following formula, based on principles of statistics:

$$\text{Estimated time} = \frac{\text{optimistic} + (4 \times \text{most likely}) + \text{pessimistic}}{6}$$

E xhibit 4-2
Estimating Familiar vs. New Work

	Familiar Work	New Work
Familiar technology	• Needs accurate performance data. • Draws on performance history and measures performance improvement. • Easiest type of project work to plan.	• Difficult to predict since activities may be different. • No performance history available or not useful. • High probability of estimates being understated. • Needs frequent project reviews and estimate revisions.
New technology	• Performance history needs to be adjusted for the complexity of technology. • Important issue is the similarity of activities. • New activities required by the technology are difficult to estimate.	• Uses a group of experts to produce the estimate. • Uses very short planning horizons. • No performance history available or not useful. • Needs close monitoring and frequent replanning.

This formula originated with the *PERT* (*Program Evaluation and Review Technique*) and is called a *weighted average* or *expected time.* This estimate accounts for the uncertainty and variability inherent in project work and provides a risk-adjusted estimate. It works equally well for both time and cost estimates.

Exercise 4-6
Weighted Estimating Formula

Think about the activity "write computer code for the order processing system" described in Exercise 4–1. Would it be appropriate to use a weighted estimating formula? Try it.

_____

_____

How different was your result using the weighted formula?

_____

_____

Range Estimates

Traditionally, we consider budgets as fixed amounts. For example, we estimate $3,875,350 to complete the project, or we budget $459,750 for the annual operation of a functional department. However, in today's business world, it can be more helpful to view functional budgets as limitations ("We expect to spend $450,000 this year to operate the functional department, and will spend no more than $475,000"). In the same vein, we view budgets as targets within limitations ("We estimate the project to cost $3.8 to $4 million, not to exceed $4.2 million"). Using a target range for projects is especially useful for the following:

- Large projects.
- Projects with greater risk.
- Projects that are more difficult to define, such as research projects.

Consider an aircraft flight plan. Because of factors beyond the pilot's control (air currents, temperature variations, side winds, etc.), the flight plan allows a range rather than a fixed course, as illustrated in Exhibit 4-3. The pilot's target is to stay in the center of the band, but as long as the aircraft stays within the mile-wide band, it is within the accepted tolerance limits. The difference between the target and the limit is the contingency. The pilot takes periodic readings to determine the plane's position from the center of the band and makes course corrections during the trip to ensure that the plane's flight stays within the accepted limits. The pilot also analyzes the corrections made to determine if there are trends that need to be accounted for. In today's business world, many accounting and budgeting procedures are changing from fixed-amount methods to ranges or limitations.

Activity-based costing uses accounting and budgeting methods that relate all work activity in the organization to projects. This forces the company to focus on its end products (sales and services) and gives managers a better picture of the real profitability of the company's products and services.

Exercise 4-7
Range Estimates

Think about the activity "write computer code for the order processing system" described in Exercise 4-1. Would it be appropriate to use a range estimate? What would be the high and low estimates for this activity?

_____

_____

_____

E xhibit 4-3
Aircraft Flight Plan
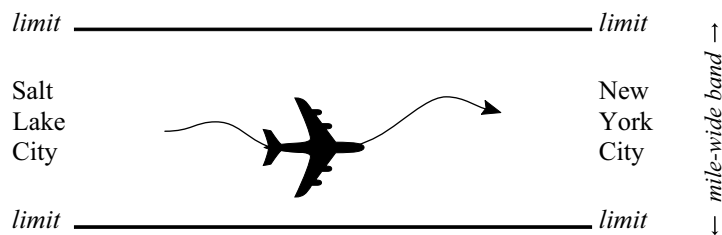
Rolling Wave Estimates

In some projects, detailed estimates might be valid for only three months. In an environment where the cost of materials changes rapidly, for example, you might want to calculate detailed estimates for only the coming three months. As you get closer to the conclusion of the project, the nondetailed ("gross") portion of the estimate grows progressively smaller and you can forecast the outcome of the project with increasing accuracy (see Exhibit 4-4).

Rolling wave estimates are especially useful for engineering, information technology, and research and development projects because subsequent phases of the project depend on requirements defined in earlier phases. For example, you may not be able to plan the second phase of an engineering project in much detail until you gather the test results at the end of the first phase. Those test results provide the necessary requirements to plan the second phase in detail.

Rolling wave estimates present an increased risk. If the project is long, it might not be efficient to break later activities into great detail before the project starts. A five-year research project to find a drug to treat an illness is a

E xhibit 4-4
Rolling Wave Estimate
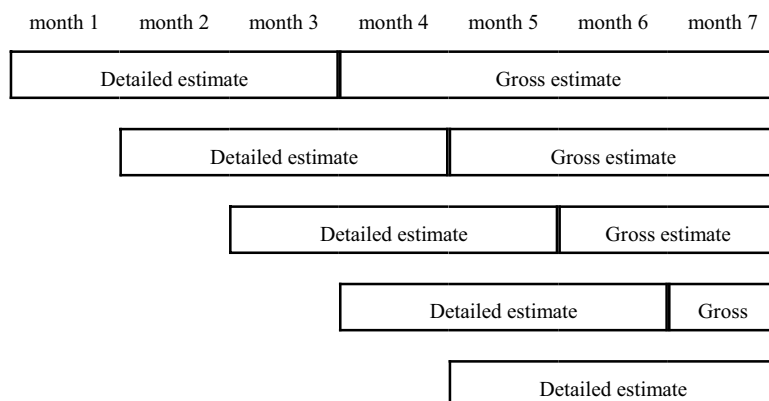
good example of a project that is difficult to plan in detail from the beginning. Planning too much detail at the outset may be a waste of effort, because you may end up reworking these activities based on information gathered later or changes that occur as the project progresses.

Exercise 4-8
Rolling Wave Estimate

Think about the activity "write computer code for the order processing system" described in Exercise 4-1.Would it be appropriate to use a rolling wave estimate? How would you divide the activity into phases?

_____

_____

WORK ENVIRONMENT AND SKILL LEVEL

When preparing estimates, it is also important to consider the work environment and the skill level of those who will do the work.

- Adjust the estimates to address situations in the work environment that make it more or less difficult to complete the work.
- Increase estimates if workers will be distracted by other responsibilities or interrupted by other projects. If you change the amount of time a worker spends on a project from 100 percent to 50 percent, it takes the worker more than twice as long to complete it because time is wasted shifting between projects.
- Increase the estimates when using less-skilled workers or workers with whom you have little experience.

Exercise 4-9
Work Environment and Skill Level

Think about the activity "write computer code for the order processing system" described in Exercise 4-1. Should any adjustments be made to the estimate because of the work environment or skill level of the workers?

_____

_____

TYPE OF CONTRACT

When estimates depend on the performance of outside vendors or contractors, the type of contract is critical. Different types of contracts are appropriate in different circumstances. The type of contract you choose depends on the nature of the product or service you are buying, how much you know about the work to be done, your confidence in the contractor, and the amount of risk you are willing to take in predicting the final cost of the work.

There are three basic types of contracts: fixed-price, unit-price, and cost-plus.

Fixed-Price Contract

With a fixed-price (also called a *lump sum*) contract, the vendor agrees to do the total work for a fixed price. The vendor assumes the risk of unforeseen problems in exchange for a larger profit. This type of contract is appropriate when dealing with unknown vendors or when the project manager anticipates that the work is risky.

Unit-Price Contract

With a unit-price contract, the vendor agrees to a preset amount per unit of service (e.g., $90 per hour for professional services, or $1.80 per cubic yard of earth removed), and the total value of the contract is a function of the quantities needed to complete the work.

Cost-Plus Contract

With a cost-plus contract, the vendor agrees to do the work for the cost of time and materials, plus an agreed amount of profit. Cost-plus contracts, also called *time-and-materials contracts* or *cost-reimbursable contracts,* are used when dealing with in-house providers or trusted vendors over whom you have great control. With these contracts, the project manager assumes the risk of unforeseen conditions, but is usually able to complete the project at a lower cost than with other contracts.

Incentives

Incentives or awards, such as completing work before a given date or managing costs to a given level, can be included in any of the contract types. If final project costs are less than the expected costs, for example, both the buyer (the organization) and the seller (the contractor) might benefit in the cost savings based on a pre-negotiated sharing formula. An 85/15 sharing formula means the buyer absorbs 85 percent of the risk and the seller absorbs 15 percent. If the expected project cost is $1,000,000 and the actual cost is only $800,000, the $200,000 savings is split 85/15 and the seller gets $30,000 and the buyer saves $170,000. A cost-plus contract with an incentive is referred to as a *cost-plus-incentive contract.*

Exercise 4-10
Contract Types

Think about the activity "write computer code for the order processing system" described in Exercise 4-1. If you were to hire out the work rather than do it yourself, which type of contract would you use? Why?

_____

_____

Would you add an incentive to the contract? List the advantages and disadvantages to you of adding this incentive:

_____

_____

List the advantages and disadvantages of this incentive to the contractor doing the work:

_____

_____

USING PROJECT MANAGEMENT SOFTWARE

Hundreds of computer software products exist to help you manage project estimates and other plans more accurately and in much less time. The right program can pay for itself in one six-month project. Managers can use project management software to store and update project plans and also to enter status information once project work begins.

Using computer software is not a substitute for practical management of project schedules and costs. A common error is to automate a function that has been a problem in the past, mistakenly believing that computerization will solve the problem. Automating a problem only helps you make the same mistake faster and more efficiently. Management problems should be identified and solved before implementing computer software, whose main value is in the efficiency in updating and processing information.

Project management software cannot establish project objectives, define project tasks or dependencies, determine and manage project constraints, or estimate timelines and budgets. Software can provide data that are easy to modify and update, run "what-if" scenarios, make complex calculations and determine variances, present information in easy-to-read formats, and make it immediately available to many people.

Consider the following as you choose project management software:

- *Ease of use.* How easy is it to learn and to use? Does the software have a good balance of powerful features and ease of use? Although the software might make it easy to begin projects quickly, will it still have the power you need when you are ready for it? Tutorials are helpful. Clear documentation and context-sensitive online help are a must.

- *Project planning.* The best programs let you generate activity outlines and summaries, such as work breakdown structures, organization breakdown structures, and resource breakdown structures. They allow you to create custom calendars for both activities and resources. They also provide planning tools that perform "what-if " analyses to evaluate alternative scheduling scenarios.

- *Resource management.* If you manage several projects that use common resources, be sure the software can manage the projects by sharing a central resource pool. This macro view of resource availability helps maximize available resources by resolving scheduling conflicts and working within resource limitations.

- *Baseline comparison.* As your project moves from the planning stage to the operational stage, you will likely need to adjust schedules and budgets from time to time. A good project management system maintains the original schedules and budgets as a baseline for future comparison.

- *Reporting.* Does the system have the power to produce custom reports, or are you limited to standard, preprogrammed reports? How easy is the report writer to use?

- *Multiple projects.* Some software programs have a limit on the number of projects you can manage, or the number of activities in a given project. Be sure the software can handle your workload. Also determine how the software merges or groups projects for analysis. If you have dependencies across projects, look for software that maintains an independent file for each project, performs true critical path calculations across projects, and automatically incorporates schedule constraints in individual project files. This helps avoid scheduling errors and resource conflicts.

- *Customization.* Look for software that lets you customize screen layouts, spreadsheets, and diagrams to your company preferences. Will you have to change your procedures to suit the program's limitations, or is the program flexible enough to match your processes?

- *Access to project data.* Can project data be shared with other software, such as spreadsheets, databases, and word processing programs?

- *Graphics.* Can the program produce the graphs, charts, and diagrams you regularly use, or will you have to export the data to another software product to produce them?

- *Product support.* Can you expect professional technical support from the vendor? Does the vendor understand project management? Can the vendor help you apply the product to your needs?

recap

Experienced project managers recognize the importance of estimating as precisely as possible, using the best estimating methods. For this reason, it is best to have estimates created by those who are experts in the field—preferably those who will actually work on the project.

Use the following steps in creating an estimate: (1) refer to the work breakdown structure, write a statement of work, and complete an estimate sheet; (2) document how the estimate is made, including assumptions; (3) review the estimate sheets for all the activities of the project and clear up discrepancies.

The four most common estimating approaches are *analogous* (using actual information from similar projects), *parametric* (using standard parameters, such as dollars per square foot), *bottom-up* (adding up all the estimates from each work package), and *simulation* (computer calculations using different assumptions).

Determine how precise you need the estimate to be, because it is expensive and time-consuming to put more detail and effort into the estimate than is necessary. Be aware of reasons that estimates may be underestimated or inflated. If the work to be done is unknown or risky, consider using a range estimate, a rolling wave estimate, or a weighted estimating formula. Adjustments to the estimate may also necessary to reflect factors in the work environment or the skill level of the workers.

The three basic types of contracts are *fixed-price* (where the contractor does work for a set price), *unit-price* (such as $90/hour), and *cost-plus* (cost of time and materials, plus a set amount of profit). Incentives may be added to any of these contracts (such as a bonus for completing work early).

Computer software can help you manage project estimates and other plans more accurately and in much less time. You can use project management software to store and update project plans and also to enter status information once project work begins.
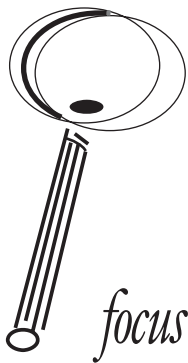
 Review Questions

1. Estimates may not be precise because: 1. (b)
    (a) it is not worth the effort to determine specific details of the project.
    (b) people tend to underestimate the amount of nonproductive time
        in a day.
    (c) a simulation estimating method was used.
    (d) a contingency of less than five percent was used.

2. The four most common estimating approaches are: 2. (a)
    (a) analogous, parametric, bottom-up, and simulation.
    (b) analogous, parametric, top-down, and bottom-up.
    (c) fixed-price, unit-price, cost-plus, and incentive.
    (d) weighted, inflated, familiar work, and new work.

3. The statement of work written for each activity includes all of the   3. (d)
following *except:*
    (a) technical specifications of the end products, such as performance
        and reliability.
    (b) compliance with governmental and institutional standards.
    (c) project assumptions, constraints, and exclusions.
    (d) a description of the estimating method used.

4. Which of the following is *not* true about estimating projects?   4. (c)
    (a) Even under the best conditions, an estimate is only a prediction of
        the time, resources, and funds required to complete an activity.
    (b) Estimating projects is difficult, since a project is a unique undertaking
        and therefore involves a degree of uncertainty.
    (c) Estimates should not be created by people who will work on the
        project.
    (d) When the estimates are completed, you may need to negotiate with
        the project sponsor to reconcile them with the project requirements.

5. If you are dealing with an unknown contractor or if the work is risky,   5. (b)
you would protect yourself best by using which type of contract?
    (a) Unit-price
    (b) Fixed-price
    (c) Cost-plus
    (d) Incentive

Planning the Activities

focus

Learning Objectives

By the end of this chapter, you should be able to:

- Create a network diagram.
- Determine the critical path.

SEQUENCING ACTIVITIES

An important part of project planning is determining the logical workflow of the various activities you identified in the work breakdown structure. This chapter will teach you how to create a *network diagram,* which is a graphical flow plan of the activities that must be accomplished to complete the project. The diagram illustrates which activities must be performed in sequence (after the previous activity is completed) and which can be done in parallel (at the same time). The diagram shows the planned sequence of steps, with all dependencies and relationships. It shows what is logically possible without the constraints of resource availability.

Using the network diagram, you can determine the *critical path,* which is the path through the network that takes the longest total time, and therefore, determines the earliest possible time the project can be completed.

Schedule Network Diagrams

Bar charts (such as Gantt charts) are helpful ways of communicating project information, but since they do not show the logical relationships among activities as clearly, they are not as helpful in planning. (See Chapter 6 for a dis-

cussion of using Gantt charts after a project schedule has been established.) Project managers typically create a network diagram of the project schedule using the Precedence Diagramming Method (PDM). It is also sometimes referred to as *activity-on-node* because it shows the activities in a node (box) with arrows showing dependencies (see Exhibit 5-1). This method makes it easy to describe in each box as much detail as you want about the activity.

Project managers may also use a method called Conditional Diagramming Method in specialized situations, such as research and development projects, where some activities might be performed more than once, only partially, or not at all. This method would be helpful in an investigational drug study where you would not know, up front, the number of trial test periods needed to gather sufficient data to complete the study.

Creating a Network Diagram

Prepare a network diagram by doing the following:

1. *For each work package activity in the work breakdown structure, determine the logical relationships (also called precedence relationships) with other activities.* That is, determine which activities depend on other activities. Some dependencies are mandatory, being inherent in the nature of the work. These often involve physical limitations; for example, the framework of a house requires that the foundation be completed first. Other dependencies are discretionary, as defined by the project team. These are preferred dependencies based on "best practices." Remember that an activity may depend on more than one other activity. In Exhibit 5-1, for example, the task *lay pipe* is dependent on two tasks: *deliver pipe* and *dig trench.*

2. *Arrange the activities into logical sequences or paths.* Place activities that are not physically or logically dependent on each other in separate paths. Each activity in a given path must be dependent on the activity that immediately precedes it. In other words, an activity cannot begin until its preceding activities have been completed.

3. *Review each path to be sure it makes sense.* The activities in a given path build

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Exhibit 5-1
Precedence Diagramming Method (PDM) or Activity-on-Node
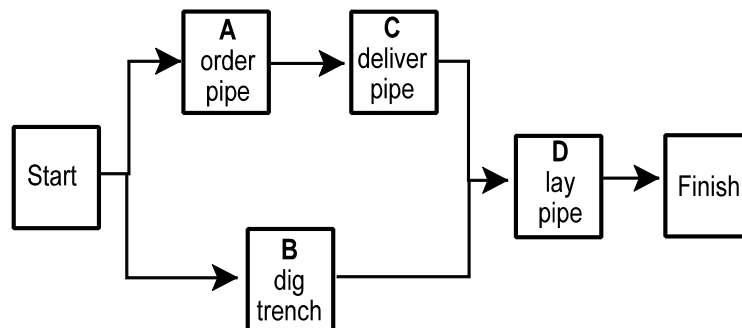
on each other. All paths come together at the end of the project. No activity can lead to a dead end. If you discover you have overlooked an activity that should be part of the project, go back and add it to the work breakdown structure.

✔ Job Aid
Network Diagram Checklist

☐ For each work package activity in the work breakdown structure, determine the logical relationships with other activities.
☐ Arrange the activities into logical sequences or paths.
☐ Review each path to be sure it makes sense.

Understanding a Network Diagram

Exhibit 5-1 shows Activities A and B that can start at the beginning of the project. Activity A must be completed before C can begin and Activities C and B must both be completed before Activity D can begin. This example has been simplified for the purpose of illustration. In reality, if part of the pipe is delivered and part of the trench is dug, that portion of pipe can be laid. However, this diagram shows that all pipe must be delivered and the entire trench dug before pipe laying can begin.

Activity Relationships
Network diagramming requires that you indicate the relationships between the activities. All activities are related in some direct way and may be further constrained by indirect relationships.

• *Direct relationships.* All activities in the network diagram must be linked using one of the relationships shown in Exhibit 5-2.
    The *finish-to-start relationship* is by far the most commonly used of these four types. Typically, one activity is planned to finish before the next activity begins. *Lag* is used to define any time delay between activities. A lag

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E xhibit 5-2
Direct Relationships Among Project-Related Activities

Finish to Start	Activity **A** must finish before Activity **B** can begin. (This is the most common.)
Start to Start	Activity **A** must begin before Activity **B** can begin.
Finish to Finish	Activity **A** must finish before Activity **B** can finish.
Start to Finish	Activity **A** must begin before Activity **B** can finish.

---

of 5 between Activities A and B (with a finish-to-start relationship) means that B cannot start until five days after A is finished; for example, the curing time needed after pouring concrete. Lag can also be expressed as a negative number, in which case it indicates an overlap in the activities. In the same example, a lag of -5 means that B can begin five days before A is finished. Negative lag (overlap) is also called *lead*.

The next two relationships (*start-to-start* and *finish-to-finish*) are used infrequently in specialized situations. Finally, *start-to-finish* relationships are rarely used, and then typically only by professional scheduling engineers. Use caution when using these three less frequently used relationships (start-to-start, finish-to-finish, and start-to-finish) in project management software. Because these relationships have not been consistently implemented among project managers, project management software may produce unexpected results.

- *Indirect relationships.* Activities can be further defined using the constraints shown in Exhibit 5-3.

  For example, assume we are to construct a pump station. Exhibit 5-4 lists the project activities identified in the work breakdown structure. The duration of each activity was identified in the estimating process, and the preceding activities were determined in the logical process of sequencing the activities. The network diagram in Exhibit 5-5 shows the planned sequence of steps and interdependencies.

Exercise 5-1
Network Diagram

Roger and Susan have decided to make a sales presentation to company EZ. For each of the activities listed in Exhibit 5-6, first determine the preceding activity, then draw a network diagram. Note: Plan for some activities to be done in parallel (at the same time) rather than all in sequence (after the previous activity is completed). (The answers are in Appendix A.)

Think About It . . .

Do you draw a network diagram for all your projects? What can you do to help your team, department, or division understand the value of a network diagram?

E xhibit 5-3
Indirect Relationship Constraints Among Project-Related Activities

Must start on . . .	Activity must start on a given date.
Must start before . . .	Activity must start before a given date.
Must start after . . .	Activity must start after a given date.
Must finish on . . .	Activity must finish on a given date.
Must finish before . . .	Activity must finish before a given date.
Must finish after . . .	Activity must finish after a given date.

E xhibit 5-4
Activities to Construct a Pump Station

Activity No.	Activity Description	Duration in Days	Preceding Activity
1	Start	0	
2	Mobilize	2	1
3	Survey	1	2
4	Grade site	2	2
5	Trench footings	5	3, 4
6	Form and pour concrete	5	5, 8
7	Cure concrete	8	6
8	Concrete and material design	5	1
9	Spec prefab metal building	4	1
10	Plumbing materials, pump	5	1
11	Electrical materials, lights, panel	5	1
12	Install pump	7	7, 9, 10
13	Erect structural steel	4	7, 9, 10
14	Install roofing and siding	5	13
15	Install lights and panels	3	11, 14
16	Test pump	2	12
17	Paint	3	15
18	End	0	16, 17

E xhibit 5-5
Network Diagram for Construction of a Pump Station
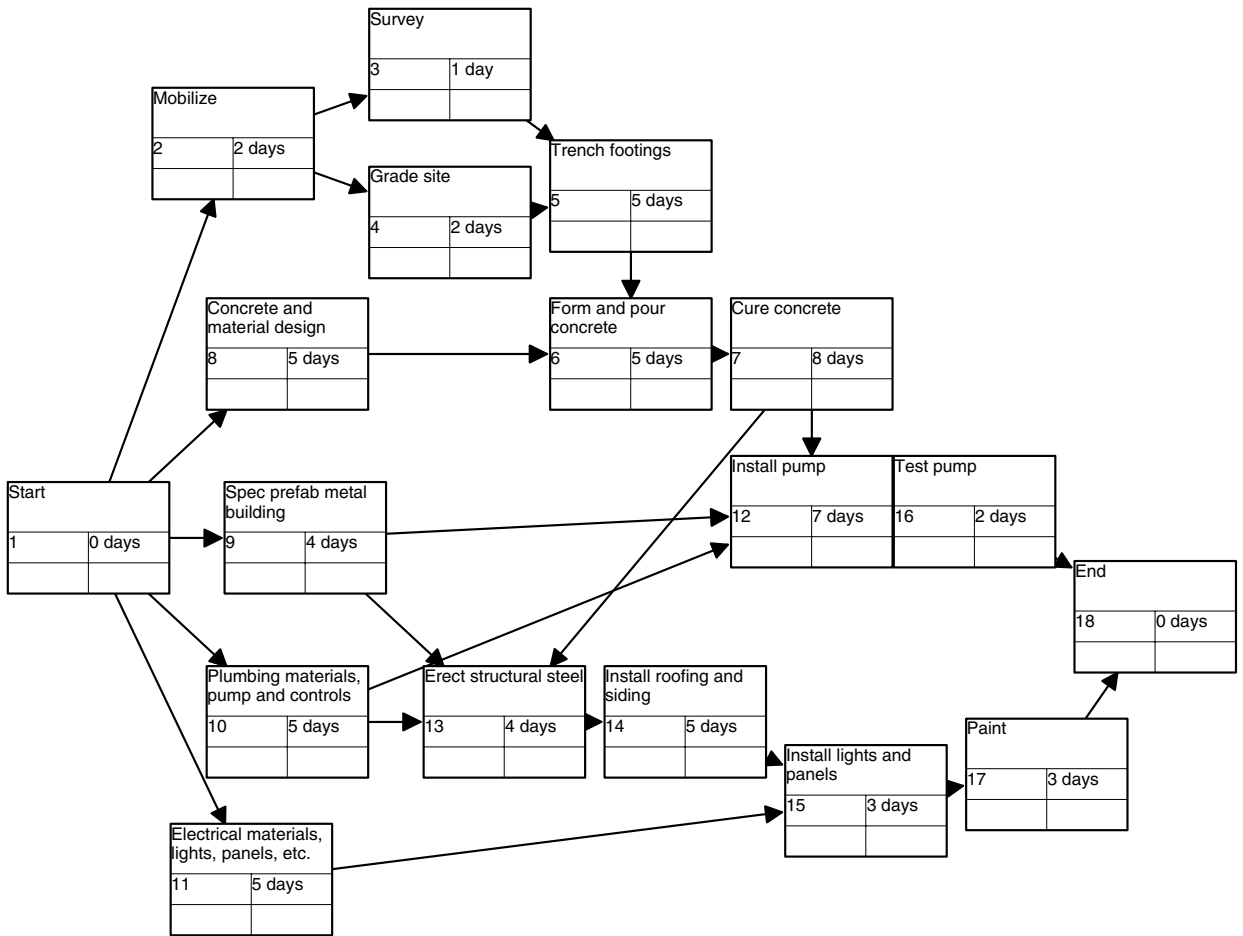
E xhibit 5-6
Sales Presentation: Planned Activities

Activity Description	Person Responsible	Duration (days)	Preceding Activity
1. Decide to make presentation	Roger & Susan	2	
2. Arrange appointments	Roger	17	
3. Collect sales data	Susan	10	
4. Prepare presentation	Susan	10	
5. Make presentation	Roger & Susan	1	
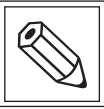
✎ **Exercise 5-2**
Case Study: Geebold Manufacturing

Five months ago, the board of directors of Geebold Manufacturing approved the building of a new facility to manufacture a new line of clothing. The company has already selected the project manager and the project team.

Ann, the project manager, has spent the past five months planning the project all by herself. She carefully defined the project in terms of cost, time, and scope, and obtained the approval of the board of directors on the statement of work.

Working diligently, she created a work breakdown structure to the best of her knowledge. The diagram contains over one hundred boxes in eight levels. Some of the work packages represent two to three hours of work, and a few represent 150 hours of work. She then estimated each of the activities using an analogous approach, drawing on plans she discovered for a similar facility the company planned three years ago but never completed.

Ann then drew a graphical network diagram, including each of the work packages from the work breakdown structure. The diagram showed the sequence of activities and their interrelationships. Ann is now ready to select the project team and get the project rolling.

What has Ann done correctly? If you were the project manager, what would you do differently? (Suggested answers are in Appendix A.)

CALCULATING THE CRITICAL PATH

Mathematical techniques for calculating schedules appeared in the early 1950s with PERT (program evaluation and review technique) and CPM (critical path method). These techniques allowed project managers to plan, analyze, and manage complex projects. The United States Navy, Booz-Allen, and Lockheed developed PERT for the Polaris program. PERT emphasized meeting schedules with cost flexibility. It was developed to estimate duration for projects with a high degree of uncertainty in the individual activity duration estimates. PERT provided a three-point estimate for each activity: *most likely* (m), *optimistic* (o), and *pessimistic* (p), which were computed with an emphasis on the most likely,

$$\text{estimated time} = (o + 4m + p) / 6$$

Although the PERT weighted estimate formula is still used, the entire PERT system is seldom used today.

The most common method used today is the CPM, which was developed by DuPont and Remington Rand for planning and scheduling plant maintenance and construction programs. It emphasizes managing cost and leaving the schedule flexible.

Using the Critical Path Method (CPM)

Using the network diagram, the next step is to determine the critical path. The *critical path* is the path through the network that takes the longest total

time. It therefore determines the earliest possible time the project can be completed.

It is important to know the activities that are on the critical path. These activities are not inherently more important than the others, but they have the least scheduling flexibility. Critical path tasks require more careful monitoring because if they are not completed on time, the project will be late (unless subsequent activities are completed in less than the scheduled time).

CPM calculates the following dates for each activity:

- *Early start* is the earliest date the activity can begin.
- *Late start* is the latest date the activity can begin that will still allow the project to be completed on time.
- *Early finish* is the earliest date the activity can end.
- *Late finish* is the latest date the activity can end that will still allow the project to be completed on time.

For activities on the critical path, the early and late start (and early and late finish) are the same.

Another important concept to understand is *float* (also known as *slack, total float*, and *path float*). Float is the time an activity can slip without delaying the project. It is equal to the difference between the early start and late start (or the difference between the early finish and late finish). The critical path generally has zero float. Activities on the same noncritical path have the same, shared float. (*Free float* is the amount of time an activity can be delayed without delaying the early start of any immediately succeeding activities.)

The network diagram in Exhibit 5-7 shows the example of the pump station from Exhibit 5-4. The critical path is identified by activities in heavy boxes.

Critical Path Calculations

Project management software (see Chapter 4) is commonly used for critical path calculations. Once the manager enters the activity durations and preceding activities, the program determines the critical path, early start, early finish, late start, late finish, and float. This saves significant time creating the original schedule and subsequent reschedules. Some programs also run simulations that calculate a range of possible schedule or cost outcomes by "performing" the project multiple times using different sets of assumptions. The most common is Monte Carlo Analysis, in which a distribution of probable results is defined for each activity and used to calculate a range of possible outcomes. Simulations are more accurate than PERT and CPM because they provide more predictive estimates as a result of the multiple project outcomes simulated.

The following sections explain how to manually calculate the early start, early finish, late start, late finish, float, and critical path. Consider the example of the sales presentation from Exercise 5-1 (see Exhibit 5-8).

Calculating Early Start and Early Finish

A forward-pass calculation is used to determine the early start and early finish times for activities. The calculations, which are expressed as units of time (such as hours, days, or weeks), do not represent scheduled dates. Calculate the early start and finish times as follows:

1. Write 0 for the early start time for the first activity.
2. Add the duration to the early start time to calculate the early finish time. Write these calculations in each box. The early finish time of one activity becomes the early start time for the next activity. (If the duration is measured in minutes, the next activity can begin the next minute; if measured in days, the next activity can begin the next day.) To calculate the early start time of an activity that has more than one predecessor, you must choose the latest of the early finish times of the preceding activities.
3. Repeat Step 2 for each activity, working from the beginning of the network to the end.

E xhibit 5-7
Critical Path for Construction of a Pump Station
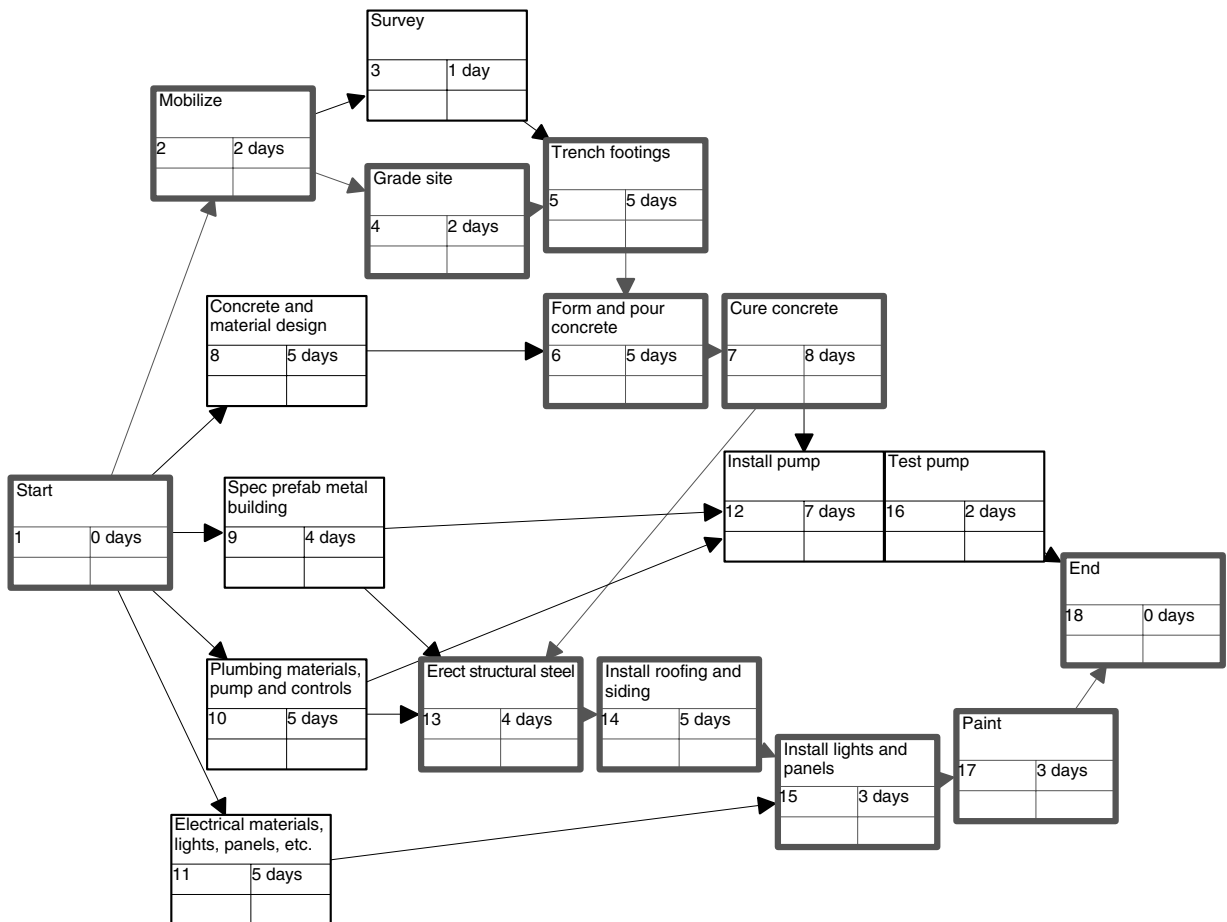
E xhibit 5-8
Sales Presentation: Planned and Preceding Activities

Activity description	Person responsible	Duration (days)	Preceding activity
1. Decide to make presentation	Roger & Susan	2	none
2. Arrange appointments	Roger	17	1
3. Collect sales data	Susan	10	1
4. Prepare presentation	Susan	10	3
5. Make presentation	Roger & Susan	1	2, 4

Calculating Late Start and Late Finish

A backward pass through the network computes the late start and late finish times for activities as follows:

1. For late finish of the last activity, write the latest time you want the project to finish (generally, this would be the early finish time for the last activity computed from the forward pass).
2. Subtract the duration from the late finish to calculate the late start time. Write these calculations in each box. The late start time of one activity becomes the late finish time for the previous activity. (If the duration is measured in minutes, the late finish time for the previous activity is the previous minute; if measured in days, the late finish time for the previous activity is the previous day.) To calculate the late finish time of an activity that has more than one successor, you must choose the earliest of the late start times of the succeeding activities.
3. Repeat Step 2 for each activity, working from the end of the network to the beginning.

Note: Calculating the early start, late start, early finish, and late finish does not determine the actual dates you should schedule for the activities in the project. Further chapters will discuss assigning resources and other considerations that will help you schedule the best dates for the activities.

Calculating Float

Float (also known as *slack, total float,* and *path float*) is calculated for each activity by subtracting the early finish from the late finish (or the early start from the late start). Float is the amount of time the activity can slip without delaying the project finish date. Free float is the amount of time an activity can slip without delaying the early start of any activity that immediately follows it.

Calculating the Critical Path

The critical path can be determined by finding the path of activities that have zero float. The critical path is shown with heavy boxes.

Exercise 5-3
Calculating the Critical Path

Refer to Exhibit 5-8 and calculate the early start, early finish, late start, late finish, and float. Then draw heavy boxes around the activities on the critical path. (The answers are in Appendix A.)

Critical Chain Method

Another schedule network analysis technique is known as *critical chain.* In this method, the critical path is calculated, then resource availability is entered and the schedule is calculated again, accounting for limited resources. The resource-constrained schedule may have a different critical path than before the resources were applied. Critical chain also adds buffers at critical points in the schedule to manage uncertainty.

recap

An important part of project planning is determining the logical work flow of the activities in the work breakdown structure. A network diagram shows which activities must be performed in sequence (activities that can be performed only after the previous activity is completed) and which can be done in parallel (activities that can be performed at the same time). The diagram shows the planned sequence of steps, with all dependencies and relationships.

The critical path is the path through the network that takes the longest total time. It therefore determines the earliest possible time the project can be completed. The activities on the critical path have the least scheduling flexibility (zero float) and, therefore, require more careful monitoring. Critical path calculations include early start, late start, early finish, and late finish.

Review Questions

1. Which of the following is true about the critical path?   1. (b)
   (a) It is the path through the network that takes the shortest total time.
   (b) It determines the earliest possible time the project can be completed.
   (c) It consists of the activities that are most important to complete the
       project.
   (d) It consists of the activities that are the most difficult to complete.

2. Which is *not* true of the critical chain method?   2. (d)
   (a) Resource availability is a key element.
   (b) Buffers are added at critical points in the schedule to manage
       uncertainty.
   (c) The schedule is calculated before and after resources are applied.
   (d) A resource-constrained schedule will always have the same critical
       path as a schedule that does not consider resource availability.

3. Which of the following is true about float?   3. (a)
   (a) It is equal to the difference between the early finish and late finish.
   (b) It is the time delay between activities.
   (c) It is equal to the difference between the early start and early finish.
   (d) The critical path has zero float and zero lag.

4. If Activities A and B have a finish-to-start relationship, this means that: 4. (c)
   (a) A cannot begin until B is completed.
   (b) A and B must be completed before other activities can begin.
   (c) B cannot begin until A is completed.
   (d) other activities must be completed before either A or B can begin.

5. Which of the following is *not* true about late finish?   5. (d)
   (a) Late finish is the latest date an activity can end and still allow the
       project to be completed on time.
   (b) Late finish is equal to the early finish for activities on the critical path.
   (c) Late finish − early finish = float.
   (d) The late finish of one activity is equal to the early finish of the next
       activity.

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Preparing a Project Plan

Learning Objectives

By the end of this chapter, you should be able to:

- Create a project schedule.
- Prepare a project resource plan.
- Prepare a project budget plan.
- Describe the risk management processes of identifying, analyzing, and responding to project risk.
- Explain how to get approvals and compile a comprehensive project plan.

In previous chapters, you learned how to define the project objectives, create a work breakdown structure, estimate the effort needed to accomplish each activity, then sequence the activities based on their logical relationships and dependencies.

In this chapter, you will learn how to put all these together into a workable project plan. You will learn how to apply the estimated work hours or days to the calendar to determine the duration of each activity, considering weekends, holidays, and vacation schedules as well as the availability of people and other resources. You will learn how to reprogram the activities, if needed, to meet required completion dates. You may even need to negotiate a modification of some of the basic project objectives to come up with workable schedules, resource plans, and budget plans. You will also learn how to identify potential risks, assess their possible impact, and prepare a plan for responding to these risks. You will compile all this into an official project plan and get final approvals before beginning project work.

PREPARING SCHEDULES

After you have prepared the network diagram and identified the critical path, you are ready to prepare schedules by following two simple steps:

1. Create the initial schedule using the early start and early finish times. If necessary, you can adjust the schedule later to the late start and late finish times to account for the availability of resources. In other words, if the necessary resources are not available on the early start date, the project manager can determine to begin the activity on the late start date.

2. Assign a calendar date to the beginning of the first activity and convert the time durations on each activity to a calendar date. Alternatively, you may assign a calendar date to the completion of the project and work backward to the beginning of the project.

If the schedule shows the project will complete before the requested date, keep this extra time (float) at the end of the project to allow recovery options

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E xhibit 6-1
Calendar Dates for Construction of a Pump Station
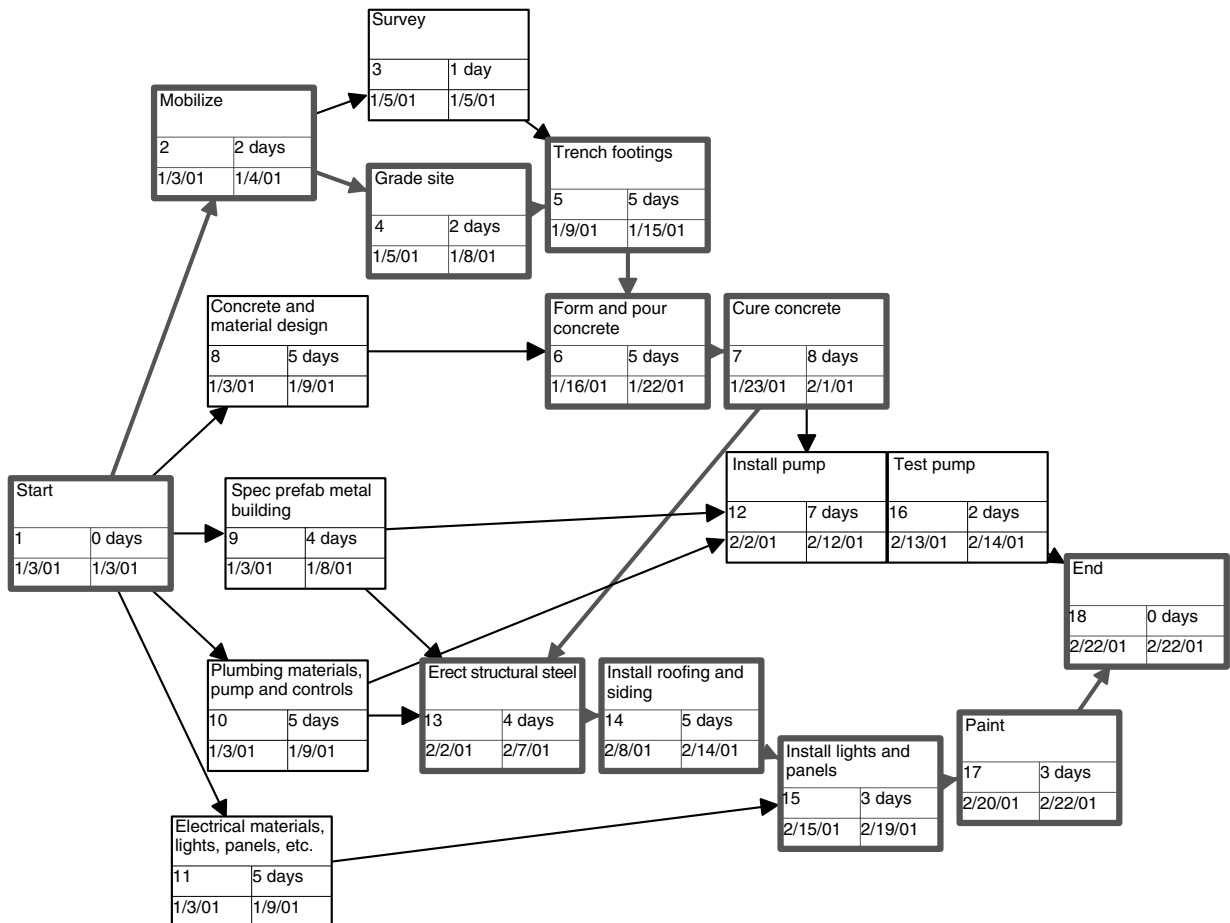
if the schedule slips during the life of the project. The project manager owns the float and should not give it away indiscriminately. The manager uses float to compensate for estimating variability or unforeseen problems. Team members should not be allowed to use float at their discretion.

The network diagram in Exhibit 6-1 shows the pump station example with calendar dates based on the early start and early finish times.

Exercise 6-1
Preparing Schedules: Sales Presentation

Exhibit 6-2 shows the sales presentation exercise with the early and late start and finish times calculated previously in Exercise 5-3. Calculate a scheduled start and finish time for each activity by assigning a start date of April 1 to the first activity Convert the time durations on each activity to a date using early start and early finish. (The answers are in Appendix A.)

Milestones

To help define and monitor the schedule of a large project, you may wish to define milestones that represent the completion of a major deliverable or group of activities. For a project that includes several functional groups or categories of activities, it may make sense to develop milestones for each. For example, a milestone for engineering on the development of a new product may be the development of a product requirements document. Milestones may be inserted in the project schedule as activities that define the completion

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Exhibit 6-2
Preparing Schedules: Sales Presentation
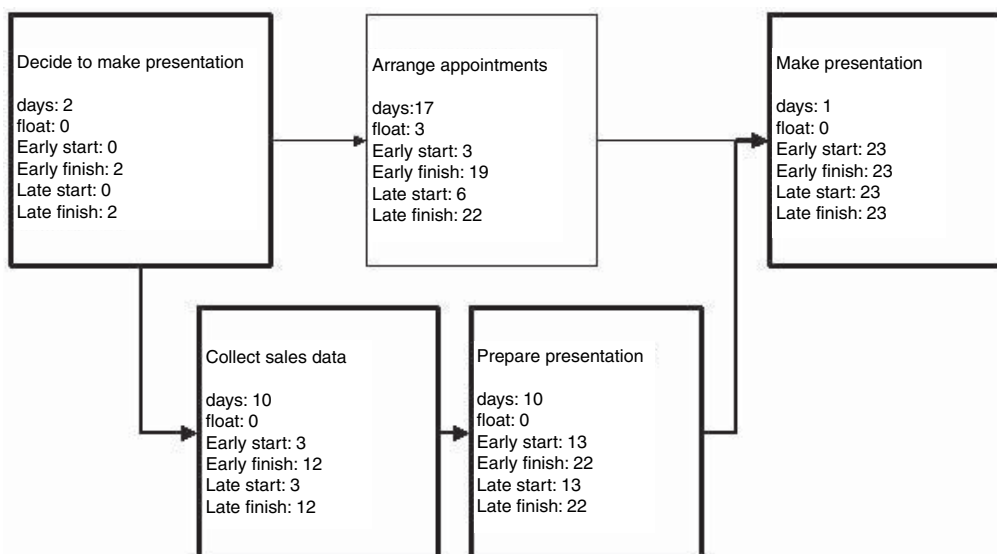
of a group of activities. A milestone has no duration, cost, or resource requirements. Milestones can be used to ensure that a project is on schedule and meeting its scope.

Gantt Charts

Once the schedule is developed, a bar chart is a helpful way to communicate schedule information since it provides an easy-to-read visual picture of the project activities. It can very quickly convey considerable information. Gantt charts (originally developed by Henry Gantt) are bar charts with time graduations along the horizontal axis and activities listed on separate lines down the vertical axis, making it easy to see the relationship between activities and time. The horizontal bars show the scheduled time frames for each activity. Connecting lines and arrows show dependencies. Exhibit 6-3 shows the example of the pump station as a Gantt chart.

Exercise 6-2
Gantt Chart: Sales Presentation

Draw a Gantt chart for the sales presentation in Exercise 6-1. (The answer is in Appendix A.)

E xhibit 6-3
Gantt Chart for Construction of a Pump Station

ID	Task Name	January					February				March			
		12/31	1/7	1/14	1/21	1/28	2/4	2/11	2/18	2/25	3/4	3/11	3/18	3/25
1	Start	◆ 1/3												
2	Mobilize													
3	Survey													
4	Grade site													
5	Trench footings													
6	Form and pour concrete													
7	Cure concrete													
8	Concrete and material design													
9	Spec prefab metal building													
10	Plumbing materials, pump,etc.													
11	Electrical materials, lights, panels													
12	Install pump													
13	Erect structural steel													
14	Install roofing and siding													
15	Install lights and panels													
16	Test pump													
17	Paint													
18	End						◆ 2/22							

?	**Think About It . . .**

To communicate project information, when would you use network diagrams and when would you use Gantt charts?

Crashing the Schedule

If the schedule you develop does not allow the project to complete when desired, you might have to take action to decrease the total project duration. This is known as *crashing the schedule.*

Analyze all the available options and choose those that provide the greatest compression for the lowest cost. Concentrate on the activities on the critical path. (Remember, shortening noncritical activities will not complete the project any sooner.) Focus first on activities that occur early in the project and, second, those with the longest durations.

Resources

One way to crash a schedule is to change the way resources are applied to the project. (The allocation of resources is discussed later in this chapter.) The following are some options to consider:

- *Relieve employees of other responsibilities* to allow them to devote more hours each day to the project.
- *Reallocate resources from noncritical activities* to provide the extra help you need. After you reassign the resources, check to see if the critical path has shifted to include other activities.
- *Add resources* to provide additional staff, overtime, additional equipment, vendor incentives to complete sooner, or the ability to outsource. Make wise choices because adding too many resources can cause problems in communication and interpersonal relations.
- *Reserve overtime as a contingency.* Rather than scheduling overtime in the original plan, keep it as a contingency for unforeseen problems. Overtime is not as effective as regular work hours. Studies show that twelve hours' overtime by a knowledge worker increases actual output only by the equivalent of two hours' regular work. Overtime might be useful if a small increment (three to four days) will make a difference in the project, if the staff can see light at the end of the tunnel, and if extra money is an incentive to them.

Activities

Another way to crash a schedule is to change the sequence of activities or reevaluate their estimates. The following are some options to consider:

- *Fast-track the project* by changing the sequence of activities in the network diagram to allow activities to be done in parallel (at the same time) rather than in sequence (one after another) or to allow some to overlap (for example, starting to write code on a software project before the entire design is complete). Fast-tracking usually increases risk.
- *Reconsider the accuracy of the estimates* for activities on the critical path. However, do not arbitrarily reduce the estimates to fit the time available.

Project Objectives

A third way to crash a schedule is to modify the project objectives. The following are some options to consider:

- *Rethink the basic strategy* to determine better ways to accomplish the same objectives.
- *Renegotiate the project objectives.* Reduce the scope, increase the budget, or increase the time.
- *If the schedule still won't work, readdress the basic problem or opportunity* to verify that it warrants the effort it will take to complete the project.

PREPARING RESOURCE PLANS

The best project plan in the world cannot be accomplished without the right people, materials, and equipment at the right place at the right time. This section explains how to assign the right resources when and where they are needed.

Consider the following principles when assigning resources:

- Schedules are meaningless unless the right resources are available when the activity is scheduled to begin.
- If you cannot get the right resources at the right time, you may need to re-plan. Do not assign the wrong person to the job just because no one else is available at that time.
- Assign scarce resources to activities on the critical path first.
- Obtain firm commitments from team members, functional managers, and senior management. Once commitments are made, the committed hours no longer belong to the function, but to the project.
- Too few people on a project cannot solve the problems; too many people can create more problems than they solve.
- Balance critical resources by adjusting schedules where there is float. If the activity was scheduled to begin on the early start date, try adjusting it to the late start date to see if the appropriate resources are available at that time. Meet with functional sections to level the workload as much as possible to keep in-house resources busy and to use preferred outside resources as much as possible.
- It may be necessary to increase the project duration to get the right resources at the right times.

The following steps may be helpful in allocating resources. Although the steps refer specifically to allocating people, the same process can be followed for allocating other resources, such as equipment and materials.

Identifying the Required Skills

Identify the skills required for each activity as identified on the activity estimate sheets. Also note the skill level required. For example, do not assign an entry-level editor to do a job specified for a senior editor. Likewise, you usually would not assign a senior (and higher paid) editor to do a job that could be accomplished by an entry-level editor.

Exercise 6-3
Identifying Required Skills: Remodeling a Bathroom

Identify the skills required to complete the job of remodeling a bathroom. The project you are hired to do includes expanding the size by using space from an adjoining room, moving the bathtub, and installing a new ceiling exhaust fan. (Suggested answers are in Appendix A.)

Recruiting Personnel

Recruit individuals who best meet the skill requirements that were identified during the creation of the work breakdown structure. Plot each person (or group of people) and the project skill requirements on a responsibility assignment matrix such as the one shown in Exhibit 6-4.

Exercise 6-4
Responsibility Assignment: Remodeling a Bathroom

Create a responsibility assignment matrix, assuming you have available the following individuals: Bob (experienced in plumbing and electrical), Roger (carpenter), and Sandy (plumber). (Suggested answers are in Appendix A.)

E xhibit 6-4
Responsibility Assignment Matrix

Person	Skill Requirement			
	Technical Writing	Proofreading	Layout Design	Customer Relations
Joe Brady	✔			
Mary Fox				✔
Bill Jones	✔	✔		
Sue Bird			✔	

Assigning People to Activities

Assign the most appropriate people to each activity. A useful tool for determining the availability of resources is a resource histogram (Exhibit 6-5), which may be prepared for an individual or for a group of people with similar skill sets.

On the resource histogram, block out time needed for the following:

- *Administrative activities* (such as time cards, personnel meetings, breaks, personal leave, and sick leave).
- *Operational support* (such as training classes, coordination meetings, internal consulting, answering phone calls, travel, research, problem solving, crisis management, and other activities needed to maintain the operation).
- *Project work* (the days and hours the person, or other resource such as equipment, is committed to project activities).

Schedules often fail because they underestimate the hours required for administrative and operational activities. When this happens, fewer hours than expected can be devoted to project work.

Leveling the Resources

When a person or other resource is overcommitted (such as on weeks beginning 4/27, 5/4, and 5/18 in Exhibit 6-5), add more people or resources to match the needs or try to level the workload of existing people and resources using one or more of the following options:

- *Resources.* Reallocate available personnel or resources to provide assistance or to replace the overcommitted resource. Authorize overtime.

E | xhibit 6-5
Resource Histogram

Senior Editors

Legend:
- Project Work
- Operational Support
- Administrative
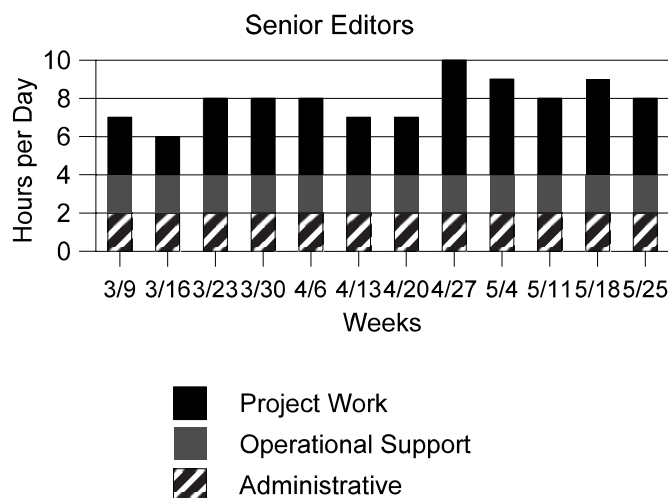
- *Activities.* When float is available, use it to shift the schedules by using the late start rather than the early start times. Use float to extend the activity duration. (For example, rather than committing a person 100 percent for two days, use her 50 percent for four days.)
- *Project objectives.* Reduce the scope of the activity, if possible, by approaching the activity in a different way.

As you allocate resources, it is important to consider the trade-offs in time, cost, and resources. For example, putting more employees on a particular project may get the job done faster, but may be less efficient. As Exhibit 6-6 illustrates, one employee can complete the job in twenty days working full-time, whereas it would require forty-two days if he worked half-time. (Working half-time wastes a couple of days because of time lost to stop and start project work each day.) Two employees can complete the job in thirteen days, and three can do it in ten days. There is no straight-line correlation between the number of employees and the days to complete the project because adding more employees means they have to expend extra time to coordinate their work. The total cost of the project increases as you add more employees: One employee half-time would cost twenty-one days' work (working half-time for forty-two calendar days), one employee full-time would cost twenty days' work, two employees would cost twenty-six days' work (2 × 13), and three would cost thirty days' work (3 × 10).

Allocate more employees if time is critical and allocate fewer employees if resources are critical. In the example above, one employee is the most cost-effective choice, but three employees can complete the job most quickly if time is critical.

E xhibit 6-6
Trade-offs in Time, Cost, and Resources

Some activities may take a fixed amount of time regardless of the number of people involved. For example, a woman can have a baby in nine months, but two women cannot do it in four and a half months.

Adjusting the Project Schedule

Finally, adjust the project schedule based on the availability of the right resources at the right time. Leveling the workload often results in increasing the total project duration. If an earlier completion date is needed, you may need to add more resources.

Exercise 6-5
Leveling Resources: Remodeling a Bathroom

Exhibit 6-7 shows a network diagram for the project to remodel the bathroom. Assign people to the activities, considering their skills (see Exercise 6-4), then adjust the schedules as needed based on the availability of resources to complete the project as early as possible. (Note: Bob is on vacation June 5, and Sandy is on vacation June 5–10.) (Suggested answers are in Appendix A.)

PREPARING BUDGET PLANS

Budgeting is the process of allocating the cost estimates to work items to establish a cost baseline for measuring project performance. Small projects may not need extensive budget plans if you use in-house resources. Larger projects may require extensive budget plans, including basic spreadsheets, cumulative spreadsheets, and cost line graphs.

To prepare a simple budget plan, do the following:

- Total the personnel costs from each activity estimate sheet.
- Total the direct costs from each activity estimate sheet. Remember to include project management and other operational costs.

Exhibit 6-7
Network Diagram for the Project to Remodel the Bathroom
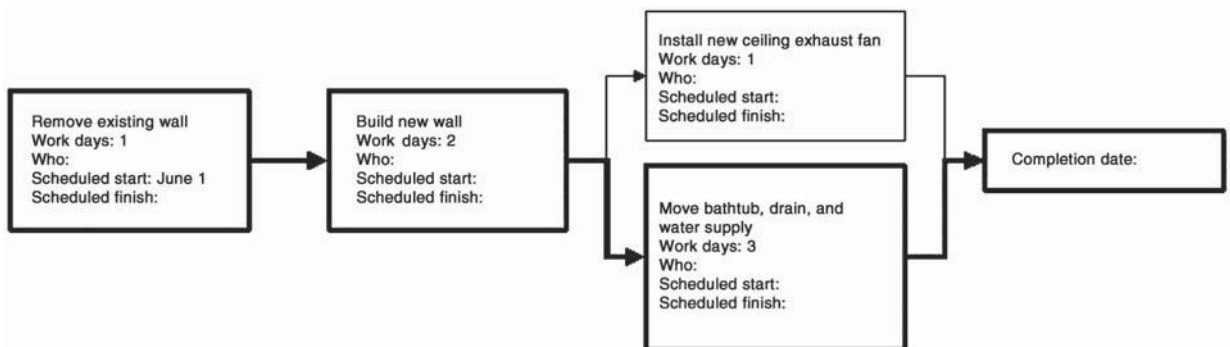
- Total indirect (overhead) costs if your organization requires they be included in your budget.
- Calculate cumulative costs.
- Determine when expenditures will be made to calculate the cash flow needed. Cash flow is usually planned according to a time interval (daily, weekly, or monthly, depending on the size and length of your project).
- Prepare tables, charts, or graphs for each activity, for each functional section, and for the project as a whole.

The result is a project cost baseline, which is a time-phased budget used to measure performance as the project progresses. It is developed by summing the cost estimates by time period and is often displayed in the form of an S-curve, as illustrated in Exhibit 6-8.

Exhibits 6-9 to 6-11 show examples of budget plans and graphs.

The basic spreadsheet in Exhibit 6-9 shows the amount of money planned for each category. As the project progresses, the actual amounts are entered and the variance calculated.

The cumulative cost spreadsheet in Exhibit 6-10 indicates the cumulative costs to date and the anticipated total cost at the completion of the project.

The cumulative cost line graph in Exhibit 6-11 shows the cumulative actual costs to date (dashed line) compared to the cumulative planned costs (solid line). It also projects future costs (dotted line). In this example, the budget shows that actual expenses to date are more than planned. Furthermore, it anticipates that future costs will exceed the planned costs even more.

MANAGING RISK

Risks are uncertain events or conditions that, if they occur, have a positive or

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Exhibit 6-8
Project Cost Baseline
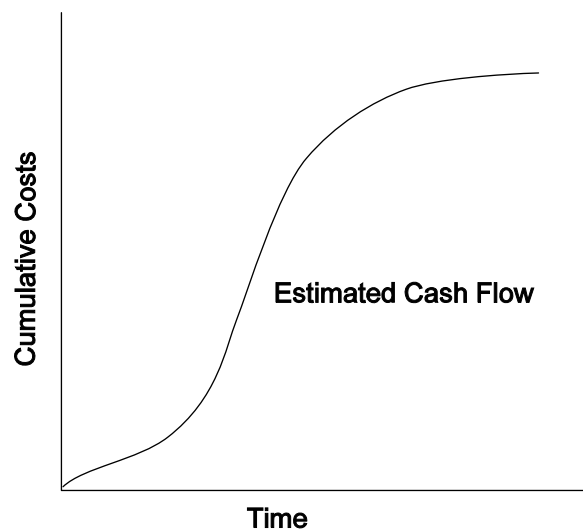
E xhibit 6-9
Basic Cost Spreadsheet

Cost Categories	January			February		
	Plan	Actual	Variance	Plan	Actual	Variance
Select demo site	$5,000			$0		
Prepare demo	$7,000			$9,000		
Conduct demo	$0			$7,500		
Evaluate demo	$0			$0		
Prepare final report	$0			$0		
Other	$200			$200		
Total direct labor	$12,200			$16,700		
Materials, etc.	$8,000			$9,500		
Total direct costs	$8,000			$9,500		
Project mgmt. support	$5,000			$5,000		
Other	$550			$550		
Total operational costs	$5,550			$5,550		
Total project costs	$25,750			$31,750		

negative effect on the project objectives. All projects have a certain degree of risk that needs to be managed. The project manager determines where risks are likely to affect the project, makes contingency plans for them, and responds to them when they occur.

This section describes the risk management processes of identifying, analyzing, and responding to project risk. The purpose of risk management is to maximize the results of positive events and minimize the results of adverse events. The output of a risk management plan includes:

- Possible risks, potential causes, and how they may affect the project.
- Prioritized list of project risks, their owners, and planned responses.
- Warning signs of a possible risk occurrence.
- Secondary risks that may arise from the response to a risk event.

Identifying Risk

The first step in developing a risk management plan is to identify the potential risk events.

E | xhibit 6-10
Cumulative Cost Spreadsheet

Cost Categories	Cumulative Costs to Date			Anticipated Total at Completion		
	Plan	Actual	Var.	Plan	Actual	Var.
Select demo site	$15,000	$14,500	$500	$15,000	$14,500	$500
Prepare demo	$17,000	$17,500	($500)	$17,000	$17,500	($500)
Conduct demo	$8,500	$9,000	($500)	$9,500	$10,000	($500)
Evaluate demo	$1,500	$50	$1,450	$2,000	$2,000	$0
Prepare final report	$750	$0	$750	$750	$0	$750
Other	$1,275	$750	$525	$2,500	$2,500	$0
Total direct labor	$44,025	$41,800	$2,225	$46,750	$46,500	$250
Materials, etc.	$8,000	$8,025	($25)	$10,000	$10,500	($500)
Total direct costs	$8,000	$8,025	($25)	$10,000	$10,500	($500)
Project mgmt. support	$12,500	$12,500	$0	$15,000	$15,000	$0
Other	$350	$325	$25	$550	$550	$0
Total operational costs	$12,850	$12,825	$25	$15,550	$15,550	$0
Total project costs	$64,875	$62,650	$2,225	$72,300	$72,550	($250)

E | xhibit 6-11
Cumulative Cost Line Graph

Project Cash Flow
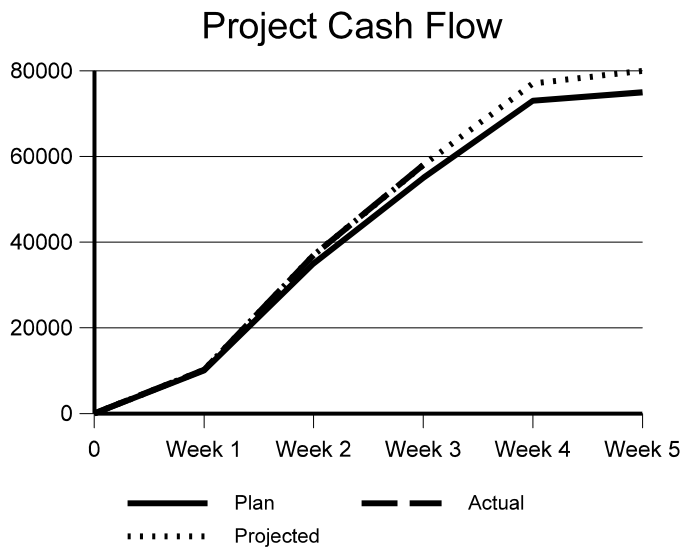
Considering Possible Sources
The chart in Exhibit 6-12 identifies the major categories of risk and gives common examples of each.

Determining Likely Risks
To identify potential risks, simply ask, "What could go wrong?" Review the work breakdown structure for the project, the cost estimates, and resource plans and consider what might happen that could cause any aspect of the project to deviate from the plans. Define specific risk events and describe what specifically might go wrong. For example, ground breaking may be delayed because of legal problems in securing the building permit. Describe the effect of each potential event. Identify what would cause the risk event to happen (often called *triggers*) and describe any conditions or signs that may warn you of the impending event.

    Consider both internal and external events that could affect the project. Internal events are things under the control of the project team, such as work assignments or cost estimates. External events are things beyond the influence of the project team, such as technology shifts or changing economic conditions.

E xhibit 6-12
Major Categories of Risk

Risk Category	Examples
Technical	new breakthroughs, design errors or omissions
Administrative	processes, procedures, changes in roles or responsibilities
Environmental	culture of the organization, change in management or priorities, office politics
Financial	budget cuts, cash flow problems, corporate unprofitability, unchecked expenditures, changing economic conditions
Resource availability	specialized skills or critical equipment not available
Human	human error, poor worker performance, personality conflicts, communication breakdown
Logistical	inability to deliver materials or work face-to-face
Governmental	government regulations
Market	product fails in the marketplace, consumer expectations change, new competitor products

Exercise 6-6
Budget Plans: Remodeling a Bathroom

Refer to the project to remodel the bathroom described in Exercise 6-5. The estimated costs are as follows: $500 to move the bathtub, drain, and water supply; $80 to remove the existing wall; $120 to build the new wall; and $150 to install the new ceiling exhaust fan. Given the dates determined in Exercise 6-5, create a cumulative cost spreadsheet as of June 3, assuming actual expenditures are 10 percent over the estimates. (Suggested answers are in Appendix A.)

We typically think of risk as a negative event that causes harm or loss to the project. However, risk events can also include opportunities with positive outcomes. A change in economic conditions may increase the available labor force and allow you to hire more workers to complete the project sooner. Although a potentially positive outcome, you need to assess the impact on the project schedule and cost plans and determine your course of action.

You can never anticipate all possible risks, nor should you expend the effort to try to identify every conceivable problem. Simply identify those that are fairly likely. The cost of prevention should never exceed the cost of impact should the potential problems actually occur.

Conducting Ongoing Risk Identification

Risk identification is not a one-time event. Economic, organizational, and other factors will change during the course of the project that may bring to light additional sources of risk. Risk factors should be identified at the outset of the project *and then* updated on a regular basis throughout the life of the project.

Exercise 6-7
Identifying Risk

Auto Parts, Inc., has purchased a new system to inventory the car parts it distributes. You are assigned to manage the implementation of the system, which includes two weeks of software installation, seven weeks of training, and twelve weeks of implementing changes in the methods of receiving parts and filling orders. Describe the possible risks to this project. (Suggested answers are in Appendix A.)

Assessing Risk

Once you have identified the potential risk events to be included in the plan, the next step is to estimate the probability of occurrence and determine the impact if the event were to occur.

You should closely analyze potential risks associated with activities on the critical path, since a delay in these activities is more likely to delay the final outcome of the project. Also pay attention to points in the network where activities converge, because these tend to have a greater degree of risk.

For each potential risk event, estimate its impact on the time, cost, scope, quality, and resources. Remember that a single risk event could have multiple effects. For example, the late delivery of a key component could cause schedule delays, cost overruns, and a lower-quality product.

To help prioritize the potential risks, you may plot them on a chart, such as the one shown in Exhibit 6-13, to help you determine which risks are most critical.

Focus primarily on risks with high impact and a high probability of occurring. Appearing in the top-right quadrant, these critical risks are more likely to happen and would have a serious consequence if they do.

In a highway construction project, potential equipment breakdowns may be one such risk. The impact is great because construction stops when equipment is not functioning. You can influence the probability of such breakdowns by using reliable equipment and having good preventive maintenance plans.

Next, focus on risks with high impact but low probability. These appear in the top-left quadrant. In our example of a highway construction project, the threat of a union strike over a requested pay raise could be such a risk; it would have great impact on the project because it would halt construction. But if there is a low probability of the union calling a strike, you could delegate this potential problem to company management and union representatives.

These types of risks require contingency plans because of their high impact. Of lesser priority are the risk events that fall in the bottom two quadrants, because their impact on the project is low. An example of a risk that may ap-

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E xhibit 6-13
Prioritizing Potential Risks

I M P A C T	High impact Low probability	High impact High probability
	Low impact Low probability	Low impact High probability

PROBABILITY

pear in the bottom-right quadrant (low impact but high probability) is late delivery of trees and bushes for landscaping along the roadside. The impact is low because traffic may begin using the highway even if the landscaping is not yet completed. Your contingency plan may be to have an alternate vendor in place, ready to deliver the trees and bushes if the primary vendor fails.

Finally, consider the potential risk events in the bottom-left quadrant (low impact and low probability). An example of such a risk may be the late arrival of permanent signs for the highway. The probability of failure on the part of an experienced vendor may be low. The impact is also low because you can continue to use the temporary signs until the permanent ones are installed.

Along with these two factors (impact and probability), you should consider your ability to do something about the potential risks—either by preventing them from happening or by responding to their impact when they do happen.

Exercise 6-8
Assessing Risk

Consider the potential risks identified in Exercise 6-7 and rank them in a chart similar to the one shown in Exhibit 6-13. (Suggested answers are in Appendix A.)

Responding to Risk

The purpose of risk response is to minimize the probability and consequences of negative events and to maximize the probability and consequences of positive events.

Planning Responses

A response plan should be developed before the risk event occurs. Then, if the event should occur, you simply execute the plan already developed. Planning ahead allows you the time to carefully analyze the various options and determine the best course of action. That way, you are not forced to make a hasty, and perhaps less thoughtful, response to a threatening situation.

Possible Responses to Risk

In developing a response plan, consider ways to avoid the risk, transfer it to someone else, mitigate it, or simply accept it.

AVOIDING ☞ It may be possible to eliminate the source of risk, and therefore

prevent it from happening. This may involve an alternative strategy for completing the project. For example, rather than assigning work to a new, less expensive contractor, you may choose to reduce the risk of failure by using a known and trusted contractor—even though the cost may be higher. You can never avoid all risk, but you can try to eliminate as many sources as possible.

TRANSFERRING ☛ It may also be possible to transfer some risk to a third party, usually for the payment of a risk premium. For example, you can avoid the chance of a cost overrun on a specific activity by writing a fixed-price contract. In such a case, the contractor agrees to complete the job for a predetermined (higher) price and assumes the potential consequences of risk events. If the risk is low, you could choose to accept the risk and write a cost-plus contract, paying the contractor only the actual costs plus a predetermined profit. Other examples of risk transference include the purchase of insurance, bonds, guarantees, and warranties.

MITIGATING ☛ Mitigation plans are steps taken to lower the probability of the risk event happening or to reduce the impact should it occur. For example, you can reduce the likelihood of a product failure by using proven technology rather than cutting-edge technology. Mitigation costs should be appropriate to the likelihood of the risk event and its potential impact on the project. Some mitigation strategies may not take a lot of effort, but may have large payoffs in eliminating the potential for disaster. On a project with a tight deadline, the risk of delayed delivery of raw materials may be disastrous. If two vendors can provide materials at essentially the same price, but one has a much larger inventory and a significantly better history of on-time delivery, choosing the vendor with the better track record may be an easy mitigation strategy with a potentially large payoff.

ACCEPTING ☛ When there is a low likelihood of a risk event, when the potential impact on the project is low, or when the cost of mitigation is high, a satisfactory response may be to accept the risk. For example, say that the economy moves into a recession midway into a project to reengineer a manufacturing plant for increased efficiency and output. The company may choose to proceed with the project anyway, and accept the risk that lower sales will reduce the return on investment below what was expected.

Developing a Response Plan
After considering the options of avoiding, transferring, mitigating, or accepting the risk, response planners may develop a risk management plan, contingency plans, and reserves. A *risk management plan* documents the procedures that will be used to manage risk throughout the project. It lists potential risk events, the conditions or signs that may warn of the impending event, and the specific actions to be taken in response. *Contingency plans* describe the actions to be taken if a risk event should occur. *Reserves* are provisions in the project plan to mitigate the impact of risk events. These are usually in the form of contingency reserves (funds to cover unplanned costs), schedule reserves (extra time to apply to schedule overruns), or management reserves (funds held by general management to be applied to projects that overrun).

After identifying your plans to avoid, transfer, mitigate, or accept the risk, you may need to add specific activities to the work breakdown structure and other plans.

Acting on the Response Plan

The project manager and other team members monitor the project throughout its life, looking for triggers and signs that may warn of impending risk events. When risk events happen, management takes the corrective action identified in the risk management plan.

When an unplanned risk event occurs, a response must be developed and implemented. This is often called a *workaround.* After the response is implemented, the risk management plan should be reviewed and updated if necessary. It may also be necessary to adjust other project plans or the basic project objectives.

As changes in the project occur, it may be necessary to repeat the steps of identifying, assessing, and planning responses to risk.

Exercise 6-9
Responding to Risk

Consider the potential risks identified in Exercises 6-7 and 6-8 and develop a response plan. Describe the avoiding, transferring, mitigating, and accepting behaviors you may take. (Suggested answers are in Appendix A.)

GETTING APPROVALS AND COMPILING A FORMAL PROJECT PLAN

Now that detailed planning has been completed, compare the final schedules, cost plans, and project specifications with the original project objectives. Where there are discrepancies, you should negotiate adjustments and get final approvals and commitment from the customer, project sponsor, senior management, functional managers, and the project team. Then, create a formal project plan containing all the planning documents.

Reconciling the Project Objectives

Compare the final schedules, cost plans, and project specifications with the original project objectives (see Exhibit 6–14). If the project plans show that the time, cost, or scope is more than the original project objectives are able to support, now is the time to negotiate any final adjustments.

E xhibit 6-14
Comparison of Final vs. Original Project Objectives

_____ original project request

---------- project plan
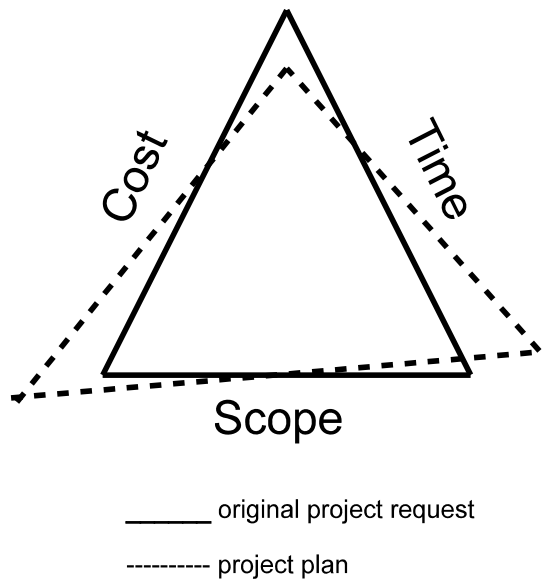
- *Internal adjustments.* Negotiate revised estimates with the project team, find a different approach to complete the project, increase personnel, schedule shift work, run some activities in parallel, or take more risks.
- *External negotiations.* Renegotiate the basic project objectives with the project sponsor.

In many projects, a core piece gives 80 percent of the value of the project. Once you identify that core piece, you may be able to reduce the size of the project by trimming back additional pieces that give only marginal value. For example, a project to build a bridge may consist of the bridge (80 percent of the cost) and the support to the bridge (20 percent of the cost), such as toll booths, approach ramps, signs, landscaping, parkways, and so on. You may be able to reduce or eliminate some of these support elements and still maintain the functionality of the bridge. However, be careful not to eliminate critical pieces of the project, such as the approach ramps.

Getting Approvals and Commitments

Obtain written approvals from the customer, project sponsor, senior management, functional managers, and project team. Get everything in writing. Unless it is on paper, it has not been said. Over time, people may forget the conditions attached to a promise and only remember the promise.

Determine what the commitments mean. To what lengths will the person go to meet the project objectives? What will happen if other work conflicts with commitments to this project? What support will senior management give

the project? What do you expect from them? Do they understand the expectations the same way you do? Get the appropriation of budgets, personnel, equipment, and other resources.

Creating a Project Plan

The comprehensive project plan is the culmination of the planning process and the road map for project execution. The formal project plan includes the following:

- *Project charter,* which formally authorizes the project, explains the business need the project addresses, states the project objectives (time, cost, and scope), and defines the approvals and authority granted by the project sponsor or senior management.
- *Schedules*
- *Project scope statement*
- *Resource plans*
- *Budget plans*
- *Risk management plans*
- *Monitoring and management plan* (see Chapter 7)
- *Change control processes* (see Chapter 7)
- *Project evaluation plan* (see Chapter 8)
- *Project reporting plan* (see Chapter 8)
- *Project closure plan* (see Chapter 8)

It is important that these documents be formalized in writing and kept in a single binder or website so that they are accessible to all members of the project team, the project sponsor, and the customer. The project plan is a dynamic document that is updated and refined as needed. However, any changes in project objectives, schedules, or budgets must be managed through a formal change process (see Chapter 7). When such changes are approved, the project plan must be updated.

Exercise 6-10
Project Plan

Consider the project for Auto Parts, Inc., described in Exercise 6-7. List the items that would be included in the project plan.

Explain where the documents would be kept and how they would be made available to all interested parties.

Exercise 6-10 continued from previous page.

How would doing this help you manage the project better?

_____

_____

_____

_____

recap

Schedule the activities in the project with calendar dates that include the early start, late start, and finish dates. If the initial schedule does not meet expectations, you can shift some activities to the late start or finish dates. Other options to crash the schedule include changing the way resources are applied to the activities, changing the sequence of activities (fast-tracking), and modifying the project objectives.

Resource plans can help you assign the right resources when and where they are needed. To create resource plans, begin by identifying the required skills, then recruit individuals who best meet the skill requirements and plot them on a responsibility assignment matrix. Next assign the appropriate people to each activity based on their availability and skills. If a person or other resource is overcommitted on a given day, make appropriate adjustments by reallocating people, shifting schedules where there is positive float, or changing the plan to approach the activity in a different way.

Budgeting is the process of allocating the cost estimates to work items to establish a cost baseline for measuring project performance. Prepare cost spreadsheets to track the cumulative costs to date and the anticipated costs at the completion of the project. Line graphs and other charts may be helpful ways of viewing the information.

Risks are uncertain events or conditions that, if they occur, have a positive or negative effect on the project objectives. Risk management includes processes to identify, analyze, and respond to risk. The purpose of risk management is to maximize the results of positive events and minimize the results of adverse events.

The first step in developing a risk management plan is to identify the potential risk events by considering possible sources, determining likely risks, and conducting ongoing risk identification. The next step is to assess the risk by estimating the probability of occurrence and determining the impact if the event were to occur. A response plan should be developed before the risk event occurs, and should include ways to avoid the risk (by eliminating the cause), transfer the risk (through fixed-price contracts, insurance, and/or guarantees), mitigate the risk (by choosing reliable providers), or accept the risk (by proceeding in spite of the negative or positive change).

The project manager and other team members monitor the project

throughout its life, looking for triggers and signs of impending risk events. When risk events happen, they take the corrective action identified in the risk management plan.

When the detailed planning is completed, compare the final schedules, cost plans, and project specifications with the original project objectives. If there are discrepancies, negotiate adjustments and get final approvals and commitment from the customer, project sponsor, senior management, functional managers, and the project team. Create a comprehensive project plan containing all these documents and plans and make it available to all interested parties before beginning project work.

Review Questions

1. A shows cumulative costs to date and the anticipated costs at the completion of the project.
(a) cumulative project cost baseline
(b) cumulative cost spreadsheet
(c) basic cost line graph
(d) budgeting allocation chart

1. (b)

2. Which of the following statements is *not* true?
(a) One way to crash a schedule is to change how resources are applied to the project.
(b) To crash the schedule, concentrate on activities that occur late in the project and those with the shortest durations.
(c) You can fast-track a project schedule by changing the sequence of activities to allow some to be done in parallel.
(d) Putting more employees on a project may get the job done faster, but it may be less efficient.

2. (b)

3. A _____ is a document that states the purpose and requirements of the project, and includes approvals by the project sponsor or senior management and the authority of the project manager to expend resources.
(a) project objective statement
(b) project charter
(c) project scope statement
(d) statement of work

3. (b)

4. Insurance and guarantees are examples of _____ risk.
(a) mitigating
(b) transferring
(c) avoiding
(d) accepting

4. (b)

5. Choosing reliable providers is an example of:
(a) financial risk.
(b) mitigation strategy.
(c) negative risk.
(d) transferring strategy.

5. (b)

Managing Time, Cost, and Scope

Learning Objectives

By the end of this chapter, you should be able to:

- Explain how to set up a monitoring and management process you can use throughout the life of the project.
- Describe how to use project plans and status information to manage time, cost, scope, and resources.
- Identify key components of a change control process.

You are now ready to begin project work. This chapter describes how to kick off the project and how to monitor and manage it through its life cycle, giving specific suggestions on managing time, cost, scope, and resources.

INITIATING THE PROJECT

When you have completed the final schedules, cost plans, and project specifications, compiled a project charter, and received proper approvals, you are ready to begin work on the project.

Kickoff Meeting

You can start a project on the right foot by holding a formal kickoff meeting with the project sponsor, customers, project team members, and other stakeholders. This is a great opportunity to explain the roles and responsibilities of everyone present and communicate the project plans clearly and concisely. It is the first step in establishing a team identity and building camaraderie. On large projects, you may wish to build team spirit and identity by develop-

ing a project logo or slogan to use on letterhead, project reports, and even T-shirts and mugs.

Communicating Project Plans

Be sure to communicate project information to all stakeholders: the project team, functional managers, senior management, customers, and the project sponsor. Present the appropriate level of detail to each group. Management may be interested in summary-level information, whereas team members need much more detail. Be sure to cover all areas of planning, including:

- Statement of the project objectives
- Work breakdown structure
- Logic network diagrams
- Schedules for individual activities and the project as a whole
- Charts showing estimated costs and projected cash flow
- Resource histograms

SETTING UP A MONITORING AND MANAGEMENT PROCESS

Project management is the process of comparing actual performance to the plan, in order to determine the variances, evaluate possible alternatives, and take appropriate corrective action. The ability to manage a project is directly tied to the effectiveness of the project plan. You need a plan to tell where the project is supposed to be, and you need status information to tell where the project is. Even with the best of planning, problems will still occur, but they will be fewer and less serious. This section explains how to set up a monitoring and management process you can use throughout the life of the project.

Principles of Monitoring and Management

The following general principles are useful in project management activities:

- Establish a formal process to control changes in the project (see the section "Controlling Changes in the Project" in this chapter). Revise project plans as needed to keep them realistic and accurate, but only allow them to be revised by those who are authorized.
- Do not micromanage the project. Let functional managers and line supervisors develop for their own use a set of subactivities, cost plans, and detailed checklists to help them accomplish their activities.
- Assign problems to the lowest level of management that can make the decision and take action. Never present a problem without a recommended solution (or two). Otherwise, management may come up with an inappropriate solution or never give you a decision.
- Be sure that schedule progress, cost expenditures, and scope performance are calculated and reported using methods consistent with the way the plan was established.
- If you manage several projects at once, you may wish to rank them so you can

handle regular-schedule projects differently from fast-track-schedule projects.
    a. *Significant, highly visible projects* require more monitoring.
    b. *Average projects* require average monitoring.
    c. *Low-priority projects* require less monitoring.

Establishing a Plan to Monitor and Manage the Project

Before the project begins, the project manager should consult with the project team, the customer, and the project sponsor to determine the information needs, data collection methods, and frequency of data collection.

Determining Information Needs
The project manager determines what information is needed to manage the project. If the needed information is not collected, the project cannot be managed. Gathering information that is not needed is a waste of effort.

   To manage the project, the project manager compares the current status with the plan to determine variances. Since the project objectives were specified in terms of time, cost, and scope, it is helpful to collect status information in the same terms. Suggestions for specific information to collect about the time, cost, and scope can be found in the following sections.

Determining Data Collection Methods
The project manager determines how project status information will be collected.

ELECTRONIC DATA COLLECTION ☛ Electronic data collection can be quick and cost-effective. When team members have access to a computerized system, they can input status information directly into the computer, making it immediately accessible to the project manager and others. Electronic systems can share information, so information need be entered only once. For example, work hours entered by team members can update project cost reports and also be transmitted directly to the finance department for payroll.

   Although many people prefer electronic data collection, it is not recommended unless:

- The organization operates consistently under sound project management principles.
- The project team members have been trained in project management concepts and methods.
- The project team has the skills and discipline to report correct data consistently.

MANUAL DATA COLLECTION ☛ If the organization lacks the maturity described above, manual data collection methods may be preferred. These consist of traditional methods of paper time cards and status reports. Refer to Chapter 8 for examples of various reports and forms that can be used to gather information as well as to report it.

ON-SITE INSPECTIONS ☛ The project manager gathers additional information by conducting scheduled and unscheduled on-site inspections. In addition to

what the numbers say, the project manager needs to see firsthand how well the team works together and if there are conflicts or other factors influencing performance.

ONE-ON-ONE INTERVIEWS ☛ A face-to-face interview is an effective way to gather information. In this setting, team members can give their opinions, suggestions, and critiques of the work.

TEAM MEETINGS ☛ Although a meeting can be used to collect project information, it is usually not an efficient use of team members' time. However, it is important that the team meet together occasionally to confirm that the data collected match the perspectives of the team as a whole. This is especially appropriate when the team completes a milestone event or a major phase of the project. With team synergy, issues may surface that would not come to light in any other way. Team meetings are also helpful for brainstorming, coordinating work, building team spirit and camaraderie, group decision making, and achieving group consensus.

Determining Frequency of Data Collection

The project manager establishes an update cycle for various types of data. This cycle may be immediate (data entered when an event happens), daily, twice a week, weekly, twice monthly, monthly, and so on. Issues to consider when determining update frequency may include:

- The requirements and expectations of the project sponsor.
- The average duration of the project activities. (For example, if most activities are scheduled to last a day or two, a weekly update cycle would not be frequent enough.)
- Experience. (For example, in dealing with unknown personnel or subject matter, it may be appropriate to collect data more often for early problem identification.)

Exercise 7-1
Monitoring Process

Consider the project for Auto Parts, Inc., described in Exercise 6-7. The company purchased a new system to inventory the car parts it distributes and you were assigned to manage the implementation of the system, which includes two weeks of software installation, seven weeks of training, and twelve weeks of implementing changes in the methods of receiving parts and filling orders. To complete this project successfully, develop a written plan for monitoring the project. Identify the information needs, data collection methods, and frequency of data collection. (A suggested answer is in Appendix A.)

Status Information

Once project work begins, the project manager systematically collects status information according to the methods and frequency previously determined. When status information is collected, the project manager compares it with the schedule, budgets, and scope identified in the project plan to determine the variances. A variance exists when the actual status does not equal the planned status.

Variances

Not all variances have a negative impact on the project and not all variances deserve corrective action. The project manager analyzes any variance to determine:

- The impact of the variance on the project.
- Whether the impact is a problem.
- The cause of the variance, including reasons and the people involved.
- Whether the cause of the variance will create variances elsewhere in the project.

Reports

Prepare and publish reports that show:

- What the plan says should be happening.
- What is actually happening (status).
- Variance between the plan and the status.
    Chapter 8 shows various types of reports that can be used to publish project information.

Course of Action

The project manager develops and analyzes solutions to the problem. If the project manager has sufficient authority, she decides on a course of action. If not, she takes recommendations to the level of management that can make that decision.
    Taking action includes the following steps:

- Implement the decision.
- Follow up to be sure the action solves the problem.
- Take additional action if necessary to solve the problem.
- Document the decisions that make significant changes in approved project plans.
- Take preventive action to be sure similar problems do not happen. (For example, double-check other estimates or analyze procedures.)

Exercise 7-2
Case Study: Urgent Care Hospital

Urgent Care Hospital has recently received several large grants to modernize and upgrade the care it provides to the community. The hospital has determined to spend some of the money to upgrade the radiology department and has hired you to manage a project to install a new CAT (computerized axial tomography) scanner to provide better care to critical patients.

The new CAT scanner will require a major renovation of the radiology department, which is estimated to take eight weeks. Although the head of the department is eager to have the new machinery, she is not happy about the disruption the construction will cause. The scanner is expected to arrive March 1 and will take three weeks to install. The construction renovation cannot begin until after the installation is complete. The four operators who will use the new equipment also need two weeks of training.

The estimated costs are as follows:

Purchase: $1,000,000
Installation: $45,000
Operator training: $16,000
Renovation: $96,000

Since the hospital expects to generate income of $50,000 a month from the new scanner, its managers are anxious to begin using it as soon as possible, with the least possible disruption to hospital functions. The head of the radiology department is asking you to reduce the total project time as much as possible. She feels that thirteen weeks is too long, and a disruption.

To accommodate the request, you now need to complete the following tasks:

- Determine what can be done to crash the schedule.
- Prepare a network diagram and assign calendar dates to each activity.
- Determine what resources are needed for each activity.
- Prepare a cash flow report showing the projected expenditures for each week of the project.

(Suggested answers are in Appendix A.)

MANAGING PROJECT OBJECTIVES

Logic network diagrams, schedules, and budget plans are not just planning tools that are archived once planning is completed. They are used regularly to manage the project throughout its life. This section explains how to use project plans, together with status information you collect as the project progresses, to manage time, cost, scope, and resources.

Time Management

Time management is the process of comparing actual schedule performance to the baseline schedule to determine variances, evaluate possible alternatives, and take the appropriate action. To effectively manage time, be sure the schedule plans are in sufficient detail to adequately manage the activities.

Actions

Consider the following actions to manage time:

- *Systematically collect schedule performance data,* including the following:
    - Actual start time of each activity
    - Estimated remaining duration of activities in process
    - Actual finish time of each activity
    - Changes in time estimates
    - New activities that have been identified
    - Previously planned activities that are no longer needed
- *Compare this status information with the baseline schedule.*
- *Analyze variances to determine their impact.* Variances can be positive or negative. The activity may have taken three days too long, or it may have been completed three days early. Not all variances have a negative impact on the project, and some variances are so small they do not deserve corrective action. Try to determine the cause of the variance so you can take corrective action, where needed, to prevent it from happening again.
- *Prepare and publish reports.* See Chapter 8 for ideas on reporting, including examples of time management reports.
- *Determine a course of action.* If you determine the variance warrants action, determine what that action will be.
- *Take corrective action.* Act on schedule deviations quickly, especially in the early stages of the project when the tone of the entire project is set. There are a variety of actions you may take to get the activity back on schedule, such as adding more or higher-skilled personnel, adding additional equipment or other resources, or changing the sequence of activities to allow activities to be done in parallel or to overlap. If you cannot get an activity back on schedule, you may be able to negotiate with those responsible for succeeding activities to see if they can complete their activities in a shorter time so the entire project can still be completed on schedule.

Avoiding Common Scheduling Problems

You can avoid common time problems by following good estimating and scheduling practices, as described in Chapters 4 to 6. Careful monitoring and quick corrective action will also help keep schedule problems to a minimum. If you find yourself in trouble, you may be able to recover by focusing on critical activities. Many projects have certain activities that consume a great percentage of the total time of the project. With the aid of detailed schedule plans, you may be able to make adjustments in these key activities to make up lost time. Delays often happen near the conclusion of a project as workers scramble to complete extra tasks identified during the course of the project. Hence the following humorous adage: "The first 90 percent of the project takes the first 90 percent of the time; the other 10 percent of the project takes the other 90 percent of the time."

Cost Management

Cost management is the process of comparing actual expenditures to the baseline cost plans to determine variances, evaluate possible alternatives, and take

appropriate action. To effectively manage costs, be sure cost plans are prepared with sufficient detail.

Actions
Consider the following actions to manage costs:

- *Systematically collect cost performance data,* including the following:
  - Labor hours expended
  - Estimated remaining labor hours needed to complete activities
  - Percentage complete of activities in process
  - Nonlabor expenditures to date
  - Estimated remaining nonlabor expenditures needed to complete activities
  - Funds committed but not paid, and dates when these obligations must be paid
  - New activities that have been identified
  - Previously planned activities that are no longer needed
- *Compare expenditures* to the baseline cost plans.
- *Analyze variances to determine their impact.* Cost variances can be positive or negative. The activity may have cost more or less than budgeted. Not all variances have a negative impact on the project, and some variances are so small they do not deserve corrective action. Try to determine the cause of the variance so you can take corrective action, where needed, to prevent it from happening again.
- *Prepare and publish reports.* See Chapter 8 for ideas on reporting, including example cost management reports.
- *Determine course of action.* If you determine the variance warrants action, determine what that action will be.
- *Take corrective action.* Act on cost overruns in a timely manner, especially in the early stages of the project when the tone of the entire project is set. Carefully analyze the deviations from the cost plan to determine where the overruns are coming from. You may be able to find less expensive alternatives to the personnel, equipment, and materials being used. You may even be able to reduce personnel or other resources on activities that are ahead of schedule. If you cannot complete an activity within budget, you may be able to negotiate with those responsible for succeeding activities to see if they can complete their activities under budget so the entire project can still be completed within budget. Be aware that expenditures may escalate near the end of a project to cover labor and purchases that had not been anticipated.

Common Causes of Cost Problems
Since costs can be a major source of frustration in a project, it is helpful to have a good understanding of where costs can get out of control. Consider the following list of common causes:

- Poor budgeting practices, such as (1) basing the estimates on vague infor-

mation from similar projects rather than the detailed specifications of the project at hand, (2) failure to plan a sufficient contingency budget, (3) failure to correctly estimate research and development activities, or (4) failure to consider the effects of inflation on the cost of materials or labor.

- Receiving or analyzing status information too late to take corrective action.
- A climate that does not support open and honest disclosure of information.
- Indiscriminate use of the contingency budget by activities that too frequently overrun their budgeted cost.
- Failure to rebudget when (1) flaws are discovered, (2) technical performance falls below performance standards, or (3) changes in project scope are approved. During the course of the project, many small decisions are made that ultimately impact costs. For example, when engineering decides on the final design of a product feature, conventional accounting reports may not show the impact of these design decisions on production costs. In that case, the project manager must make sure that the cost impact is known before such decisions are made.

Avoiding Common Cost Problems
You can avoid such cost problems by following good estimating and budgeting practices, as described in Chapters 5 and 6. Careful monitoring and quick corrective action will also help keep cost problems to a minimum. If you find yourself in budget trouble, you may be able to recover by focusing on critical activities. Many projects have certain activities that consume a great percentage of the total cost of the project. With the aid of a detailed cost breakdown and current information on costs committed, you may be able to adjust these key activities to contain costs.

Scope and Quality Management

The scope document includes not only a description of the features and functions of the product or service but also quality measures, such as technical specifications, performance requirements, grade or excellence of materials, functionality of product features, safety regulations, security issues, and environmental considerations. These quality measures must be defined in the project scope statement in quantifiable terms that can be measured and reported. These terms can then be used throughout the life of the project to manage project work and the quality of the product or service created by the project. Many people think quality is synonymous with grade, excellence, or price, whereas quality is actually conformance to specifications.

Scope and quality management is the process of comparing actual performance to the scope statement, in order to determine variances, evaluate possible alternatives, and take the appropriate action. It includes all the processes and activities needed to ensure that the project produces the quality specified in the scope statement. First, you plan for appropriate quality levels, then you perform quality assurance by auditing project activities and results, and, finally, you manage quality by monitoring and taking corrective action when needed.

Project quality management encompasses the following areas:

- *Customer satisfaction.* An important role of a project manager is to ensure that the project produces what it was expected to produce. Along the way, it is important to understand and manage the expectations of all project stakeholders.
- *Prevention rather than inspection.* Modern quality management focuses on planning, designing, and building quality into the products of the project, rather than trying to inspect them in. The cost of preventing mistakes is usually less than the cost of correcting them after they are found in an inspection.
- *Continuous quality improvement.* Modern quality improvement techniques focus on improving the quality of project management and of the production processes, as well as the quality of individual project results.
- *Management responsibility.* A successful project requires the participation of management to provide the resources and approvals needed by a project.

As you manage scope and quality, consider that they may be more difficult to measure and control than time or cost. In addition, when workers are up against tight time and cost restrictions, the quality of the final product often suffers. Modern approaches to project quality management can help you balance quality with time and cost. When your measurements focus primarily on time and cost, you send the message that quality is less important. You should hold workers as accountable for quality as they are for meeting the schedule and budget.

Actions
Consider the following actions to manage scope and quality:

- *Systematically collect performance data.* Are the specifications being met as identified in the scope statement? Are the quality standards being met as identified in the scope statement?
- *Compare performance to the scope statement.*
- *Analyze variances to determine their impact.* Variances can be positive or negative. The finished product may not meet the specifications or it may exceed them. Not all variances have a negative impact on the project, and some variances are so small they do not deserve corrective action. Try to determine the cause of the variance so you can take corrective action, where needed, to prevent it from happening again.
- *Prepare and publish reports* that detail where the project is meeting, not meeting, or exceeding project specifications. See Chapter 8 for examples of reports.
- *Determine a course of action.* If you determine the variance warrants action, determine what that action is.
- *Take corrective action.* Act on scope deviations quickly, especially in the early stages of the project, when the tone of the entire project is set. Corrective action may consist of penalties for nonconformance or rewards for conformance to project specifications. Poor performance may also be a result of poor communication of project specifications. Clearly communicating expectations can be one of the most significant ways to improve project quality.

Avoiding Common Quality Problems

You can avoid common quality problems by identifying quality standards as part of the initial project plan. Careful monitoring and quick corrective action help keep quality problems to a minimum. Although quality is the responsibility of everyone on the project team, there should be a quality management function within the project team to ensure that all aspects of the project satisfy the quality standards. Poor project quality leads to customer and management dissatisfaction, high maintenance costs, and increased outsourcing of critical functions.

Resource Management

The project manager must develop and manage all resources used in a project. Human resources are more difficult to manage than nonhuman resources.

Resource management is the process of comparing actual performance to the resource plans to determine variances, evaluate possible alternatives, and taking the appropriate action.

Actions

Consider the following actions for resource management:

- Be sure that all team members understand the basic objectives of the project and know how their tasks contribute to the project as a whole.
- Have team members prepare individual plans for accomplishing their work.
- Ensure that team members have the appropriate skills and resources to do the job.
- Empower team members to accomplish their tasks by giving appropriate authority and information. Also provide supervision and performance feedback.

Avoiding Common Resource Problems

Careful monitoring and quick corrective action help keep resource problems to a minimum. If team members manage appropriately, then weekly reports simply serve as checks and balances. A project is in control at the macro level only when all team members are in control of their own work at the micro level. Rather than micromanaging team members, the project manager sets up an environment wherein team members can manage their own work.

Control Thresholds

Consider again the example of an aircraft flight plan presented in Chapter 4. The pilot's flight plan (see Exhibit 7-1) allows a range rather than a fixed course. As long as the pilot stays within the mile-wide band, the plane is within the accepted tolerance limits, and the pilot is considered "in control."

By comparison, a project manager determines the ranges in schedule, budget, and scope that are acceptable variances from the plan. Should the project manager report and take action on a schedule variance of one day? Or two days? Should action be taken if the team spends $100 over the planned cash flow for the week? Or $1,000 over? Or $10,000?

E xhibit 7-1
Range Limits for an Aircraft Flight Plan
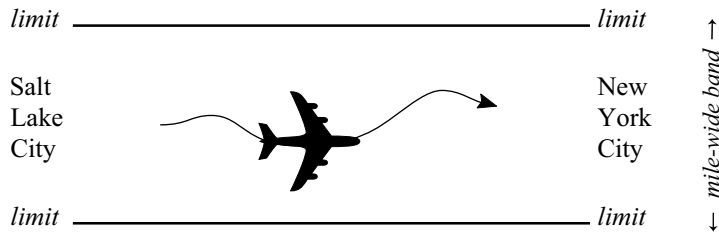
Some projects can be more tightly managed than others. Work that can be measured accurately can be managed with tighter tolerances. Work that is less precise (such as research or knowledge work) must be allowed greater tolerances.

Exercise 7-3
Control Thresholds

You are assigned to manage a six-month company training program. If the training schedule falls behind schedule by a week, should you take corrective action? Why or why not? (A suggested answer is in Appendix A.)

Tools for Managing Project Objectives

A variety of tools and techniques may be used to determine whether work is being accomplished according to the quality level and specifications defined in the project planning stage. Some of the more typical methods are discussed in the following sections.

Inspection
Inspections include measuring, examining, and testing, and are used to determine whether the results conform to predefined specifications. Inspections should be performed on individual activities and also on the final product of the project. A variety of inspection forms and checklists may be developed to allow information to be collected quickly and in a standardized format.

Statistical Sampling

Because it is not always possible or practical to inspect every activity or every item produced, principles of statistical sampling may be applied to ensure that inspection results are reliable. For example, you can choose to inspect ten activities at random out of the total one hundred activities. Principles of statistical sampling and probability must be used to determine the number of items out of the total that must be inspected in order to apply those results to the total with reasonable accuracy. A great body of literature is available on appropriate sampling techniques.

Flowcharting

Flowcharts can provide useful information about process flow and may be helpful to analyze how problems occur. It may be sufficient to have a general top-down flowchart that shows the major steps in the process (see Exhibit 7-2). If more specific information is needed, a detailed flowchart may be created to show each process step, including decision points and feedback loops.

Control Charts

Control charts are graphs that display periodic results along with established control limits. They are used to determine if a process is in control or in need of adjustment. Control charting helps to distinguish between normal variations that are to be expected and unusual variations produced by special causes that need to be identified and corrected. The sample control chart in Exhibit 7-3 shows the average daily rejections in a production facility for two weeks.

Control limits identify the natural variations that occur in the process. In the example, if the production facility had established an upper control limit of 8 and a lower control limit of 3.5, all the points in this two-week period

Exhibit 7-2
Flowchart of Publications Process

Planning and Project Request

Executive Committee Approval

Budget Approval

Project Planning

Writing Editing Design

Translation

Printing

Shipping

Delivery to Customer
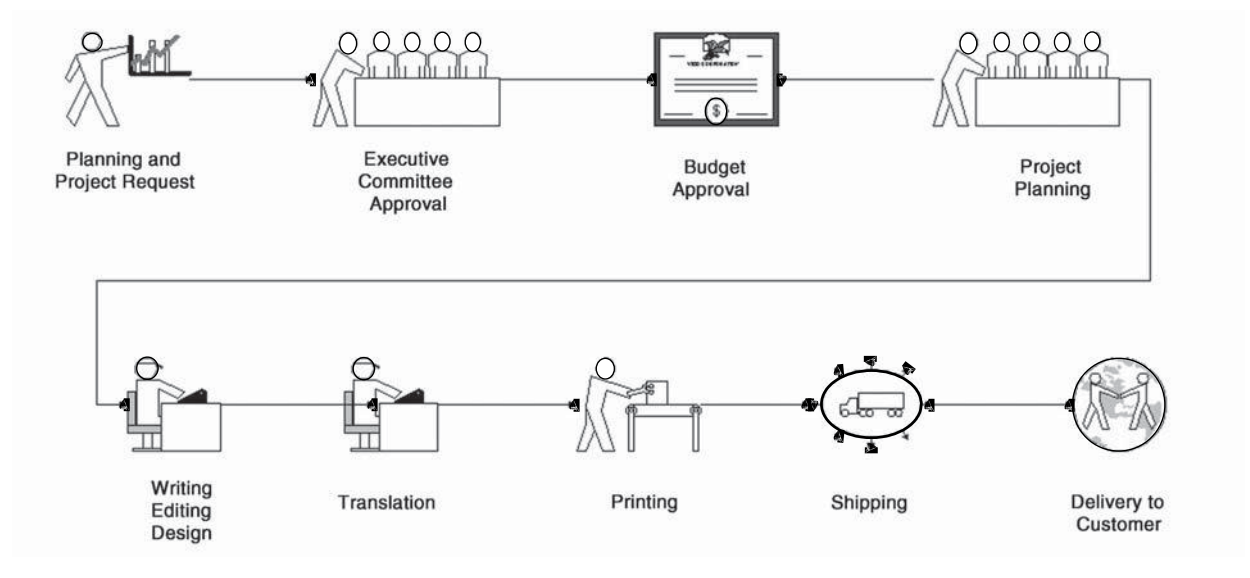
Exhibit 7-3
Sample Control Chart

Control Chart
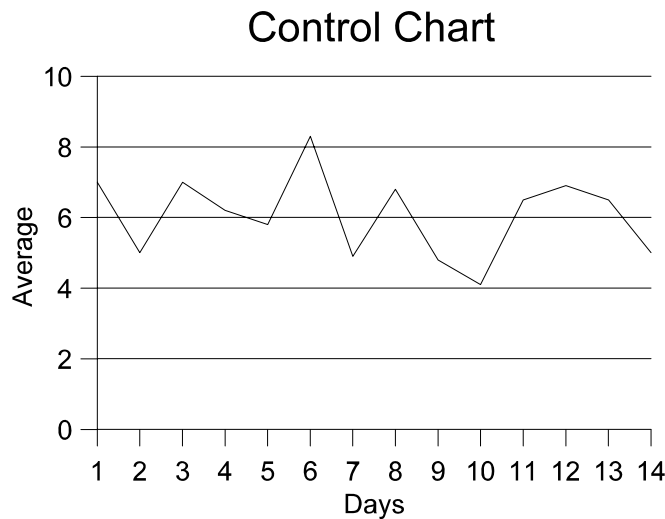
would be within the normal and expected variation except the rejection rate of 8.3 on Day Six. Points outside the control limits generally signal that something has occurred that requires attention, such as a problem with equipment, materials, or an employee. In addition, the *rule of seven* indicates that when seven or more points in a row occur on the same side of the mean, or when they tend in the same direction—even though they may be within the control limits—they should be investigated. It is extremely unlikely that seven points in a row would be on the same side of the mean if the process is in control.

Trend Analysis
Trend analysis uses mathematical techniques to forecast future outcomes based on historical results. Line graphs, pie charts, bar charts, and histograms may be used to identify trends and to focus on managing the influencing factors (see Exhibit 7-4).

Pareto Diagrams
The Pareto Principle of Problems states that a few vital elements (20 percent) account for the majority (80 percent) of the problems. For example, in a manufacturing facility, 20 percent of the equipment problems may account for 80 percent of manufacturing downtime. Therefore, it would be advantageous to identify and focus on correcting that 20 percent of the equipment problems. A Pareto diagram (see Exhibit 7-5) may be used to focus attention on the most critical issues. It is a bar chart with elements arranged in descending order of importance, generally by magnitude of frequency, cost, or time.

Cause-and-Effect Diagrams
A cause-and-effect diagram is a graphical representation of the relationships that exist between factors (see Exhibit 7-6). It can be used to explore a wide

E xhibit 7-4
Sample Graphs for a Printing Facility

Histogram

Frequency

12
10
8
6
4
2
0

2   4   6   8   10   **12**   14

Rejects per Job

Pie Chart

Type of Defects

Wrinkled pages 43%

Bent corners 12%

Color out of register 45%

Line Graph

Rejects per 1,000

Frequency

14
12
10
8
6
4
2
0

Jan Feb Mar Apr May Jun Jul Aug Sep Oct Nov Dec
Month
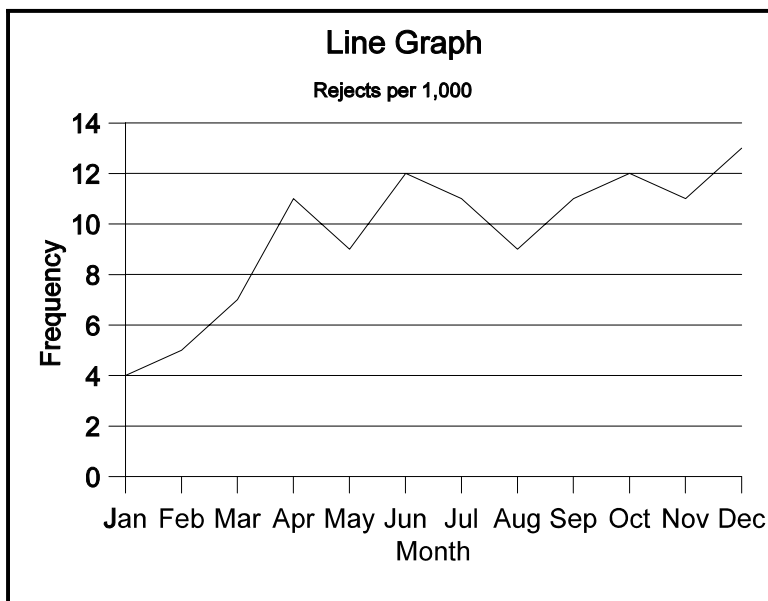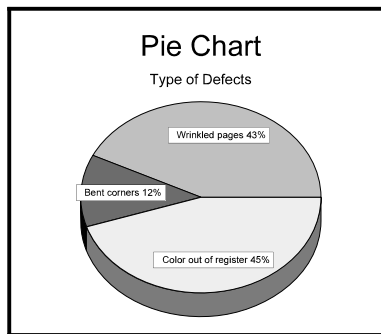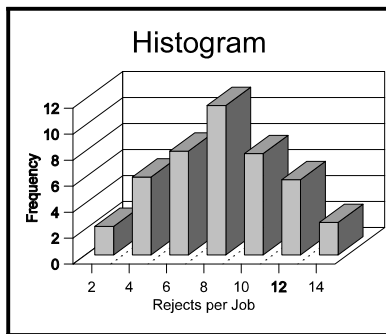
variety of factors and how they relate to factors that may cause them. Also called a *fish bone diagram*, it is a useful tool in brainstorming, planning activities, and examining processes.

Earned Value Analysis

Earned value analysis (also known as variance analysis) is a way to measure and evaluate project performance. It compares the amount of work planned with what is actually accomplished to determine whether the project is on track.

Earned value analysis, which was developed in the 1960s to allow government agencies to determine when a contractor should receive progress payments for work, is a helpful tool for monitoring and managing projects. It uses various calculations and ratios to measure and report on the status and effectiveness of project work.

E xhibit 7-5
Pareto Diagram

Frequency by Cause
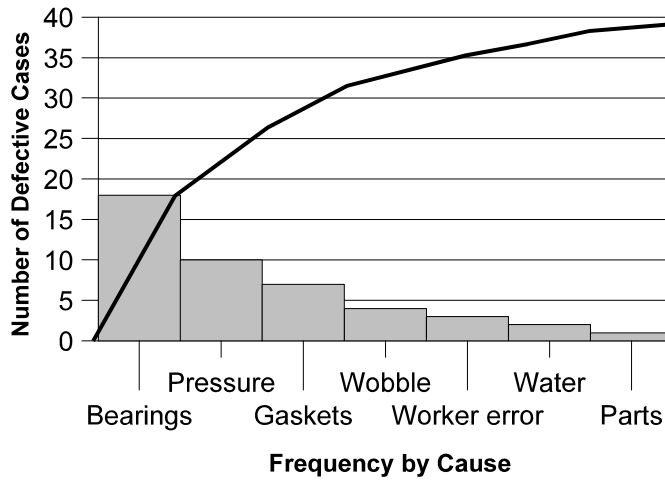
E xhibit 7-6
Cause-and-Effect Diagram
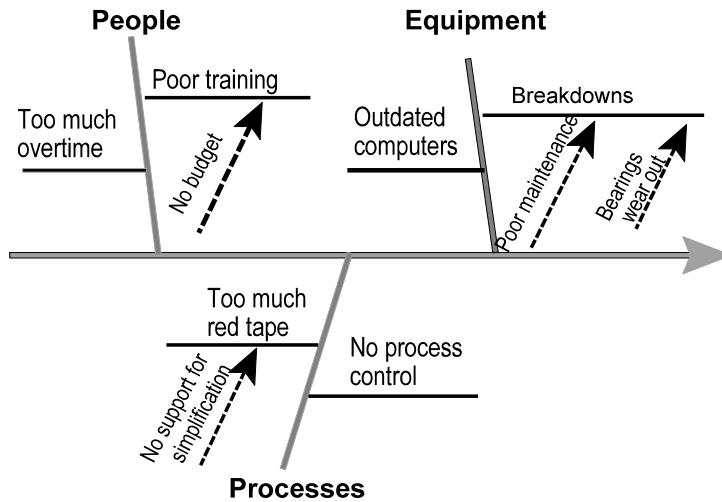
Although earned value calculations are usually done by computer, it is important to know the basis of each calculation and understand what they mean.

Exercise 7-4
Tools for Managing Project Objectives

Review the previous sections, and in the following spaces, list a project activity where you might use each one of them.

Inspection

Statistical sampling

Flowcharting

Control charts

Trend analysis

Pareto diagrams

Cause-and-effect diagrams

The first step in earned value analysis is to determine the following three key values:

1. *Planned value (PV)* is the planned cost of work scheduled to be done in a given time period. The amount of PV is determined by totaling the cost estimates for the activities scheduled to be completed in the time period. Planned value is also called the *budgeted cost of work scheduled (BCWS)*.
2. *Earned value (EV)* is the planned cost of work actually performed in a given time period. This is a measure of the dollar value of the work actually performed. The amount of EV is determined by totaling the cost estimates for the activities that were actually completed in the time period. Earned value is also called the *budgeted cost of work performed (BCWP)*.
3. *Actual cost (AC)* is the cost incurred to complete the work that was actually performed in a given time period. The amount of AC is determined by totaling the expenditures for the work performed in a given time period. It should include only the types of costs included in the budget. For example, if indirect costs were not included in the budget, they should not be included in AC calculations. Actual cost is also called the *actual cost of work performed (ACWP)*.

Once these values are determined, you can use them in various combinations to provide measures of whether work is being accomplished as planned. For example:

Schedule variance (SV). Schedule variance is determined by subtracting the planned value from the earned value. This calculation measures the difference between the planned and the actual work completed. A positive result means the project is ahead of schedule; a negative result means the project is behind schedule.

$$SV = EV - PV$$

Cost variance (CV). Cost variance is determined by subtracting the actual cost from the earned value. It measures the difference between the planned (budgeted) cost and the actual cost of work completed. A positive result means the project is under budget; a negative result means the project is over budget.

$$CV = EV - AC$$

Once these calculations are made, various indices or ratios can be used to evaluate the status and effectiveness of project work. These efficiency indicators provide valuable information that can be used to manage the project. The two most commonly used indices are the schedule performance index and the cost performance index.

1. *Schedule performance index (SPI)*. This is a ratio of work performed to work scheduled. The index is calculated by dividing the earned value by the

planned value. This ratio is a measure of efficiency in the schedule. A value less than 1 means the project has accomplished less than what was planned and is behind schedule; a value greater than 1 means the project is ahead of schedule. Analyzing the SPI several times during the project provides an indication of how the project is performing compared to the project plan. This index may also be used to forecast the project completion date.

$$SPI = EV / PV$$

2. *Cost performance index (CPI).* This is a ratio of budgeted costs to actual costs. This index is calculated by dividing the earned value by the actual cost. This ratio is a measure of cost efficiency (how efficiently dollars are being spent). A value less than 1 means the work is costing more than planned; a value greater than 1 means the work is being produced for less than planned. For example, a CPI of 0.67 means that for each $1.00 spent on the project, the result is $0.67 worth of value. Analyzing the CPI several times during the project provides an indication of the project's direction concerning costs.

$$CPI = EV / AC$$

These indices provide a quick snapshot of the project's efficiencies at a given point in time. However, they are more valuable when used periodically during the life of the project to track trends and take corrective action. They also provide an element used in the following calculations to forecast the completion of the project:

Budget at completion (BAC) is the estimated total cost of the project when completed. It is calculated by totaling the cost of all activities outlined on the work breakdown structure.

Estimate to complete (ETC). This is the expected additional cost needed to complete the project. It is calculated by subtracting the earned value (EV) from the budget at completion (BAC), then dividing the result by the cost performance index (CPI). This estimate shows the expected additional cost needed to finish the project, including adjustments to the BAC based on project performance to date.

$$ETC = (BAC - EV) / CPI$$

Estimate at completion (EAC). This is the expected total cost of the project when completed. It is calculated by adding the actual cost (AC) and the estimate to complete (ETC). This estimate includes adjustments to the BAC based on performance to date.

$$EAC = AC + ETC$$

Exercise 7-5
Earned Value Analysis

The Dunbar Project was scheduled to cost $1,500 and was originally scheduled to be completed today. As of today, however, the project has spent $1,350, and it is estimated that only two-thirds of the work has been completed.

Calculate the schedule and cost variances and the schedule and cost indices. (The answers are in Appendix A.)

MANAGING CHANGES IN THE PROJECT

During the course of a project, circumstances may come to light that necessitate minor or major adjustments to the plan. Not all changes are bad, yet not all changes can be made once a project is underway and project time, cost, and scope have been established.

Frequent scope changes may be an indication of inadequate up-front planning. They most often occur because of errors or omissions in the planning stage. Frequent changes may also be an indication of weak management in the organization, or a sign that the organization is trying to accomplish more work than available resources can handle. Changes may also be brought on by external events, such as changes in government regulations, new technologies, or new products or competitors.

It is important to establish a formal change control process to handle proposed changes to the plan. The system should include processes for submitting, evaluating, approving, and communicating changes in the project plan. However, avoid making the system more complex than it needs to be. A lack of control can mean chaos, whereas an excessive amount of red tape can be overly burdensome to the project. Large projects with high visibility or a great degree of risk deserve a more rigorous change control process.

Change control is necessary to manage the potential effects on the project budget, schedule, and scope. Remember that the project triangle must be kept in balance. Changes in the time, cost, or scope of the project must be accompanied by appropriate changes in at least one other side of the triangle. After the project is under way, the project sponsor may decide he wants new features added to the product, but he may still expect it to come in on the original schedule and budget. Change control can protect the project from "scope creep" (the tendency for scope to increase during the course of the project without proportionate increases in time or cost).

Actions

Consider the following actions to manage project changes:

- Establish processes for submitting, evaluating, approving, and communicating changes in the project plan, including changes in time, cost, or scope. Define tolerance guidelines within the approved project objectives so team members know which minor changes they can accept and which changes must go through the formal change control process.
- Review change requests with the project team. Consider the impact of the change on all aspects of the project. Determine what added value the change represents for the project sponsor, customer, or project team. Identify the causes of the change and determine if these causes necessitate changes in other areas of the project or in future projects.
- Study alternative courses of action and determine their effect on the project.
- Submit change requests to the project sponsor or customer and receive the appropriate approval or rejection.
- Communicate approved changes to all concerned.
- Document and track all changes, reporting on their effect on the project.

Change Request and Approval Form

The form in Exhibit 7-7 illustrates the kind of information needed to control change requests. Develop an appropriate form to use with your project.

_E_ xhibit 7-7
Project Change Request and Approval Form

Project Change Request and Approval Form	
Project title: Software Demo	**Date:** 8/30/2010
Activity # 15	**Revision #** 1
Activity description: Set up demonstration equipment	
Submitted by:	Date:
Description of request for change: Since this activity was originally estimated, new equipment has become available that can greatly increase the effectiveness of the software demo. Senior management requests that we use the new equipment. The demo staff also prefers the new equipment.	
Reason for change: The new equipment was not considered in the original project plan because it was not available at that time. This new equipment should be considered for all future demo projects.	

Exhibit 7-7 continued from previous page.

Impact of change on this activity and other activities			
Activity	**Impact on schedule**	**Impact on cost**	**Impact on scope**
#15 s/w demo	no impact	new equipment costs $500 more than old equipment	better quality demo; not more difficult to operate
#13 site preparation	2 additional hours to install cables; can complete the same day	increase of $100	change in specifications to allow additional cables
Approvals			
Project Manager:			Date:
Activity Owner:			Date:
Functional Manager:			Date:
Senior Manager:			Date:

E xhibit 7-8
Change Control Log

Change Control Log				
#	**Date of change request**	**Description of change and business reason**	**Impact on schedule, resources, and risk**	**Decision (date, by whom)**
1	9/20/10	New equipment for software demo. New equipment became available after the demo project was planned.	Cost increased $600; better quality demo; no schedule impact	Approved 9/22/10 by Bob Tagg
2				
3				

Change Control Log

A change control log (see Exhibit 7-8) also may be used by the project manager to document and track changes. Such a form helps:

- Keep track of changes.
- Determine why changes are made.
- Justify changes to management.
- Capture lessons learned for future projects.

recap

For larger projects, you may want to hold a formal kickoff meeting with the project sponsor, customers, project team members, and other stakeholders to explain the roles and responsibilities of everyone present and communicate the project plans clearly and concisely. Be sure to communicate the appropriate level of project information to each group. Management may be interested in summary-level information, whereas team members need much more detail.

Project management is the process of comparing actual performance to the plan to determine the variances, evaluate possible alternatives, and take appropriate corrective action. The ability to manage a project is directly tied to the effectiveness of the project plan. You need a plan to indicate where you are supposed to be, and you need status information to track where you are. The steps in establishing a plan to monitor and manage a project are as follows:

- Determine information needs (what must be known to manage the project).
- Determine the methods to collect data (such as electronic, manual, on-site inspections, one-on-one interviews, or team meetings).
- Determine how frequently data must be collected (based on the length and requirements of the activity and your level of confidence in it).

Once project work begins, the project manager systematically collects status information and compares it with the schedule, budgets, and scope identified in the project plan to determine variances. Not all variances have a negative impact on the project, and not all variances deserve corrective action. The project manager develops and analyzes solutions to the problem, then takes the appropriate corrective course of action.

Time management is the process of comparing actual schedule performance to the baseline schedule, in order to determine variances, evaluate possible alternatives, and take the appropriate action. Cost management is the process of comparing actual expenditures to the baseline cost plans, in order to determine variances, evaluate possible alternatives, and take appropriate action. Scope and quality management is the process of comparing actual performance to the scope statement, in order to determine variances, evaluate possible alternatives, and take the appropriate action. Resource management is the process of comparing actual performance to the resource plans, in order to determine variances, evaluate possible alternatives, and take the appropriate action.

Some projects can be more tightly managed than others. Work that can be measured accurately can be managed with tighter tolerances. Work that is less precise (such as research or knowledge work) must be allowed greater tolerances.

Helpful tools to use in managing project objectives include inspections, statistical sampling, flowcharting, control charts, trend analysis, Pareto diagrams, cause-and-effect diagrams, and earned value analysis. Earned value analysis involves various calculations that measure and evaluate project performance by comparing the amount of work planned with what is actually accomplished.

Establish a formal change control process to handle proposed changes to the plan while the project is in process. The system should include processes for submitting, evaluating, approving, and communicating changes in the project plan. Change control is necessary to manage the potential effects on the project budget, schedule, and scope.

Review Questions

1. Which of the following is *not* true about tools used in managing project objectives?   1. (c)
  (a) Inspecting ten activities at random out of the total one hundred activities is an example of statistical sampling.
  (b) The *rule of seven* indicates trends that should be investigated.
  (c) Control charts are also known as fish bone diagrams.
  (d) The Pareto Principle of Problems states that 20 percent of the elements account for 80 percent of the problems.

2. Which of the following is true about managing quality?   2. (a)
  (a) When workers are up against tight time and cost restrictions, they tend to cut corners on quality.
  (b) Quality standards must be determined while work is being done to ensure good quality.
  (c) Project managers should have the technical expertise to recognize good or poor quality.
  (d) The more technical or complex the work, the more control the project manager has over quality.

3. Which of the following is true about data collection?   3. (a)
  (a) Team meetings can be used to collect project information, but are often not an efficient use of team members' time.
  (b) Face-to-face interviews are not effective ways to gather information.
  (c) Scheduled and unscheduled on-site inspections are not good ways to gather additional information.
  (d) It is best to use paper data collection methods when the project team has the skills and discipline to report correct data consistently.

4. Which of the following is true about change control?   4. (b)
  (a) A change in one of the project objectives (time, cost, or scope) means you must make some change in both of the others.
  (b) Frequent scope changes may be an indication of inadequate up-front planning.
  (c) "Scope creep" means increasing the project scope with proportionate increases in time and cost.
  (d) All projects deserve a rigorous change control process.

5. Which of the following is true about managing project objectives?   5. (b)
  (a) Expenditures may escalate at the beginning of a project to cover labor and purchases that had not been planned.
  (b) Careful monitoring and quick corrective action will help keep cost problems to a minimum.
  (c) To effectively manage scope, quality standards must be defined after project work begins.
  (d) Corrective action should be taken on all variances.

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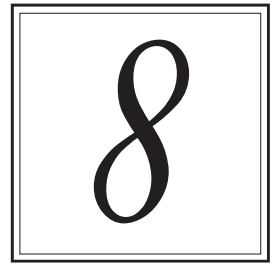
Evaluating and Reporting on Project Performance
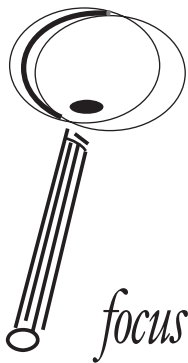
Learning Objectives

By the end of this chapter, you should be able to:

- Explain the various types of project evaluations that may be conducted.
- Analyze and describe issues to consider as you prepare project reports.
- Explain the basic steps in effectively closing a project.

CONDUCTING PROJECT EVALUATIONS

To ensure project success, you need periodic project evaluations to verify that work is being accomplished as planned. Even though you constantly collect data about costs, schedules, and work accomplished, you should plan specific reviews as a chance to step back and take a good look at the project to be sure everything is progressing as it should.

A project is like a journey, and project plans (such as work breakdown structures, schedules, and cost reports) serve as road maps to help team members measure their precise location. Project reviews are checkpoints along the way to ensure the project is on course. If the project has deviated from course, the review can identify the variance and help you make the proper adjustments.

Project reviews also help motivate team members, customers, and project sponsors. The evaluations provide feedback that helps everyone stay focused on the project objectives. People work best when they know how they are progressing toward the goal. Feedback helps people stay committed and motivated. People thrive on constructive feedback.

When to Perform Project Evaluations

Project work should be evaluated in four general ways: ongoing reviews, periodic inspections, milestone evaluations, and final project audit.

Ongoing Reviews

Work on the project should be reviewed constantly by project team members as part of an ongoing quality assurance program. Even though others may inspect for quality at specified checkpoints, the responsibility for quality rests with individual workers. They must feel a commitment to produce quality work, even if no one were to inspect it! Quality must be incorporated into the project from the beginning. It cannot be "inspected in" later.

Ongoing reviews should ensure that the standards included in the project scope statement are being applied to the work. Such standards may include safety regulations, security issues, licensing requirements, environmental considerations, and legal requirements. Ongoing reviews should also verify that finances are being handled according to guidelines and that other project data, such as schedule data, are being reported correctly.

Periodic Inspections

Team leaders, functional supervisors, or quality inspectors should review project work periodically (both scheduled and unscheduled) to ensure that project objectives are being met. These may be daily, weekly, or monthly inspections according to the needs of the project. Since it is generally not feasible to inspect every bit of work produced, it should be determined at the beginning of the project what will be inspected at what frequency.

Milestone Evaluations

Additional project evaluations should take place when milestone events are reached (for example, at the conclusion of each major phase of the project). Such an evaluation is used to certify that all work scheduled for that phase of the project has been completed according to specifications.

Final Project Audit

A final audit should be made at the conclusion of the project to verify that everything was completed as agreed upon by the project sponsor, customer, and project team. This audit provides information that may be used in project closure and acceptance. This is also a time to gather and document lessons learned during the project. What was done well? What could be improved? What could be learned from this project to help future projects?

Considerations in Project Evaluations

Each of the four types of project evaluation should consider quality of work, team performance, and project status.

Quality of Work

Each evaluation should review the work performed to ensure it meets specifications. The project scope statement specifies the project scope and quality

goals. The audit should determine whether proper quality has been maintained, or whether quality has been compromised to meet schedule and cost objectives. For example, in a home construction project, quality evaluations should determine if the proper materials have been used, or if lower-grade lumber was substituted to make up for cost overruns. Also, an audit would ensure that the construction complies with all building codes and industry standards, and that workers did not produce inferior work in an attempt to meet the schedule.

Team Performance

Sports teams review game films periodically to evaluate their performance and see where they need to improve. Without this kind of review, they may become very good at playing badly. Project teams also need to evaluate whether they are performing as well as they can. Such reviews may focus on efficiency and effectiveness of the work performed. They may analyze the work processes to determine if there is a more efficient workflow. These reviews may be conducted by the project team members themselves, the project manager, independent auditors, or other specialists.

COMPARISON WITH PAST PERFORMANCE ☞ If consistent data are gathered over time, periodic reviews provide a history to which current performance may be compared. This comparison over time shows whether team performance is improving or declining.

COMPARISON WITH BENCHMARKS ☞ Team performance may also be compared with that of other companies or industry standards. Benchmarking is the process of defining a standard or point of reference to measure quality or performance. A survey of comparable companies showing their performance or quality levels could be used as a reference point in evaluating your project. If the industry standard to construct a comparable building is $75 per square foot, you could measure your results against that to see if you are doing as well as the industry average.

Project Status

The project status review compares the planned with actual results and notes the variances. It reports any deviations in the schedule, cost, scope, or performance, and whether such deviations appear to be likely in the future.

Special attention should be given to activities on the critical path, because any delay in these activities will cause the project to be late (unless, of course, subsequent activities are completed in less than the scheduled time). Also give special attention to activities with high risk. Early identification and mitigation of problems can minimize their impact on your project.

Exercise 8-1
Project Evaluations

Blankets, Inc. is upgrading its order processing system. You are assigned to manage the project, which includes six months of software development and two weeks of training.

Describe below the evaluations you plan to perform for the project. For each, consider the quality of work, team performance, and project status. (A suggested answer is given in Appendix A.)

REPORTING ON PROJECT OBJECTIVES

Project managers spend much time collecting and analyzing data, but often they exert too little effort to determine what information needs to be communicated and to whom. Reports should be designed to convey concise information to the target audiences. Because projects are approved on the basis of three objectives—time, cost, and scope—it makes sense to focus reports on these three aspects. This section discusses issues to consider as you prepare and publish reports, and then provides samples of various kinds of reports.

Reporting Considerations

As you prepare reports, use the following guidelines:

- Maintain concise, top-quality project plans and status reports. Be sure everything you publish is accurate.
- Keep all stakeholders, including team members, customers, project sponsors, functional managers, and senior management appropriately informed. For each audience, determine what information they need to perform their functions and design reports accordingly. Provide just the data they need to make decisions and take corrective action.
- Use exception reporting by including only major variations from the plan. Since you do not have time to digest pages and pages of project information, use software programs to analyze the information and report on variances from the project plans. You can then focus your attention on these problem areas. Give stakeholders summary information about activities successfully completed and describe your plans to correct any deviations from the plan.
- Establish problem-reporting thresholds. Determine how significant a variation from the plan needs to be before you report on it. For example, establish thresholds for how many dollars over budget or how many days' delay need to be reported.
- Choose the best format for each report (text, table, line graph, histogram,

bar chart, or Gantt chart).
- Clearly state the purpose of each report and the action to be taken.

Graphical Reports

It is important to make reports easy to read. The first step is to be sure reports contain only the information needed by the recipient. Next, determine whether the reports can be further simplified by converting data to graphics.

This is particularly useful in summary reports sent to upper management. A simple pie chart or line graph may be much easier to interpret than a page full of text or numbers. Some reports use the symbol of a traffic semaphore (stop light) as a visual indicator of project status (see Exhibit 8-1). Green means the project is on track, yellow indicates minor trouble, and red warns of major trouble. The project manager establishes the thresholds for each project. For example, green may indicate less than 5 percent variance from the plan, yellow could be a variance of 5 to 10 percent, and red indicates any variance over 10 percent.

Reporting Percent Complete

Planning and reporting percent complete is particularly useful when one part of the activity is more difficult than another. Consider the construction of a brick wall (see Exhibit 8-2). What happened? Did the workers slack off as the days went by? Actually, the construction plan was faulty because it specified laying 100 bricks per day, with the unstated assumption that it takes the same effort to lay each of the 1,000 bricks. To assume this—and to measure and report it as such—is misleading. As you can see from this example, the workers laid more bricks per day in the early days of the project and fewer bricks per day toward the end of the project, because the higher rows of bricks required scaffolding and additional time to move materials up and down. The project

---

E xhibit 8-1
Traffic Signal as Indicator of Project Status
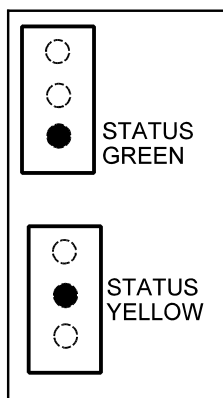
E xhibit 8-2
Construction of a Brick Wall: Plan vs. Actual

Specifications:
    1,000 total bricks
    20 bricks wide by 50 bricks high

Construction plan:
    lay 100 bricks per day
    for 10 days

Actual performance:

Day	Bricks laid
1	139
2	131
3	127
4	119
5	113
6	98
7	85
8	76
9	61
10	51

team should have considered this in the original estimates and planned the project accordingly.

The theory of percent complete provides a more accurate way of planning and reporting on an activity where one part of the activity is more difficult than another. Rather than measuring and reporting on the number of bricks laid, this method measures and reports the percent complete. A report of "629 bricks laid of the total 1,000 bricks at Day 5" may be misleading to those who do not understand how the project was planned. A report of "job 50 percent complete at Day 5" is clearer.

Sample Reports

Sample reports include status reports, schedule baseline plans, schedule status reports, summary schedule status reports, cost reports, cumulative cost reports, and cumulative cost line graphs.

Status Report
The status report in Exhibit 8-3 is highly graphical and presents a lot of information quickly. It was designed to report summary information to upper management on the three aspects of the project objectives: schedule, cost, and scope.

- *Schedule information* is presented on a single timeline, with a solid arrow above the line indicating performance to date (in the example, positioned

Exhibit 8-3
Sample Status Report

Status Report: 1 June

Schedule (6 months to complete)

| Mar | Apr | May | Jun | Jul |

Cost

Cumulative Expenditures

Legend	
Plan	Actual
Projected	

Scope

	Status to date	Status at completion
Quality standards	ok	ok
Legal requirements	ok	anticipate delays
Zoning variance	ok	ok
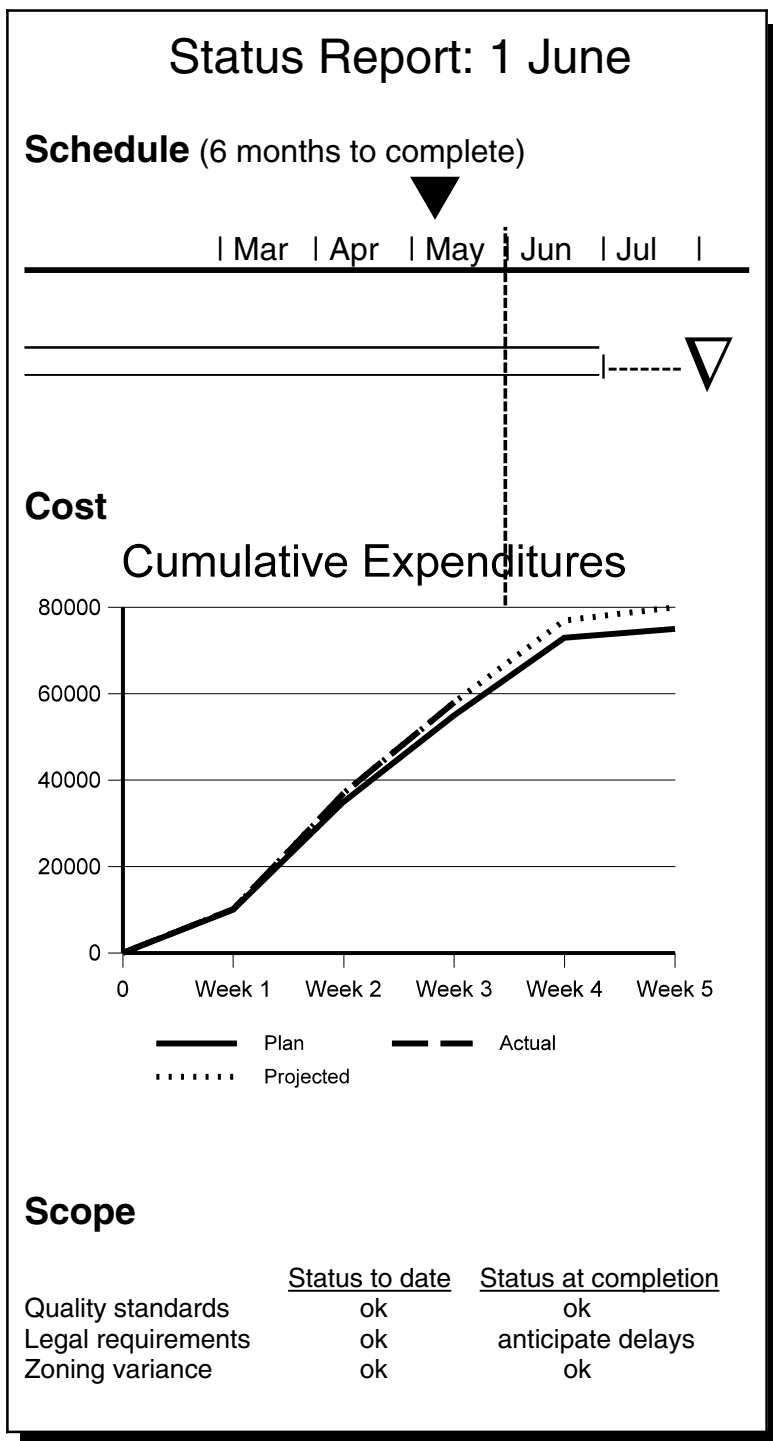
at the end of the first week of May). A quick visual comparison with the dashed vertical line indicating the date of the report (1 June) tells the recipient of the report that the project is running three weeks late (the difference between the end of the first week of May and 1 June). The solid horizontal bar shows the scheduled length of the project. In this example, the project is scheduled to be completed at the end of June. However, the dashed line and arrow indicate that the expected completion date has been extended to the end of July. Therefore, although the project is only three weeks late as of the date of the report, additional delays are anticipated such that the project is expected to complete four weeks late (at the end of July rather than at the end of June).

- *Cost information* is presented next in a chart showing cumulative project expenditures. The dashed line shows that actual expenditures to date are more than planned. Furthermore, the dotted line shows a projection to overspend even more before the project is completed.
- *Scope information* identifies a few key indicators that are listed with a simple "ok" or a warning of potential problems.

Schedule Baseline Plan

The Gantt chart in Exhibit 8-4 shows the baseline plan for a software demonstration project. The activities are shown as gray bars. The black bars represent a summary of the activities in each phase of the project. The lines show dependencies between the activities. This is the baseline schedule plan distributed to everyone involved in the project.

Schedule Status Report

Because everyone involved with the project is familiar with the baseline plan,

Exhibit 8-4
Schedule Baseline Plan: Gantt Chart

E | xhibit 8-5
Schedule Status Report

ID	Task Name	Act. Start	Act. Finish	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
1	**Select Demonstration Site**	**Feb 7**	**Apr 7**												
2	Identify possible sites	Feb 7	Mar 10												
3	Evaluate sites	Mar 13	Mar 31												
4	Select site	Apr 3	Apr 7												
5	**Prepare for Demonstration Site**	**Apr 10**	**Apr 28**												
6	Develop plan	Apr 10	Apr 21												
7	Approve plan	Apr 24	Apr 28												
8	**Conduct Demonstration**	**May 1**	**NA**												
9	Conduct demonstration	May 1	NA												
10	**Evaluate Demonstration Results**	**NA**	**NA**												
11	Prepare evaluation plan	NA	NA												
12	Collect data	NA	NA												
13	Analyze data	NA	NA												
14	Determine recommendations	NA	NA												
15	**Prepare Project Report**	**NA**	**NA**												
16	Prepare report	NA	NA												
17	Review and approve report	NA	NA												

a project manager may decide to use the same chart to monitor and report on progress throughout the life of the project (see Exhibit 8-5). As activities are completed, solid lines are drawn through the gray activity bars and actual start and finish dates appear in the appropriate columns.

Summary Schedule Status Report
The chart in Exhibit 8-6 is identical to the chart in Exhibit 8-5 except the individual activities have been removed, leaving only the summary steps. This report is sent to recipients who only require summary information. It is also called a milestone schedule.

The simple spreadsheet in Exhibit 8-7 lists the same steps as the previous schedule reports, but provides financial data (rather than schedule data) for a given period.

E | xhibit 8-6
Summary Schedule Status Report

ID	Task Name	Act. Start	Act. Finish	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov
1	Select Demonstration Site	Feb 7	Apr 7										
2	Prepare for Demonstration Site	Apr 10	Apr 28										
3	Conduct Demonstration	May 1	NA										
4	Evaluate Demonstration Results	NA	NA										
5	Prepare Project Report	NA	NA										

E xhibit 8-7
Sample Cost Report

Cost Categories	January			February		
	Plan	**Actual**	**Variance**	**Plan**	**Actual**	**Variance**
Select demo site	$5,000			$0		
Prepare demo	$7,000			$9,000		
Conduct demo	$0			$7,500		
Evaluate demo	$0			$0		
Prepare final report	$0			$0		
Other	$200			$200		
Total direct labor	$12,200			$16,700		
Materials, etc.	$8,000			$9,500		
Total direct costs	$8,000			$9,500		
Project mgmt. support	$5,000			$5,000		
Other	$550			$550		
Total operational costs	$5,550			$5,550		
Total project costs	$25,750			$31,750		

Cumulative Cost Report
The spreadsheet in Exhibit 8-8 is similar to the cost report but shows cumulative costs to date and the anticipated total costs at the completion of the project.

Cumulative Cost Line Graph
The report in Exhibit 8-9 shows the same information as the previous report, but in graphical form.

Instructions on Reports
Reports are most helpful when they clearly explain the purpose of the report and the action requested. Consider the report, from one company division to another, shown in Exhibit 8-10.

E xhibit 8-8
Sample Cumulative Cost Report

Cost Categories	Cumulative Costs to Date			Anticipated Total at Completion		
	Plan	Actual	Var.	Plan	Actual	Var.
Select demo site	$15,000	$14,500	$500	$15,000	$14,500	$500
Prepare demo	$17,000	$17,500	($500)	$17,000	$17,500	($500)
Conduct demo	$8,500	$9,000	($500)	$9,500	$10,000	($500)
Evaluate demo	$1,500	$50	$1,450	$2,000	$2,000	$0
Prepare final report	$750	$0	$750	$750		$750
Other	$1,275	$750	$525	$2,500	$2,500	$0
Total direct labor	$44,025	$41,800	$2,225	$46,750	$46,500	$250
Materials, etc.	$8,000	$8,025	($25)	$12,700	$17,950	($5,250)
Total direct costs	$8,000	$8,025	($25)	$12,700	$17,950	($5,250)
Project mgmt. support	$12,500	$12,500	$0	$15,000	$15,000	$0
Other	$350	$325	$25	$550	$550	$0
Total operational costs	$12,850	$12,825	$25	$15,550	$15,550	$0
Total project costs	$64,875	$62,650	$2,225	$75,000	$80,000	($5,000)

Exercise 8-2
Reports

Exercise 6-5 presents a project to remodel a bathroom, which includes the following activities: remove existing wall, build new wall, install new ceiling exhaust fan, and move bathtub, drain, and water supply.

Describe how each of the following reports could be used to report on this project, giving the benefits of each. (Suggested answers are in Appendix A.)

Schedule baseline plan

E xhibit 8-9
Sample Cumulative Cost Line Graph

Cumulative Expenditures

Plan — — Actual

.... Projected
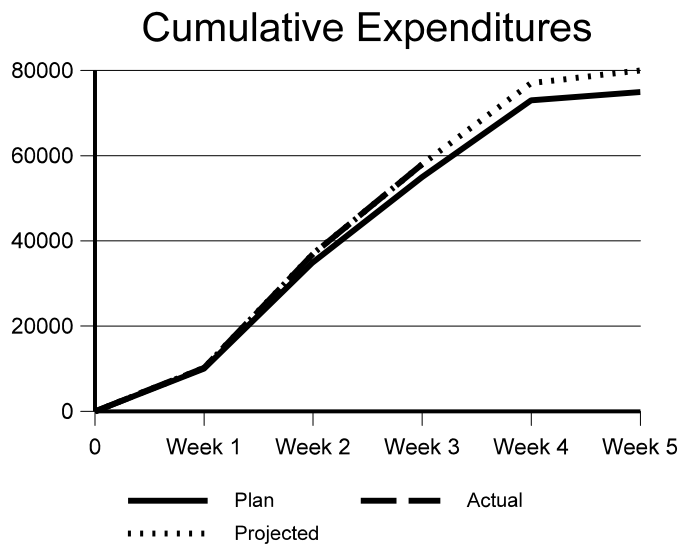
E xhibit 8-10
Sample Report Instructions

To: Europe Translation Division
From: Headquarters Production Control
Date: 15 December 2010
Re: Resubmission of Translations in French

According to the central tracking system, the following manuals have been translated but not yet received in the production division for graphics production.

Please submit these jobs to us at your earliest convenience so they may be processed without delay.

Item #	Language	Title	Date Translation Completed
52206	French	PRT Software Manual	30 Nov 10
31596	German	T5 Software Screens	10 Dec 10
52206	Spanish	PRT Software Manual	13 Dec 10

Exercise 8-2 continued from page 153.

Schedule status report

_____

_____

_____

Summary schedule status report

_____

_____

_____

Cost report

_____

_____

Cumulative cost report

_____

_____

Cumulative cost line graph

_____

_____

_____

_____

CLOSING THE PROJECT

A good project management methodology includes formal steps to close the project. The purpose of project closure is to verify that all work has been accomplished as agreed upon and that the project sponsor or customer accepts the final product. This is often called _scope verification_. At times, it may be dif-

ficult to get the project sponsor or customer to agree that the project is finished. For example, what does a project manager do with a project sponsor who says, "I'm not signing off until the application is 100 percent bug-free?" You will find project sponsor acceptance much easier to achieve if you have done a careful job of scoping and documenting the project plans. When project specifications are vague, you are more likely to have differences of opinion and disagreements at the time of project acceptance. When project specifications are detailed and accurate, project acceptance is a straightforward effort to match project deliverables with the specifications.

The steps involved in project closure ensure that all payments are made and finances reconciled. Project documentation and final reports are completed, and any remaining budget, materials, or other resources are properly dispersed.

Project closure is also a time to recognize individual efforts and celebrate project success. Typically, employee evaluations, vendor evaluations, and customer satisfaction reviews are completed at this time as well. The project manager ensures that team members have a smooth transition to other projects or work assignments.

In large projects, many of these actions may be appropriate at the end of each phase of the project as well as at the conclusion of the entire project. The checklist in Exhibit 8-11 gives further detail on items you may need to consider in the project closeout.

E xhibit 8-11
Project Closure Checklist

		Check when completed
Project		
1	Have all activities in the project plan been completed?	
2	Have all work orders been completed?	
3	Have all contracts been completed?	
4	Have all outstanding commitments been resolved?	
5	Has the client or customer accepted the final products?	
6	Are all deliverables completed?	
7	Has agreement been reached with the client on the disposition of any remaining deliverables?	

Exhibit 8-11 continues on next page.

Exhibit 8-11 continued from previous page.

		Check when completed
8	Have external certifications and authorizations been signed and approved?	
9	Have all audits been completed and issues resolved?	
10	Have ongoing maintenance procedures been activated?	
11	Has the project been handed over to ongoing operations?	
Finances		
12	Have all payments been made to vendors and contractors?	
13	Have all costs been charged to the project?	
14	Have project accounts been closed?	
15	Have remaining project funds been returned?	
Project documentation		
16	Have project plans and supporting documentation been revised to reflect the "as-built" condition?	
17	Have final project reports been prepared and distributed?	
18	Has the project plan been archived with all supporting data?	
19	Have "lessons learned" been documented, shared with appropriate people, and archived with the project plans?	
Personnel		
20	Are all parties aware of the pending closeout?	
21	Has effort been recognized and rewarded?	
22	Have employee and vendor evaluations and customer satisfaction reviews been completed?	
23	Have project personnel been reassigned?	
Resources		
24	Has excess project material been dealt with?	
25	Have project facilities, equipment, and other resources been reallocated?	
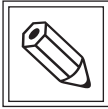
Exercise 8-3
Project Closure

Consider the upgrade project for the order processing system for Blankets, Inc. described in Exercise 8-1 (six months of software development and two weeks of training). Explain how you would close this project in an effective way. (Suggested answers are in Appendix A.)

_____

_____

_____

_____

_____

Lessons Learned Documentation

At the conclusion of a project, as well as at the end of major phases of a project, it is helpful to gather the team together and collect information about what went wrong, what went well, the causes of issues and variances, the reasoning behind the corrective actions taken, and the results achieved. These documented lessons learned can also contain advice for future projects. This documentation then becomes part of the historical database for the project and can also be used to guide other similar projects.

recap

To ensure project success, you need periodic project evaluations to be sure work is being accomplished as planned. Even though you constantly collect data about costs, schedules, and work accomplished, you should plan specific reviews as a chance to step back and take a good look at the project to verify everything is progressing as it should. Project reviews can also help motivate team members and provide helpful feedback.

Project work should be evaluated in four general ways: ongoing reviews, periodic inspections, milestone evaluations, and final project audit. Each of these project evaluations should consider quality of work, team performance, and project status.

Project managers spend much time collecting and analyzing data, but often they exert too little effort to determine what information needs to be communicated, to whom, and how it could best be presented. Graphical reports are often easier to interpret than a page full of text and numbers.

Planning and reporting on percent complete is particularly useful when one part of the activity is more difficult than another. Rather than measuring and reporting on the number of units of work completed, this method meas-

ures and reports the percent complete.
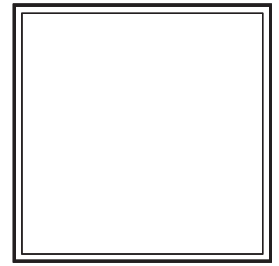
Typical, useful reports include schedule baseline plans, schedule status reports, summary schedule status reports, cost reports, cumulative cost reports, and cumulative cost line graphs. Reports are most helpful when they clearly explain the purpose of the report and the action requested.

A good project management methodology includes formal steps to close the project. The purpose of project closure is to verify that all work has been accomplished as agreed upon and that the project sponsor or customer accepts the final product. The steps involved in project closure ensure that all payments are made, finances reconciled, final documentation completed, and remaining budget, materials, and other resources properly dispersed. The final step ensures that all lessons learned are documented and added to the project history to be shared with future projects.

Review Questions

1. Which of the following is *not* good advice about project reports?   1. (b)
   (a) Publish only concise, top-quality, accurate reports.
   (b) Provide detailed reports to all stakeholders.
   (c) Analyze project information and report on variances from project plans.
   (d) Clearly state the purpose of each report and the action to be taken.

2. _____ reports are particularly useful when one part of   2. (c)
   the activity is more difficult than another.
   (a) Cumulative
   (b) Exception
   (c) Percent complete
   (d) Summary schedule status

3. Formal project closure includes: 3. (a)
   (a) verifying that all work has been accomplished as agreed upon.
   (b) making regular payments on all accounts.
   (c) preparing project schedules and documentation.
   (d) responding to unplanned risk events.

4. A report using a traffic semaphore (stop light) is an example of which   4. (d)
   type of report?
   (a) Table
   (b) Histogram
   (c) Gantt chart
   (d) Graphical

5. The four types of project evaluations are: 5. (a)
   (a) periodic inspections, ongoing reviews, milestone evaluations,
      and final project audit.
   (b) quality inspections, ongoing reviews, periodic evaluations, and
      final project audit.
   (c) schedule reviews, team performance reviews, milestone
      evaluations, and final project audit.
   (d) schedule reviews, financial reviews, scope reviews, and final
      project audit.

Post-Test

Successful Project Management
Third Edition

Course Code 98005

INSTRUCTIONS: *Record your answers on one of the scannable forms enclosed. Please follow the directions on the form <u>carefully</u>. Be sure to keep a copy of the completed answer form for your records. <u>No photocopies will be graded</u>. When completed, mail your answer form to:*

Educational Services
American Management Association
P.O. Box 133
Florida, NY 10921

If you are viewing the course digitally, the scannable forms enclosed in the hard copy of AMA Self-Study titles are not available digitally. If you would like to take the course for credit, you will need to either purchase a hard copy of the course from www.amaselfstudy.org or you can purchase an online version of the course from www.flexstudy.com.

1. Which of the following is true of functional work?
   (a) Functional work is routine, ongoing work.
   (b) Functional work is a unique, temporary endeavor.
   (c) A functional manager is responsible for the approved objectives of a project (budget, schedule, and scope).
   (d) Functional work has a specific beginning and end.

Do you have questions? Comments? Need clarification?
Call Educational Services at 1-800-225-3215
or e-mail at ed_svcs@amanet.org.
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http://www.amanet.org/

161

2. Project quality management encompasses which of the following areas:
(a) customer satisfaction.
(b) prevention over inspection.
(c) continuous quality improvement.
(d) all of the above.

3. The critical path generally has:
(a) zero duration.
(b) zero float.
(c) zero lag.
(d) zero resources.

4. _____ reports include only major variations from the plan.
(a) Schedule status
(b) Cumulative
(c) Exception
(d) Summary schedule status

5. Potential risks can be classified in the following four ways:
1. low impact; high probability
2. high impact; high probability
3. low impact; low probability
4. high impact; low probability

Which of the following describes the priority order in which you should address these risks (with the most important listed first)?
(a) 2, 4, 3, 1
(b) 4, 2, 3, 1
(c) 2, 4, 1, 3
(d) 4, 2, 1, 3

6. The major organizational structures are:
(a) functional, project, and matrix.
(b) project, operational, and functional.
(c) reactive, proactive, and functional.
(d) matrix, project, and operational.

7. Which of the following is the most common type of activity relationship used in a network diagram?
(a) Start-to-start
(b) Finish-to-finish
(c) Start-to-finish
(d) Finish-to-start

8. Which of the following is *not* true of project management?
    (a) Project management skills can help you complete projects on time, on budget, and on target.
    (b) Project management is a reactive management style.
    (c) Project management helps you avoid serious errors of omission and eliminate costly mistakes.
    (d) The objective of project management is to ensure that projects meet agreed goals of time, cost, and scope.

9. Which of the following is true about managing project objectives?
    (a) Logic network diagrams, schedules, and budget plans are used to manage the project.
    (b) A project activity that is completed early is a variance that causes no harm.
    (c) Quality and cost are more difficult to measure than scope and time.
    (d) The cause of a variance is of little consequence in managing project objectives.

10. Which of the following is true about project evaluations?
    (a) Reviews help ensure that the standards included in the project scope statement are being applied to the work.
    (b) Work on a project should be reviewed weekly as part of an ongoing quality assurance program.
    (c) Evaluation results should not be shared with workers because it can decrease motivation.
    (d) Periodic evaluations are necessary only on large projects to ensure compliance with industry standards.

11. A rolling wave estimate would be most appropriate in which of the following situations?
    (a) In projects with greater risk
    (b) In times of inflation when the cost of materials is increasing rapidly
    (c) In projects with a unit-price contract
    (d) When a novice project manager is assigned to a project

12. Which of the following is true in managing projects?
    (a) Accountability is an agreement between two or more people for the purpose of achieving a desired result.
    (b) Authority should be given commensurate with the responsibility.
    (c) Accountability is a detriment to good performance.
    (d) Responsibility is the power given to a person to complete an assignment.

13. Which of the following is true about risk management?
    (a) Potential risks should be identified before the project begins and during the course of the project.
    (b) Risks are uncertain events that have a negative effect on the project; those with positive effects are not considered risks.
    (c) Risk management should plan for all possible negative events, regardless of their impact or likelihood.
    (d) The purpose of risk management is to ensure that no negative events occur.

14. Which of the following statements is *not* true about the skills of a project manager?
    (a) The stronger a project manager's interpersonal skills, the greater the chance of successfully leading the project team.
    (b) A successful project manager needs to understand the culture of the organization.
    (c) A project manager needs greater technical skills than the team members.
    (d) Project managers typically use a combination of formal authority and persuasion skill.

15. Which of the following is true about evaluating team performance?
    (a) Team performance should be audited weekly to ensure schedules are met.
    (b) If consistent data are gathered over time, periodic reviews are not needed.
    (c) Team performance should not be compared with other companies since every project is unique.
    (d) Benchmarking can be a helpful point of reference to measure performance.

16. Which of the following is true about work breakdown structures?
    (a) Each box is a summary of the boxes in the levels below it.
    (b) The sum total of boxes must represent the complete project.
    (c) The boxes in the top level are called work packages.
    (d) The diagram should represent a logical or time sequence of events.

17. Which of the following is true about activities on the critical path?
    (a) The late start and early finish are the same.
    (b) The early start and late start are the same.
    (c) The early start and early finish are the same.
    (d) The early start and late finish are the same.

18. Budget cuts and cash flow problems are examples of:
    (a) logistical risks.
    (b) mitigation strategies.
    (c) financial risks.
    (d) contingency reserves.

19. Which of the statements below correctly identifies the relationship between project personnel?
    (a) Functional managers lead project team members.
    (b) Team members work with the project manager in the planning process.
    (c) Customers and project sponsors determine the sequence of individual project activities.
    (d) The project sponsor provides performance reviews for team members.

20. Which of the following is true about earned value analysis?
    (a) Schedule variance is determined by subtracting the earned value from the planned value.
    (b) The cost performance index is a ratio of budgeted costs to actual costs.
    (c) Cost variance is determined by subtracting the earned value from the actual cost.
    (d) A schedule performance index (SPI = EV/PV) greater than 1 means the project is behind schedule.

21. When using a cost-plus contract, who assumes the risk of unforeseen problems?
    (a) Contractor
    (b) Project manager
    (c) Worker
    (d) No one

22. A planning tool that displays the levels of project work is a:
    (a) Gantt chart.
    (b) Pareto diagram.
    (c) skills inventory.
    (d) work breakdown structure.

23. If you contract with a vendor to do a job for $90 per hour, you are using which type of contract?
    (a) Fixed-price
    (b) Unit-price
    (c) Cost-plus
    (d) Incentive

24. A risk response plan includes all of the following *except*:
    (a) possible risks, potential causes, and how they may affect the project.
    (b) a prioritized list of project risks, their owners, and planned responses.
    (c) warning signs of a possible risk occurrence.
    (d) a mitigation strategy to eliminate the possibility of risk events from occurring.

25. When a project schedule is slipping, corrective action might entail all of the following *except*:
    (a) adding more or higher-skilled personnel.
    (b) adding additional equipment or other resources.
    (c) changing the sequence to allow activities to be done in parallel or to overlap.
    (d) negotiating with preceding activities to complete their activities in a shorter time.

Appendix A
Answers to Exercises
and Case Studies

EXERCISE 1-1: PROJECT MANAGEMENT IN TODAY'S WORLD

Project management is a sound strategy in today's business world because it allows a proactive way to manage the schedule, budget, and scope of projects. In today's world, speed, cost, and quality are increasingly important.

You can benefit in many ways from using more project management principles. Your list may include specific principles or techniques you would like to begin using. All these can help you complete projects on schedule, within budget, and in full accordance with project specifications.

Problems you may encounter in managing the projects include:

- Unrealistic completion dates or budgets.
- Project plans that omit important activities.
- Lack of commitment to quality.
- Late or useless reports.
- Lack of consistent project management methodology.
- Difficulty obtaining decisions, even on elementary issues.
- Unrealistic expectations about the availability of resources, or no commitment to make resources available.
- Changes in the time, cost, or scope of the project without making adjustments in other areas.
- Poor estimates.
- Late identification and reporting of serious project problems.

EXERCISE 1-4: CXI CELLULAR CASE STUDY

This case study illustrates mistakes commonly made in managing projects.

Some of these problems are listed below, along with suggestions on what Robert (the project manager) could do to help the project succeed.

Understanding of Project Management Principles

The company appears to know little about project management. For example, why did the vice president of marketing appoint Robert as the project manager? Why is marketing taking the lead in managing an engineering and manufacturing project? Robert was also asked to develop a schedule and budget for a large project in a week. Robert may need to take steps to educate the management team about project management—if indeed he knows much about project management himself, since he is a salesman in marketing.

Definition of Roles and Responsibilities

The vice president of marketing appointed Robert to be the project manager. Later, the COO asked Robert to report directly to him. Robert needs to clarify his role as a project manager and clearly define the reporting relationships.

He needs to define his authority to form and manage a project team. He also needs to be given financial authority to approve project expenses himself, at least to a certain dollar amount.

Skills of the Project Manager

Robert was the top salesperson in the marketing department, yet he was chosen to be the project manager. Being a good salesperson does not necessarily qualify him to be a good project manager. If he is not already proficient in project management skills or able to learn them quickly, the project may fail. Not only will the company suffer financially with a failed project, but it will also lose the sales Robert would have made if he had been left in marketing.

Approval and Buy-In by Management

When Robert presented his plans to the executive management team, there was considerable discussion about whether the company should begin manufacturing the new phone. Robert needs the approval and support of the management team. Although the COO's support is helpful, it will not be sufficient to accomplish such a large engineering and manufacturing project.

EXERCISE 3–3: PROJECT OBJECTIVES

As the project manager for the construction of a building, you might propose the following definition of project objectives in terms of cost, time, and scope.

Cost: $10,000,000

Time: Completion of all construction (including landscaping and parking lot), final building inspections, and permit to occupy the building within 24 months of initiating the project.

Scope: Building to be constructed according to approved blueprints and quality of materials specified in the building plans, complying with all applicable building codes, city ordinances, and industry safety requirements.

EXERCISE 3-4: PROJECT REVIEWS

The following reviews may be appropriate for the building construction project.

Conceptual Review

A conceptual review would address whether it makes sense for this company to construct a building, given its mission, goals, and specific business plans. This review would determine if the building helps the company solve a problem or appropriately take advantage of an opportunity.

Feasibility Study

A feasibility study would help determine if it is realistic for the company to accomplish the construction, given its expertise, manpower, finances, and time commitments to other projects.

Benefit-Cost Analysis

A benefit-cost review would compare the costs with expected benefits to determine if the building will give the company the value it expects to receive.

Profitability Measures

Measures such as payback period, internal rate of return, return on assets, return on investment, and return on sales help determine if the building makes financial sense to the company.

Alternative Course of Action Review

This review of options (renting a building versus purchasing an existing building, for example) would help ensure that constructing a new building is the best alternative.

Opportunity Cost Review

This review would compare the value of constructing the building to other projects the company might undertake instead. If the company could make more profit from some other project, it may decide not to construct the building.

Preliminary Risk Assessment

A risk assessment determines what could go wrong in the project and identifies the potential consequences.

E xhibit A-1
Work Breakdown Structure of a Building Construction Project
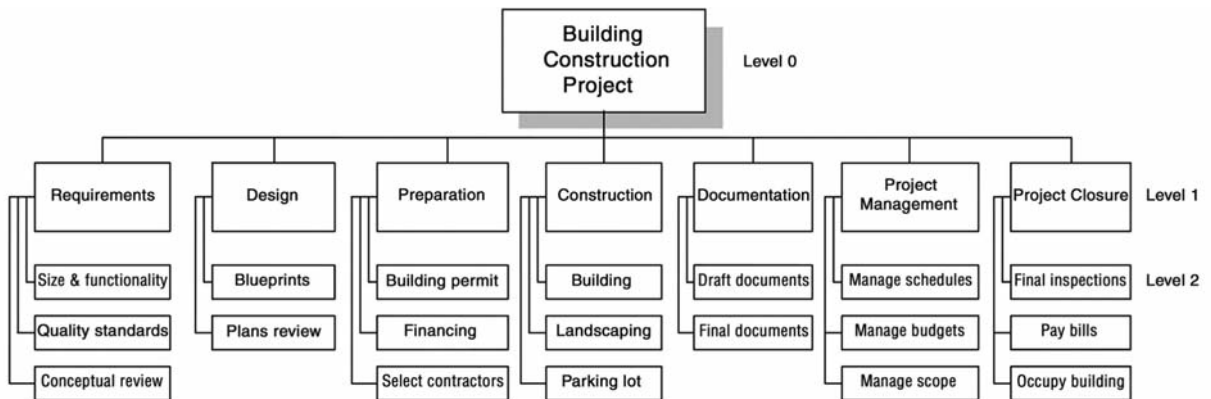
EXERCISE 3–5: WORK BREAKDOWN STRUCTURE

The following exhibits show a suggested work breakdown structure for the building construction project, presented in graphic (Exhibit A-1) and textual (Exhibit A-2) formats.

E xhibit A-2
Work Breakdown Structure for a Building Construction Project

Building Construction Project
1.0 Requirements
  1.1 Size and functionality
  1.2 Quality standards
  1.3 Conceptual review
2.0 Design
  2.1 Blueprints
  2.2 Plans review
3.0 Preparation
  3.1 Building permit
  3.2 Financing
  3.3 Select contractors
4.0 Construction
  4.1 Building
  4.2 Landscaping
  4.3 Parking lot
5.0 Documentation
  5.1 Draft documents
  5.2 Final documents

Exhibit A-2 continued from previous page.

6.0 Project Management
       6.1 Manage schedules
       6.2 Manage budgets
       6.3 Manage scope
7.0 Project Closure
       7.1 Final inspections
       7.2 Pay bills
       7.3 Occupy building

EXERCISE 4–1: ACTIVITY ESTIMATE SHEET

Exhibit A-3 is a suggested activity estimate sheet for Activity #2, "write computer code for the system."

E xhibit A-3
Activity Estimate Sheet

ACTIVITY ESTIMATE SHEET

Activity # *2*   Title: *Write computer code for the order processing system*

Team Responsible *Programming Team A*

Team Leader *Bob Johnson*

Statement of work:

Write computer code for the order processing system using J2EE programming

language. Includes internal quality control. Formal testing will be completed in a

subsequent project activity.

Describe completion condition:

Functioning computer code to perform all functions described in the Features

Specifications Document. All bugs found during internal quality control processes

are fixed.

Exhibit A-3 continues on next page.

Exhibit A-3 continued from previous page.

Describe assumptions, exclusions, constraints:

Programmers with appropriate skills are available when needed. No customer changes

in specifications during programming. Access to customer when needed to answer

questions and review prototypes.

Time Number of working days needed *20*

Personnel

5 person hours of   *Program analyst*   skill group

120 person hours of   *Senior programmer*   skill group

Direct costs

item *Software*   cost *$175*   needed at day *1*.   *30* days to pay

Inputs to this activity

Design specifications documents.

Outputs to other activities

Functioning computer code.

Predecessor steps
This activity cannot begin until

100 % of activity # *1* is complete.

Successor steps

Other activities that cannot begin until this activity is complete

Define if less than 100%

Activity # *3* can begin when this activity is *75*% complete.

Testing can begin when 75% of code is completed.

Signature _____   Date_____

E xhibit A-4
Sales Presentation: Preceding Activities

Activity description	Person responsible	Duration (days)	Preceding activity
1. Decide to make presentation	Roger & Susan	2	none
2. Arrange appointments	Roger	17	1
3. Collect sales data	Susan	10	1
4. Prepare presentation	Susan	10	3
5. Make presentation	Roger & Susan	1	2, 4

EXERCISE 5–1: NETWORK DIAGRAM: SALES PRESENTATION

The chart in Exhibit A-4 shows the preceding activities.

Exhibit A-5 shows the network diagram based on the information in Exhibit A-4.

EXERCISE 5–2: CASE STUDY: GEEBOLD MANUFACTURING

This case study illustrates mistakes commonly made by project managers in planning projects. In her enthusiasm, Ann has spent five months planning and

E xhibit A-5
Sales Presentation: Network Diagram
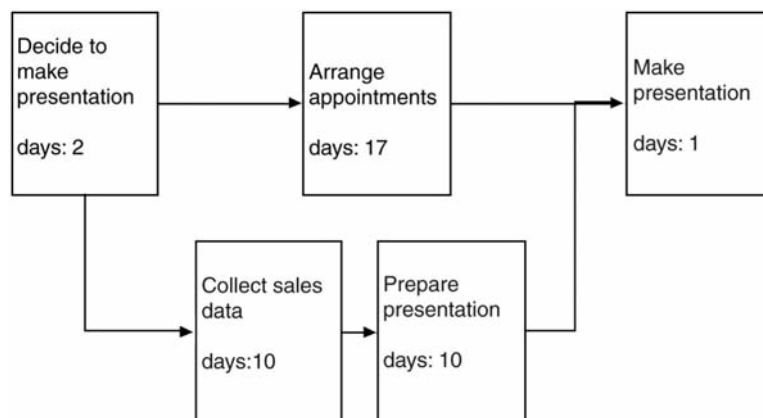
estimating the project all by herself. While she may be complimented on her diligence, she appears to lack common sense. She could have better used those five months involving the project team from the beginning of the planning process. The team members should have helped develop the work breakdown structure, provided the estimates, and given input on all phases of planning. Not only may Ann's plans have serious faults, it may now be difficult for Ann to get the support of the project team when she presents the plans to them.

Project Objectives

It appears she carefully defined the project objectives of cost, time, and scope, and she wisely got the approval of the board of directors on the scope statement.

Project Reviews

No mention is made of project reviews, such as a conceptual review, feasibility study, benefit-cost analysis, alternative course of action review, or risk assessment. These are critical in a large project.

Work Breakdown Structure

The work breakdown structure appears to be imbalanced. Typically, the work packages should represent 8–80 hours' work. Her packages with 2–3 hours' work are probably too detailed to be scheduled and managed by the project manager. The packages with 150 hours' work probably need to be broken down further.

Estimating

Ann estimated each of the activities using an analogous approach, drawing on plans she discovered of a similar project that the company planned three years ago but never completed. The time and costs in these three-year-old plans need to be verified in the current economy. Furthermore, since this old plan was never executed, the assumptions in the plan should be verified carefully. She should have more wisely used skilled team members to create accurate plans and estimates. Parametric estimating or even a bottom-up estimate may be more appropriate for this construction project, since she has created a very detailed work breakdown structure.

Sequencing the Activities

Ann has drawn a network diagram showing the sequence of each activity and their interrelationships. As she involves the project team in the planning process, she should verify the accuracy of the diagram with the team.

EXERCISE 5–3: CALCULATING CRITICAL PATH: SALES PRESENTATION

Exhibit A-6 shows the critical path calculations.

EXERCISE 6–1: PREPARING SCHEDULES: SALES PRESENTATION

Exhibit A-7 shows the scheduled start and finish times for each activity.

EXERCISE 6–2: GANTT CHART: SALES PRESENTATION

Exhibit A-8 shows a Gantt chart for the sales presentation exercise.

EXERCISE 6–3: IDENTIFYING REQUIRED SKILLS: REMODELING A BATHROOM

Required skills include the following:

- Carpentry skills to remove the existing wall(s) and build new wall(s).
- Plumbing skills to move drain and water supply pipes for the bathtub.
- Electrical skills to install the new ceiling exhaust fan.

E xhibit A-6
Critical Path Calculations: Sales Presentation
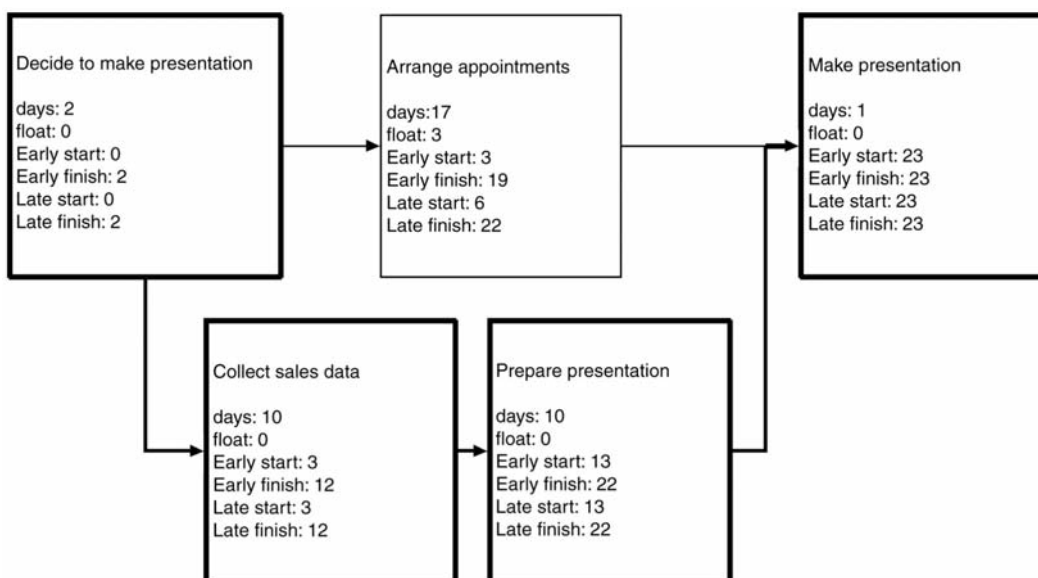
E xhibit A-7
Sales Presentation: Preparing Schedules

Decide to make presentation	Arrange appointments	Make presentation
days: 2 float: 0 Scheduled start: April 1 Scheduled finish: April 2 Early start: April 1 Early finish: April 2 Late start: April 1 Late finish: April 2	days: 17 float: 3 Scheduled start: April 3 Scheduled finish: April 19 Early start: April 3 Early finish: April 19 Late start: April 6 Late finish: April 22	days: 1 float: 0 Scheduled start: April 23 Scheduled finish: April 23 Early start: April 23 Early finish: April 23 Late start: April 23 Late finish: April 23

Collect sales data	Prepare presentation
days: 10 float: 0 Scheduled start: April 3 Scheduled finish: April 12 Early start: April 3 Early finish: April 12 Late start: April 3 Late finish: April 12	days: 10 float: 0 Scheduled start: April 13 Scheduled finish: April 22 Early start: April 13 Early finish: April 22 Late start: April 13 Late finish: April 22

EXERCISE 6-4: RESPONSIBILITY ASSIGNMENT: REMODELING A BATHROOM

Exhibit A-9 shows a suggested responsibility assignment matrix.

EXERCISE 6-5: LEVELING RESOURCES: REMODELING A BATHROOM

Exhibit A-10 shows the network diagram with appropriate people assigned, based on their availability and skills. Note that the project takes a day longer because plumbing skills (Bob and Sandy) are not available on June 5.

E xhibit A-8
Sales Presentation: Gantt Chart
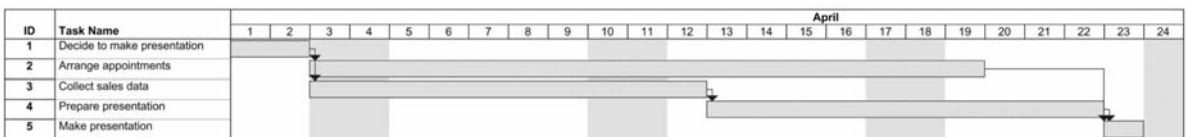
E xhibit A-9
Responsibility Assignment Matrix: Remodeling a Bathroom

	Skill Requirement		
Person	**Plumbing**	**Carpentry**	**Electrical**
Bob	✔		✔
Roger		✔	
Sandy	✔		

EXERCISE 6-6: BUDGET PLANS: REMODELING A BATHROOM

Exhibit A-11 shows the cumulative cost spreadsheet as of June 3.

EXERCISE 6-7: IDENTIFYING RISK

The following describes some of the possible risks in this project:

Technical Risks

One possible risk is that during training or implementation, it may be discovered that the software purchased does not meet the needs of the company. This may mean coding changes to the system (at additional expense and time) or purchasing new software. After training is completed, it could be discovered that critical business processes were not covered in the training.

E xhibit A-10
Leveling Resources: Remodeling a Bathroom
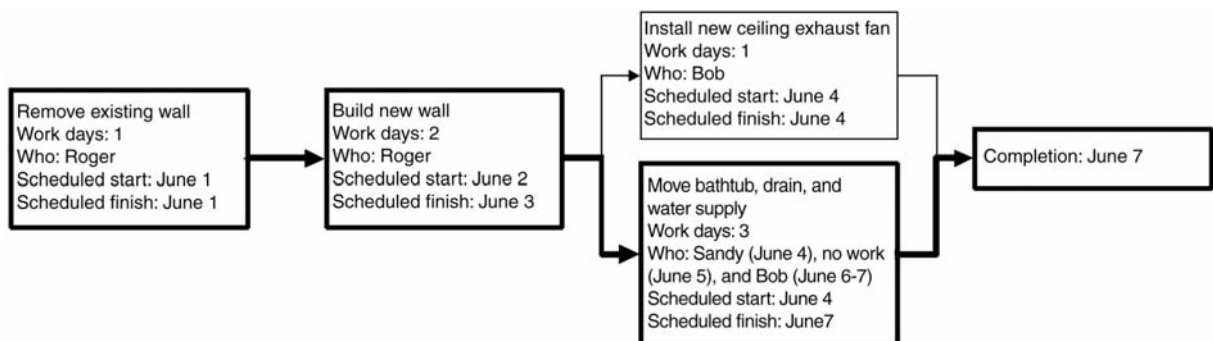
E xhibit A-11
Cumulative Cost Spreadsheet: Remodeling a Bathroom

Cost categories	Cumulative costs to date as of June 3		
	Plan	Actual	Var.
Remove wall	$80	$88	($8)
Build new wall	$120	$132	($12)
Move tub	$500	$0	$500
Install ceiling fan	$150	$0	$150
Total	$850	$220	$630

Administrative Processes, Procedures, Changes in Roles or Responsibilities

During the project, management may change or the existing management may set different priorities for the company that change some or all of the objectives of the project.

Financial Risks

Economic conditions may change, creating budget cuts or cash flow problems.

Resource Availability

Software engineers, trainers, or critical equipment may suddenly become unavailable.

Human Risk Factors

Mistakes or unforeseen factors (human error, poor worker performance, personality conflicts, or communication breakdown) could be encountered, delaying the project or overspending the budget.

Logistical Risks

The software may not be delivered on schedule to begin the installation.

Market Risks

The software program may fail in the marketplace, and the manufacturer discontinues support. Another company may release a software program that better meets your needs at a lower cost.

EXERCISE 6–8: ASSESSING RISK

The chart in Exhibit A-12 shows one way to rank the potential risks.

EXERCISE 6–9: RESPONDING TO RISK

The following describes some of the possible actions that could be taken in response to the potential risks:

- *Software doesn't meet needs.* You could mitigate this potential risk by taking steps to ensure that needs are clearly identified and verified up front.
- *Personnel, equipment, or software not available when needed.* You could try to avoid the problem by using vendors with sufficient capacity to ensure their availability. You could mitigate the impact by using a fixed-price contract with a vendor with negative incentives for late delivery. If the risk is great, and the consequences dire, you could also transfer some of the risk to a third party by purchasing insurance, a bond, or guarantee.
- *Training doesn't cover critical processes.* You could mitigate this potential risk by taking steps to ensure that training needs are clearly identified and verified up front.
- *Management changes priorities.* You could mitigate the chance of this risk by ensuring complete buy-in by management. If unforeseen events cause changes in priorities, you could accept the consequence.
- *Budget cuts or cash flow problems.* Since such problems would largely be out of your control, you could accept the consequences.
- *Manufacturer discontinues support.* You could mitigate the chance of this risk by dealing with a reputable, solid company and researching its plans for continued support of the product. Since the consequences would be dire, you could also transfer some of the risk to a third party by purchasing insurance.
- *Another company releases better software.* You could mitigate the chance of this risk by thoroughly researching software available from other companies. If the risk occurs, you could accept the consequences.

E xhibit A-12
Assessing Risks: Auto Parts, Inc.

I M P A C T	• Software doesn't meet needs • Budget cuts or cash flow problems • Management changes priorities	• Software not delivered on schedule • Personnel or equipment not available when needed • Training doesn't cover critical processes
	• Manufacturer discontinues support • Another company releases better software	• Mistakes delay the project or overspend budget

PROBABILITY

- *Mistakes delay the project or overspend budget.* You could mitigate the chance of errors by carefully monitoring the project and following your project management system. Ensure that personnel have the proper skills and appropriate training in processes. To mitigate the impact of such errors, you could plan a contingency reserve in both the schedule and budget.

EXERCISE 7-1: MONITORING PROCESS: AUTO PARTS, INC.

The following sections outline a suggested plan for monitoring the project.

Information Needs

The information you need depends on the detail of the time, cost, and scope plans you want to manage. Be sure you gather information on cost and scope as well as schedule information. Your purpose for gathering information is to compare the status reports throughout the project with the plan to determine variances. During the software installation, you will likely need schedule information (to determine if the installation will be completed at the end of two weeks), cost information (to determine if it will be completed within budget), and scope information (to be sure the installation is according to specifications). During the seven weeks of training, you should be monitoring the quality of the training (to determine whether participants are passing the final certification tests, for example), and ensuring that all required personnel are involved in the training. This will involve gathering specific information such as names of people attending classes and individual test scores. During the twelve weeks of implementing changes in the methods of receiving parts and filling orders, be sure all appropriate people are involved in the changes, appropriate training occurs, transition plans are followed, and business processes continue to run as needed. This may include detailed information such as names of people attending change control meetings, minutes of such meetings, details of transition plans followed, and metrics on the day-to-day business to be sure parts are being received and orders are being filled.

Data Collection Methods

Where possible, use electronic methods of collecting data. If there are no electronic systems in place (such as project management software or electronic time card systems), use manual systems. Manual attendance roles may need to be circulated in the software training classes and in meetings to train personnel on the new procedures for receiving parts and filling orders. You will likely want to conduct on-site inspections, one-on-one interviews, and team meetings to gather additional information and verify the information received from other sources.

Frequency of Data Collection

The frequency depends on the length of the activities and the seriousness of

E xhibit A-13
CAT Scan Project: Crashed Schedule

Activity description	Duration (weeks)	Preceding Activity
1. Receive CAT scan	0	none
2. Install CAT scan	3	1
3. Renovate radiology department	8	2
4. Train CAT scan operators	2	2
5. End	0	3, 4

possible variances from the plan. Since software installation is expected to take two weeks, data should probably be collected at least twice a week or perhaps daily, since delays in software installation would delay all other activities in the project. Since training will last seven weeks, it would be helpful to collect data at least weekly. Implementing procedural changes is planned for twelve weeks, so a weekly collection of data would likely be sufficient.

EXERCISE 7–2: CASE STUDY: URGENT CARE HOSPITAL

This case study asks you to find a way to crash the schedule. Although the four activities could be done in sequence (one after another), the schedule can be fast-tracked by beginning the training before the renovation is completed. The result is two activities being performed in parallel (at the same time), with the project being completed two weeks sooner, as illustrated in Exhibit A-13.

Exhibit A-14 is the network diagram based on the information in the chart in Exhibit A-13. The scheduled dates have been included.

E xhibit A-14
CAT Scan Project: Network Diagram
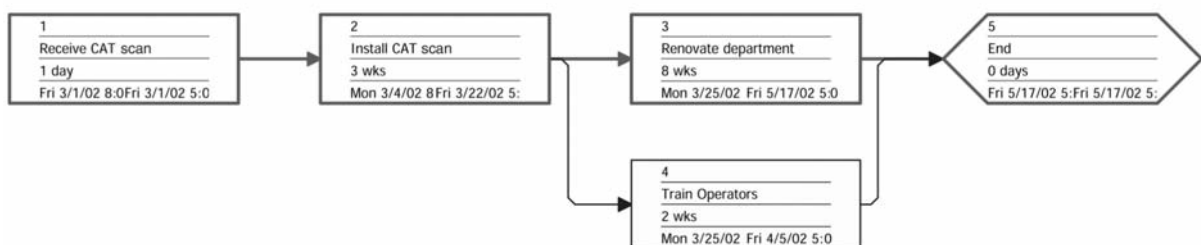
E xhibit A-15
CAT Scan Project: Anticipated Cash Flow

Cost Categories	Weeks												Total (in 000's)
	0	1	2	3	4	5	6	7	8	9	10	11	
Purchase	$1,000												$1,000
Installation		$15	$15	$15									$45
Renovation					$12	$12	$12	$12	$12	$12	$12	$12	$96
Training											$8	$8	$16
Total	$1,000	$15	$15	$15	$12	$12	$12	$12	$12	$12	$20	$20	$1,157

Exhibit A-15 shows a cash flow report of the projected expenditures during each week of the project.

EXERCISE 7–3: CONTROL THRESHOLDS

If the company training program lasts six months, a delay of one week would likely be a manageable problem. If the delay happens during the first month, there would be sufficient time to get back on schedule. Perhaps no corrective action is needed immediately, since future events may make up the time. Try to determine why the delay happened and make small corrective actions to adjust for the week's delay. However, if the delay happens during the last month, you would need to take a large corrective action to complete the program on time.

EXERCISE 7–5: EARNED VALUE ANALYSIS: THE DUNBAR PROJECT

The following explains the calculations of the schedule and cost variances and the schedule and cost indices in the exercise.

The planned value (PV) is the planned cost of work scheduled to be done in a given time period. In this example, it is $1,500 because all work was scheduled to be completed by today.

The earned value (EV) is the planned cost of work actually performed. Since only two-thirds of the planned work has actually been performed as of today, the EV is 2⁄3 of $1,500, or $1,000.

The actual cost (AC) is the cost incurred to complete the work actually performed as of today. The exercise stated the amount as $1,350.

The schedule variance (SV) = EV − PV. In this example, $1,000 − $1,500 = -$500. This calculation measures the difference between the planned and the actual work completed. The large negative result means the project is significantly behind schedule.

The cost variance (CV) = EV − AC. In this example, $1,000 − $1,350 = −$350. This calculation measures the difference between the planned (budgeted) cost and the actual cost of work completed. The negative result means the project is over budget. The schedule performance index (SPI) = EV / PV. In this example, $1,000 / $1,500 = 0.67. This ratio is a measure of efficiency in the schedule. Since the value is significantly less than 1, it indicates that the project has accomplished less than planned and is significantly behind schedule.

The cost performance index (CPI) = EV / AC. In this example, $1,000 / $1,350 = 0.74. This ratio is a measure of cost efficiency (how efficiently dollars are being spent). Since the value is less than 1, it indicates that the project is costing more than planned. Each $1.00 spent on the project has produced only $0.74 worth of value.

EXERCISE 8-1: PROJECT EVALUATIONS: BLANKETS, INC., SOFTWARE PROJECT

The following sections outline evaluations you may wish to plan to perform for this project.

Ongoing Reviews

During the software development, you should conduct reviews to ensure that quality code is being written. Portions of code could be given to others to test for accuracy and efficiency. The code should also be reviewed to ensure it follows any standards that may have been specified in the project scope statement. If a team of software developers is working on the project, ensure that they are working together and communicating efficiently. Ongoing reviews should also ensure that finances and schedule data are being reported correctly. If they are not maintaining the project schedule, determine what the problems are and resolve them.

During training, reviews should ensure the quality of training, that all necessary personnel are being trained, and that personnel are passing the final certification exams. Ensure that the training is according to schedule so all personnel will be trained by the end of the two weeks.

Periodic Inspections

Periodic inspections may also be held to check for the things mentioned under ongoing reviews. These scheduled and unscheduled inspections (perhaps weekly or biweekly during the software development phase, and perhaps four times during the two weeks of training) may be used to ensure that the objec-

tives are being met. They can be a check and balance against the regular reports you receive as a project manager.

Milestone Evaluations

A milestone evaluation should occur at the conclusion of the software development.

This is usually a testing phase during which the software code is thoroughly tested and certified before it is used. It is also a review of the schedule and finances of this phase of the project.

A milestone evaluation should also occur at the conclusion of training, when certification test scores are reviewed and a decision is made whether training has been successful and whether to proceed with the implementation of the project. The milestone evaluation is also a review of the schedule and finances of this phase of the project.

Final Project Audit

The final audit is made at the conclusion of the project to verify that all project objectives (time, cost, and scope) were completed as agreed upon, and that the project sponsor, customer, and project team accept the project as completed.

Also create a written report reviewing the things that did and did not go well during the project so others can learn from this project for the benefit of future projects.

EXERCISE 8–2: REPORTS

The following suggestions describe the appropriateness and benefits of each type of report for the bathroom remodeling project.

Baseline Plan

It is always good to have a baseline report for the project schedule. You use it as a starting point, and then you show all progress on project work as a comparison against this baseline plan. This graphical report is easier for most people to read than a description containing only text and numbers.

Status Report

This status report shows the progress on project work as a comparison against the baseline plan described above. This is a good, standard report appropriate for this project.

Summary Schedule Status Report

This summary report is a simplified version of the previous report. It should be provided to those who only require summary information, such as upper management. It is a good practice to inform, but not overinform, each specific audience. However, if this is a homeowner bathroom remodeling project, there

are likely no levels of upper management that require summary information, and therefore, this report may not be needed in this situation.

Cost Report

A spreadsheet with cost information is a simple and informative report that is appropriate in this and nearly every type of project.

Cumulative Cost Report

This spreadsheet is also helpful in nearly every type of project, because it is always useful to see cumulative costs to date and the anticipated total costs at the completion of the project.

Cumulative Cost Line Graph

This graphical representation of the previous report is helpful to see at a glance the actual costs and projections. It is appropriate in this and nearly every type of project.

EXERCISE 8-3: PROJECT CLOSURE

The following are issues to consider upon closing the upgrade project for the order processing system for Blankets, Inc.

Project Work

Verify that all work has been accomplished as agreed upon. This would include verification that the software is performing according to specifications and at the predetermined quality level (in terms of bugs, response time, reliability, etc.). Also ensure that training has achieved its desired results so that employees are able to use the system efficiently.

Finances

Ensure that all payments have been made and finances reconciled. Any remaining project funds should be properly dispersed.

Project Documentation

Be sure that project plans have been revised to reflect the "as-built" condition, reflecting approved changes during the project. All final reports should be complete.

Personnel

Recognize individual efforts and celebrate project success. Complete employee evaluations, vendor evaluations, and customer satisfaction reviews. Be sure that team members have a smooth transition to other projects or work assignments.

Resources

Ensure that any remaining materials, facilities, equipment, and other resources are properly reallocated.

Lessons Learned

Be sure that you document the lessons learned from the project. Include information about what went wrong, what went well, the causes of issues and variances, the reasoning behind the corrective actions taken, and the results achieved. Make this documentation available to other project teams so they can benefit from what you've learned.
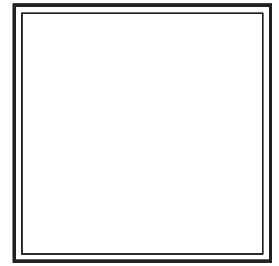
Appendix B
Glossary

Activity   A unit of work performed during a project. An activity usually has a duration, a cost, and resource requirements. Also called a *task*.

Activity estimate sheet   A form used to gather information needed to estimate a project activity.

Activity-on-node   A diagramming method that shows the activities in a node (box) with arrows showing the dependencies. Also called *precedence diagramming method*.

Actual cost (AC)   The cost incurred to complete the work that was actually performed in a given time period. Also called *actual cost of work performed* (*ACWP*).

Alternative course of action review   A review to identify other things that could be done to solve the problem or take advantage of the opportunity instead of the approach being taken by the proposed project.

Analogous estimate   A method of estimating that uses the actual costs and durations of previous, similar projects as the basis for estimating the current project. Also called *top-down estimating*.

Baseline   The original schedule or cost plan for the project, including approved changes. This is the basis from which actual performance is measured to determine variances.

Benchmarking   The process of defining a standard or point of reference to measure quality or performance.

Bottom-up estimate   A method of estimating that sums the cost and duration of the individual work packages.

Budget at completion (BAC)   The estimated total cost of the project when completed.

Budgeted cost of work performed (BCWP)   See *earned value* (*EV*).

Budgeted cost of work scheduled (BCWS)   See *planned value* (*PV*).

Budgeting   The process of allocating the cost estimates to work items to establish a cost baseline for measuring project performance.

Cause-and-effect diagram   A graphical representation of the relationships that exist between factors. Used to explore a wide variety of factors and the relationships among them that may cause them. Also called a *fish bone diagram.*

Change control   A formal process to manage proposed changes to the project plan. Includes processes for submitting, evaluating, approving, and communicating changes.

Conceptual review   A review to determine if the project fits within the organization's goals and if the project will solve the stated problem or appropriately take advantage of the current opportunity.

Contingency plan   A plan that describes the actions to be taken if a risk event should occur.

Contingency reserve   See *reserve.*

Contract, cost-plus   See *cost-plus contract.*

Contract, cost-reimbursable   See *cost-plus contract.*

Contract, firm-fixed-price   See *fixed-price contract.*

Contract, fixed-price   See *fixed-price contract.*

Contract incentives   Additional payments included in contract terms, such as completing work before a given date or controlling costs to a given level.

Contract, time-and-materials   See *cost-plus contract.*

Control charts   Graphs that display periodic results along with established control limits. They are used to determine if a process is in control or in need of adjustment.

Cost   The money and resources required to complete a project.

Cost budgeting   See *budgeting.*

Cost management   The process of comparing actual expenditures to the baseline cost plans to determine variances, evaluate possible alternatives, and take the appropriate action.

Cost performance index (CPI)   A ratio that measures cost efficiency by comparing budgeted costs to actual costs. In earned value analysis, the budgeted cost of work performed divided by the actual cost of work performed.

Cost-plus contract   A contract in which the vendor agrees to do the work for the cost of time and materials, plus an agreed amount of profit. Also called *cost-plus-fixed-fee, cost-reimbursable,* or *time-and-materials contract.*

Cost-reimbursable contract   See *cost-plus contract.*

Cost variance (CV)   The difference between the planned and actual cost of an activity. In earned value analysis, the difference between the budgeted cost of work performed and the actual cost of work performed.

CPM   See *critical path method.*

Crashing the schedule   Taking action to decrease the total project duration after analyzing the options to determine how to get the maximum compression for the least cost.

Critical activity   An activity on the critical path.

Critical chain   A scheduling technique that takes the results of the critical path calculations and applies resource availability. This provides a more realistic schedule that accounts for limited resources. Critical chain also adds buffers at critical points in the schedule to manage uncertainty.

Critical path   The path through the network that takes the longest total time, and therefore determines the earliest possible time the project can be completed. All activities on this path generally have zero float, meaning that the early and late start (and early and late finish) are the same.

Critical path method (CPM)   A technique used to estimate project duration. It analyzes which sequence of activities (which path) has the least amount of scheduling flexibility (the least amount of float).

Customer   A person or group that will use the result of the project (the product, service, or result).

Deliverable   Something delivered at the end of a project, such as a product, service, or result.

Duration   The number of work periods (such as hours, days, or weeks) required to complete an activity. Does not include holidays or other nonworking periods. Not the same as *effort.*

Early finish   The earliest date an activity can end.

Early start   The earliest date an activity can begin.

Earned value (EV)   The planned cost of work actually performed in a given time period. Also called *budgeted cost of work performed* (*BCWP*).

Earned value analysis   A method of measuring and evaluating project performance. It compares the amount of work planned with what is actually accomplished, to determine if the project is on track. Earned value analysis is also known as *variance analysis.*

Effort   The number of labor units required to complete an activity. Also called *work effort.* Not the same as *duration.*

Enterprise portfolio management   The practice of managing all projects of the organization as a portfolio.

Estimate at completion (EAC)   The expected total cost of the project when completed, including adjustments to the original estimate based on project performance to date. In earned value analysis, AC + ETC.

Estimate to complete (ETC)   The expected additional cost needed to complete the project, including adjustments to the original estimate based on project performance to date. In earned value analysis, (BAC − EV) / CPI.

Exception report   A report that shows only major deviations from the project plan, rather than all deviations.

Fast-tracking   Compressing the project schedule by changing the sequence of activities to allow activities to be done in parallel (at the same time) or to allow some overlap.

Feasibility study   A review to determine if the project can realistically be accomplished.

Finish-to-finish activity relationship   A dependency between activities where one activity must finish before the other can finish.

Finish-to-start activity relationship   A dependency between activities where one activity must finish before the other can begin.

Firm-fixed-price contract   See *fixed-price contract.*

Fish bone diagram   See *cause-and-effect diagram.*

Fixed-price contract   A contract in which the vendor agrees to do the total work for a fixed price. Also called *firm-fixed-price contract* or *lump-sum contract.*

Float   The amount of time an activity can slip without delaying the project finish date. It is equal to the difference between the early start and late start (or the difference between the early finish and late finish). Also known as *slack, total float*, and *path float.* See also *free float.*

Flowchart   A quality management tool that provides information about process flow.

Free float   The amount of time an activity can slip without delaying the early start of any activity that immediately follows it. See also *float.*

Functional manager   A person assigned to manage a specific function (such as accounting, manufacturing, or marketing) and to provide technical direction. Also called *resource manager.*

Functional organization   A hierarchical organizational structure where each functional division has its own project managers who operate independently from project managers in other divisions.

Gantt chart   A bar chart of schedule information, typically with dates across the horizontal axis, activities listed down the vertical axis, and activity durations shown as horizontal bars under the appropriate dates.

Incentives   See *contract incentives.*

Integration management   The processes required to ensure that the various elements of the project are properly coordinated.

Internal rate of return   A profitability measure that represents an average rate of return for the project, expressed as a percentage.

Lag   The time delay between the start or finish of one activity and the start or finish of another activity. When expressed as a negative number, lag indicates an overlap in the activities and is also called *lead*.

Late finish   The latest date an activity can end and still allow the project to be completed on time.

Late start   The latest date an activity can begin and still allow the project to be completed on time.

Lead   The time overlap between the start or finish of one activity and the start or finish of another activity. See also *lag*.

Logic network diagram   See *network diagram*.

Lump-sum contract   See *fixed-price contract*.

Management reserves   See *reserves*.

Matrix organizational structure   An organizational structure that is a blend of functional and project organization. The project team reports both to a project manager (who provides project management skills) and a functional manager (who provides specific job-related skills).

Milestone   An activity that defines the completion of a major deliverable or group of activities. A milestone has no duration, cost, or resource requirements.

Milestone schedule   A schedule that includes only significant (milestone) activities. Also called a *summary schedule*.

Mitigation plans   Steps taken to lower the probability of the risk event happening or to reduce the impact should it occur.

Network diagram   A graphical flow plan of the activities that must be accomplished to complete the project. It shows the planned sequence of steps, time requirements, interdependencies, and interrelationships. Also called *precedence diagram*.

Objectives   The statement of cost, time, and scope required to complete a project.

Opportunity cost   The cost of choosing one alternative (project) and, therefore, giving up the potential benefits of another alternative (project).

Parallel activities   Two or more activities that occur at the same time. Also called *concurrent* or *simultaneous activities*.

Parametric estimate   A method of estimating that uses mathematical parameters (such as a dollar amount per square foot) to predict project costs.

Pareto chart   A bar chart with elements arranged in descending order of importance, generally by magnitude of frequency, cost, or time. Used to focus attention on the most critical issues.

Pareto Principle   The concept that a vital few elements (20%) account for the majority (80%) of the problems.

Path float   See *float*.

Payback period   The number of periods (usually years) until cumulative revenues exceed cumulative costs, so that the project "turns a profit."

Percent complete   A method of reporting where the amount of work completed on an activity is expressed as a percent of the total work required for the activity.

PERT   See *Program evaluation and review technique*.

Planned value (PV)   The planned cost of work scheduled to be done in a given time period. Also called *budgeted cost of work scheduled* (*BCWS*).

Portfolio   A collection of projects or programs that are managed together, and usually prioritized against larger strategic organizational objectives.

Precedence diagram   See *network diagram*.

Precedence diagramming method (PDM)   A network diagramming method that shows the activities in a node (box) with arrows showing the dependencies. Also called *activity-on-node*.

Predecessor activity   An activity that occurs before another activity in a project.

Preliminary risk review   An initial review of the potential risks involved in a project to determine if the expected benefits of the project are worth the risk.

Program   A group of related projects that are managed together for increased benefit and control.

Program evaluation and review technique (PERT)   A technique used to estimate project duration. It uses the critical path method and a weighted average of estimates for each activity. See also *three-point estimate*.

Program management   The centralized or coordinated management of a program (or group of related projects). Programs are often tied to larger organizational objectives.

Project   "A temporary endeavor undertaken to create a unique product, service, or result." A project has a definite beginning and end. (See *A Guide to the Project Management Body of Knowledge* (*PMBOK® Guide*), p. 4.)

Project charter   A document that formally authorizes the project, explains the business need the project addresses, states the project objectives (time, cost, and scope), and defines the approvals and authority granted by the client or senior management.

Project closure   Formal steps taken at the conclusion of a project to get acceptance of the final product, close project records, and reallocate personnel and other resources.

Project management   A set of principles, methods, and techniques used to effectively plan and manage project work.

Project manager   The person assigned to manage a specific project, and is expected to meet the approved objectives of the project, including project scope, budget, and schedule.

Project objectives   See *objectives.*

Project organization   An organizational structure in which an autonomous division of project managers is responsible for planning, managing, and reporting the progress of all projects in the organization.

Project plan   A document or website that contains the project charter, schedules, project scope statement, resource plans, budget plans, risk management plans, monitoring and management plan, change control processes, project evaluation plan, project reporting plan, project closure plan, etc.

Project scope statement   The documented narrative description of the scope of a project.

Project sponsor   The person or group that requests a project.

Quality assurance   The process of evaluating project performance to ensure compliance with quality standards.

Reserves   Provisions in the project plan to mitigate the impact of risk events. Usually in the form of contingency reserves (funds to cover unplanned costs), schedule reserves (extra time to apply to schedule overruns), or management reserves (funds held by general management to apply to projects that overrun).

Resource   Funds, personnel, equipment, facilities, or materials needed to complete an activity or a project.

Resource histogram   A chart showing the commitment of resources over a period of time.

Resource leveling   Taking action to minimize the peaks when resources are overallocated.

Resource management   The process of comparing actual performance to the resource plans to determine variances, evaluate possible alternatives, and take the appropriate action.

Resource manager   See *functional manager.*

Responsibility assignment matrix   A chart that relates skill requirements to people (or groups of people).

Return on assets   A measure of net profit divided by total assets.

Return on investment   A measure of net profit divided by total investment.

Return on sales   A measure of net profit divided by total sales.

Risk management   The process of identifying possible risks, making preventive and contingency plans, and executing those plans when risk events occur.

Risk management plan   A plan that documents the procedures that will be used to manage risk throughout the project.

Risk review, preliminary   See *preliminary risk review.*

Rolling wave estimate   A method of estimating that provides a gross estimate for the entire project and periodically calculates detailed estimates for the next short period of time.

Rule of seven   A rule of thumb in control charting indicates that when seven or more points in a row occur on the same side of the mean, or when they tend in the same direction—even though they may be within the control limits—they should be investigated.

Schedule performance index (SPI)   A ratio that measures schedule efficiency by comparing work performed to work scheduled. In earned value analysis, the budgeted cost of work performed divided by the budgeted cost of work scheduled.

Schedule reserves   See *reserves.*

Schedule variance (SV)   The difference between the scheduled and actual completion of an activity. In earned value analysis, the difference between the budgeted cost of work scheduled and the budgeted cost of work performed.

Scope   A description of the features and functions of the end products or services to be provided by the project.

Scope creep   The tendency for scope to increase during the course of the project without proportionate increases in time or cost.

Scope management   The process of comparing actual performance to the scope statement to determine variances, evaluate possible alternatives, and take the appropriate action.

Scope statement   A narrative description of the project objectives, including justification for the project, description of the product or service to be created, and a list of the project deliverables.

Scope verification   The process of confirming that all project deliverables have been accomplished as agreed upon.

Sequential activities   Two or more activities that occur one after the other. Also called *consecutive activities.*

Simulation estimate   A method of estimating that calculates multiple costs or durations with different sets of assumptions.

Slack   See *float.*

Stakeholders   People who are affected by or have an interest in the project, including project sponsors, senior management, middle management, functional managers, project managers, project team members, customers, and vendors.

Start-to-finish activity relationship   A dependency between activities where one activity must begin before the other can finish.

Start-to-start activity relationship   A dependency between activities where one activity must begin before the other can begin.

Statement of work   A narrative description of the work to be accomplished. A general statement of work may apply to the entire project, while a more specific statement of work may apply to a project activity or the work of an individual team member.

Successor activity   An activity that occurs after another activity in a project.

Summary schedule   A schedule that includes only significant (milestone) activities. Also called a *milestone schedule*.

Task   See *activity*.

Team members   The people who work with the project manager directly or indirectly to accomplish project goals and complete project activities.

Three-point estimate   A weighted estimating formula that uses three points: *most likely* (m), *optimistic* (o), and *pessimistic* (p), with an emphasis on the most likely. The formula is (o + 4m + p) / 6.

Time   The time required to complete a project.

Time-and-materials contract   See *cost-plus contract*.

Time management   The process of comparing actual schedule performance to the baseline schedule to determine variances, evaluate possible alternatives, and take the appropriate action.

Total float   See *float*.

Trend analysis   The use of mathematical techniques to forecast future outcomes based on historical results.

Trigger   An occurrence or condition that causes an event to happen.

Unit-price contract   A contract in which the vendor agrees to a preset amount per unit of service (for example, $90 per hour).

Work breakdown structure   A hierarchical breakdown of activities and end products that organizes and defines all work to be completed in a project.

Work effort   The number of labor units required to complete an activity. Also called *effort*. Not the same as *duration*.

Work packages   The deliverables in the lowest level of the work breakdown structure. A work package may be divided into the specific activities to be performed.

Workaround   The response to an unplanned risk event.

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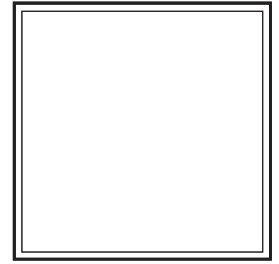
Appendix C
Organizations
and Websites

Organizations

Project Management Institute (PMI®) (14 Campus Boulevard, New-town Square, PA 19073-3299 USA, phone 610-356-4600, *www.pmi.org*, e-mail: customercare@pmi.org) establishes project management standards, provides seminars, educational programs, and the PMP® professional certification. Founded in 1969, this professional organization has more than a half million members and credential holders from over 170 countries.

International Project Management Association (IPMA) (P.O. Box 1167, 3860 BD Nijkerk, The Netherlands, phone: +31 33 247 3430, *www.ipma.ch*, e-mail info@ipma.ch) is a nonprofit organization founded in 1965 that is an international umbrella organization for national project management associations from more than 40 countries worldwide. They represent their members on the international level. IPMA provides standards and certification programs.

American Management Association (1601 Broadway, New York, NY 10019, phone: 877-566-9441, *www.amanet.org*, e-mail: customerservice@amanet.org) is a world leader in professional development, advancing the skills of individuals, teams, organizations, and government agencies. AMA promotes the goals of individuals and organizations through a comprehensive range of solutions, including over 140 business seminars, blended learning, Webcasts and podcasts, conferences, books, whitepapers, articles, and more. AMA's publishing arm, AMA-COM, is one of the world's largest publishers of books on project management.

George Washington University, in association with **Educational Services Institute** (phone: 202.994.1212, e-mail mspminfo@gwu.edu), offers a Master of Science degree in project management.

University of Phoenix (phone: 866-766-0766, *www.phoenix.edu*) has campuses in many states and online programs. Offers a bachelor of science degree in project management.

ProjectWorld (phone: 888.670.8200, *www.ProjectWorld.com*) hosts events that combine a practical education in project management with a world-class exposition hall to meet the needs of today's project and business professionals.

Websites

American Management Association, *www.amanet.org*

Project Management Institute, Inc., *www.pmi.org*

The Standish Group International, *www.standishgroup.com*

Gantthead.com, *www.gantthead.com*

PMboulevard, *www.pmboulevard.com*

@task, *www.attask.com*

Whatis.com, *whatis.techtarget.com*

The Improvement Encyclopedia, *www.syque.com/improvements/a_encyclopedia.htm*
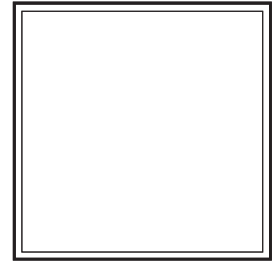
Value Based Management.net, *www.valuebasedmanagement.net*

Project Management Center, *www.projectman.org*

Project Connections, *www.projectconnections.com*

PROJECTMANAGEMENT.com, *www.projectmanagement.com*

PMForum, *www.pmforum.org*

Appendix D
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Index